TUESDAY, SEPTEMBER 10, 2019 MEETING

DATE & TIME: 9/10/19 | 6:00pm - 8:30pm

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

MENTORS: Mr. Prettyman, Nick

AGENDA
Welcome Rhyme Know Reason and Logics & Lyrics
Review Team member's slides
Watch Kickoff Video—assemble Field in lab
Review Game Rules
Brainstorming/Planning session!

TIMELINE REVIEW

Brainstorming	9/10 - 9/17
CAD	9/21 - 10/12
Building chassis	Finished by 9/28

MECHANICAL ACCOMPLISHMENTS

General Planning:

For a better understanding of the game, we identified the various point-scoring objectives, broke them down into steps, and listed general solutions (not designs) for the objectives. Using this, we can prioritize different objectives based on its point value and predicted difficulty.

OBJECTIVES	STEPS	MECHANISMS/SOLUTIONS
1) Moving the foundation ● 10 pts (Auton) ● 15 pts (EG)	1) Control foundation (Push/Pull) 2) Move Foundation	1) - Clamp (Push/Pull) - Plow/Bulldozer (Push) - Hooks (Pull) 2) - Line Detection* - Vuforia Localization* - Odometry*
2) Delivering stones ● 10 pts (A. Skystone)	1) Identify Skystone* 2) Intake stone	1) - Camera 2) - Rollers

• 2 pts (A. Stone) • 1 pts (TO Stone)	3) Move under bridge	- Surgical Tubing/Zip tie - Claw - Plow/Bulldozer (Push) 3) - Line Detection* - Vuforia Localization* - Odometry*
3) Scoring Stones • 4 pts (A. Stone) • 1 pts (TO Stone)	1) Transfer Stone (Intake -> Scorer) 2) Dispense	*9/14/19* 1) - Claw (Grab) - Passthrough/Intake in 2) - "Pez" dispensing (random, no accuracy) - Elevator "firetruck" approach - Reverse stacking - Claw (Place)
4) Stacking Stones • 2 pts/level in Highest Skyscraper	1) Identify location of placement 2) Transfer Stone (Intake -> Scorer) 3) Re-orientate Stone 4) Lift Stone 5) Place Stone	*9/14/19* 1) - Driving "normally" - Assisted Driving (Automated) 2) Refer to Scoring Stones 3) - Claw Manipulation - Drive to Position - Orient from the top 4) - Reverse Stack - Normal Stack 5) - Single Stack - Double Stack
5) Capstone Scoring • 5 pts (Capping) • 1 pt/Level (Level Bonus)	1) Retrieve Capstone 2) Lift Capstone 3) Place Capstone	

*These steps/mechanisms are autonomous-specific.

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

MOVING FOUNDATION

DEFINE PROBLEM: IDENTIFY POINT VALUE AND LIST STEPS

Moving the Foundation into Building Zone in Autonomous gives **10 points.**
Moving the Foundation outside the Building Zone in End Game gives **15 points.**

The necessary steps we listed in order to complete this objective are:

1) Control foundation (Push/Pull)
2) Move Foundation

GENERATE CONCEPTS: GENERAL SOLUTIONS FOR MOVING FOUNDATION

There are 3 overall categories for mechanisms that can control the Foundation:

1) Clamps (for Pushing and Pulling motions)
2) Plows and Bulldozers (for Pushing motions)
3) Hooks (for Pulling motions)

There are 3 general solutions to successfully moving the foundation into the building zone in Autonomous:

1) Line Detection
2) Vuforia Localization
3) Odometry

These can help us categorize our brainstorming during our more specific brainstorming session.

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

DELIVERING STONES

DEFINE PROBLEM: IDENTIFYING POINT VALUE & LIST STEPS

Delivering the Skystone underneath the Sky Bridge and completely in the Building Zone in Autonomous gives **10 points** (if it is one of the first two Delivered Skystones)
Delivering Stones underneath the Sky Bridge and completely in the Building Zone in Autonomous gives **2 points.**
Delivering Stones underneath the Sky Bridge and completely in the Building Zone in Tele-Op gives **1 point**

The necessary steps we listed in order to complete this objective are:

1) Identify Skystone (for Autonomous)
2) Intake Stone
3) Move under bridge

GENERATE CONCEPTS: GENERAL SOLUTIONS FOR CONTROLLING FOUNDATION

One general solution for Identifying the Skystone (for Autonomous)

1) Camera Identification

There are 4 overall categories for mechanisms that can intake the Stones:

1) Rollers
2) Surgical Tubing/Zip tie
3) Claw
4) Plow/Bulldozer (Pushing)

There are 3 general solutions to successfully moving completely into the Building Zone.

1) Line Detection
2) Vuforia Localization
3) Odometry

These can help us categorize our brainstorming during our more specific brainstorming session.

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

SCORING STONES

DEFINE PROBLEM: IDENTIFYING POINT VALUE & LIST STEPS

Scoring Stones onto the Foundation in Autonomous gives **4 points per Stone.**
Scoring Stones onto the Foundation in Tele-Op gives **1 points per Stone.**

The necessary steps we listed in order to complete this objective are:
1) Transfer Stone (from Intake To Scoring Mechanism)
2) Dispense Stone onto Foundation

GENERATE CONCEPTS: GENERAL SOLUTIONS FOR TRANSFERRING AND DISPENSING THE STONE

There are 2 overall categories for mechanisms that can Transfer the Stone:
1) Claw/Grabbing (no transfer, just carrying stone)
2) Pass through/Intaking (using an internal storage to move the stone)

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

STACKING STONES

DEFINE PROBLEM: IDENTIFYING POINT VALUE & LIST STEPS

Stackings Stones onto the Foundation in Tele-Op gives **2 points per level. (of the highest *Skyscraper*)**

The necessary steps we listed in order to complete this objective are:
1) Identify Location of Placement
2) Transfer Stone (from Intake to Stacking Mechanism)
3) Re-orientate Stone
4) Lift Stone
5) Place Stone

GENERATE CONCEPTS: TESTING LIFTING CONCEPT

Bryan and Jonas were discussing concepts on different ways to lift the Stone.
Bryan noticed that the smallest mechanism would lift the Stone from between the two protruding extrusions. He quickly tested and demonstrated this concept using compliant wheels to provide pressure and friction.

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

SCORING CAPSTONES

DEFINE PROBLEM: IDENTIFYING POINT VALUE & LIST STEPS

Scoring Capstones onto the Foundation gives **5 points per Capstone.**
Stacking Capstones onto the Foundation gives **1 points per level.**

The necessary steps we listed in order to complete this objective are:

1) Control Capstone
2) Lift/Place Capstone

GENERATE CONCEPTS: GENERAL SOLUTIONS FOR TRANSFERRING AND DISPENSING THE STONE

The Capstone can either stay in the robot, or controlled later from the Depot.
It is possible to use the same mechanism for Stone Stacking/Scoring for the Capstone.

Our plan is to use two chassis.

1) Our competition chassis will be primarily used by programmers during the early season. After mechanisms have been designed and built, we would transfer them to this chassis and conduct QA (Quality Assurance) tests led by Rohan.
2) Our secondary chassis will be used by the builders for testing new mechanisms and potentially for use at meets in the early season.

PRUSA I3 MK2 TO MK2.5 3D PRINTER UPGRADE

- Ian continued to on the extruder assembly by mounting the extruder and started wire organization:
  - Ian completed steps 31 to 45

NON-TECHNICAL DISCUSSION

Notable change for Delaware States Qualification: Only ONE team qualifies to World's through Delaware: the 1st Place Inspire Winner

1. PA States is before Delaware States so it would be nice to qualify through PA.
2. This places an important focus on award categories, as winning the Inspire Award is the only way to qualify to World Championships through Delaware.
3. If the quality of Delaware teams continues to improve, we will hopefully be able to raise this number of qualifying spots. To help this, we will continue to collaborate and share ideas with teams in our local region and nationally.

Teams #8528 Rhyme Know Reason and #13467 Lyrics & Logic visited our meeting.

They were not able to make it the Delaware Kickoff, so we watched the Skystone video together to get everyone familiar with the game.

More information on this outreach can be found on **E11.**

Patrick took some time to mentor Isha on CAD basics. She learned about mating and flush constraints. Also, she learned the various functions that CAD provides when creating parts and assemblies. She also was given advice on how to learn CAD at home efficiently.

MEETING SUMMARY

- First Meeting after Kickoff
- Establish Season Timeline
- Host brainstorming w/ Rhyme Know Reason and Lyrics & Logic
- General Planning

SATURDAY, SEPTEMBER 14, 2019 MEETING

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

STUDENTS: Rohan, Isha, Helen, Karthik, Jonas, Katy, Marcus, Ian, Aidan, Paige, Suraj

MENTORS: Ron Prettyman, Andrew Szeto

AGENDA
Finish Brainstorming session and generate concepts for all game elements
Test Stacking Strategies/Patterns
Review CAD/Build Chassis
Brainstorm Autonomous Objectives

TIMELINE REVIEW

Brainstorming	9/10 - 9/17
CAD	9/21 - 10/12
Building chassis	Finished by 9/28

MECHANICAL ACCOMPLISHMENTS

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

SCORING STONES

GENERATE CONCEPTS: GENERAL SOLUTIONS FOR TRANSFERRING AND DISPENSING THE STONE

There are 4 overall categories for mechanisms that can Transfer the Stone:

1) "Pez" Dispensing (no accuracy, spits out stone anywhere)
2) Elevator/"Firetruck" Approach (elevate Stone with linear slide to the top of the Skyscraper)
3) Reverse Stacking (lift tower and stack Stone directly on foundation)
4) Claw (directly place Stone onto the top of the Skyscraper)

These can help us categorize our brainstorming during our more specific brainstorming session.

STACKING STONES

GENERATE CONCEPTS: GENERAL SOLUTIONS FOR STACKING STONES

There are 2 overall methods that can help the robot find its location:

1) Driving “Normally”
2) Using automation to combine with the driver (assisted driving)

For the transferring of stones, refer to scoring stones

There are 3 overall methods that can help the robot reorient the stone structure:

1) Claw (driving to the position)
2) Horizontal Stacking to Vertical Position (laying blocks out on the floor and flipping them up 90 degrees)
3) Orienting from the top of the stone (the two cylindrical obtrusions on the top that can be grabbed)

There are 2 overall methods that can help the robot lift the stones/stacked structure:

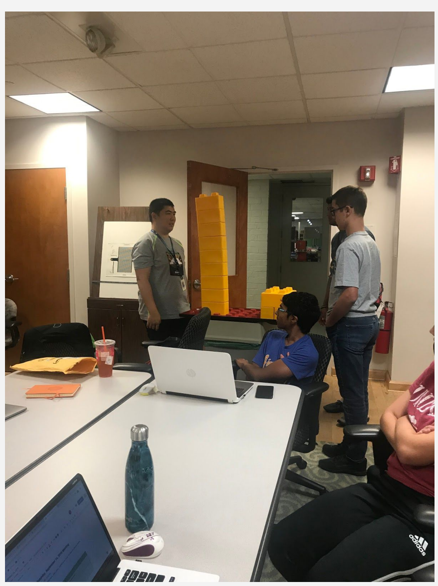
1) Reverse stack (lifting already stacked structure to place the new stone underneath)
    a) Max. 6 stones
2) Normal stack (stacking stones on top)
    a) Max. 9 stones
    b) Safer

Time Restrictions:

1) 6 second cycle time per stack if stones are delivered by alliance
2) 10 second cycle time per stack if the same robot delivers and stacks every Stone

There are 2 overall methods that can help the robot place the stones on stacked structure:

1) Single Stack
    a) Max. 9 stones/9 levels
2) Double Stack
    a) Max. 16 stones/10 levels


The first two pictures above demonstrate an unstable stacked structure.

The third structure was discussed by the team as more ideal, providing a stable foundational structure to single stack in the upper half of the Skyscraper (second half of the game). The ideal Skyscraper utilizes 9 stones and includes 7 levels in order to ensure there is a stable structure that can be built during the tele-op time period and moved back to the starting foundation position.

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

CHASSIS

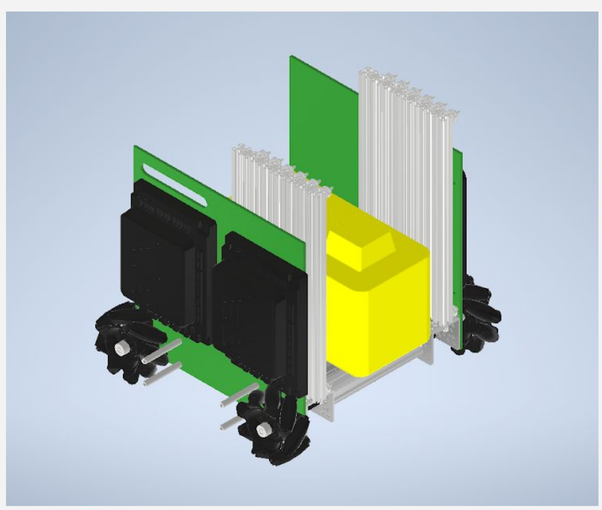
DEFINE PROBLEM: ASSIGN PRIORITY

We noted that having two chassis with odometry was high priority. Making a prototype and competition chassis right away will increase our ability to test mechanisms, and we already made a design prior to the meeting.
Odometry will vastly improve autonomous accuracy, so it was placed at a high priority.

DEVELOP A SOLUTION: CHASSIS CAD (PRE-MEETING)

We decided we wanted a small chassis because we felt as if there is no need to create a big robot. This way we have more space on the outside of the robot for other mechanisms. We definitely wanted to be under 14 inches in height in order to drive under the Team Bridges. We chose mecanum wheels because of the reliability, simplicity, and our comprehension with mecanum wheels.

We were able to slim the frame down by making certain decisions
1. Smaller Mecanum Wheels: The REV wheels has basically has half the width of the Nexus Wheels that we previously ordered
2. Belt-based Drive-Train: Since we are able to house the pulleys and belts in between the Actobotics C-Channel, we save space.



We are also using a more reliable motion system because of:
1. Hex Axles: These make your motion less reliant on set screws, thus they are more robust after long days of driving
2. Bearings: Using Bearings instead of Bushings create a much lower friction motion system.
3. Ball-Bearing Based Mecanum Wheels: Similarly as above, strafing with mecanum wheels will be much smoother because of the bearings.
4. Face Mounted Motors: This allows for a more consistent motor orientation, which makes the motion

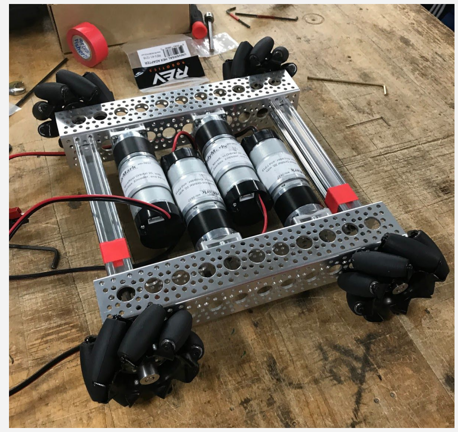
system less likely to misalign.

5. Belts: These are slightly elastic which gives more compliance in the transmission

FABRICATE AND INTEGRATE: CHASSIS BUILD

When working on building the chassis we used the CAD for reference. This chassis for this year is going for a smaller design than previous years. This is so we could add more mechanisms later as the year goes. When starting the chassis, we measured everything to make sure our CAD was as close to the measurements as the physical version of it. During the process there were little to no problem that we came across. The only one, was to measure the motors apart. This was to make sure we can fit as much as we possibly can so we can add more to these chassis later in the season.

We built two chassis (same design) so we could have a programming chassis and a secondary chassis.



The programming chassis will be the main competition chassis. The programmers will have the robot, and only complete mechanisms will go on to this robot.
The secondary chassis for testing prototype and to see if a mechanism can integrate well onto the robot.

PROGRAMMING ACCOMPLISHMENTS

General Autonomous Planning:

For a better understanding of the goals for the autonomous period, we identified the various objectives and steps necessary to accomplish these objectives, as well as additional accomplishments and the required sensors.

OBJECTIVES	STEPS
1) Moving the foundation ● 10 pts (Auton) ● 15 pts (Endgame)	1) Move Foundation 2) Clamp onto Foundation 3) Move Foundation (Endgame)
2) Detect stones	1) Positioning to detect Skystones 2) Detect Skystones
3) Deliver stones ● 1 pt (under skybridge)	1) Move to stone 2) Harvest stone 3) Move to Building zone
4) Placing stones ● 2 pts/level in Highest	1) Move to foundation 2) Put stone on foundation

Skyscraper	
5) Stacking stones	1) Move to foundation 2) Localize relative to foundation 3) Orient stone 4) Place stone
6) Parking	1) Move to alliance bridge
7) Movement*	1) Localize 2) Create path to end destination 3) Follow path

*Tool for objectives

Outline/Routine for One Robot Autonomous

STEPS	OVERALL SENSORS REQUIRED
1) Start on Quarry Side	- Front camera
2) Identify Skystone	- Gyro
3) Move to Skystone	- Odometry
4) Harvest Skystone	- Motor encoders
5) Drive to Building Zone	- Back camera
6) Detect Foundation Location	
7) Move to Foundation	
8) Drop Skystone on Foundation	
9) Move Foundation to Building Site	
10) Move to site	
11) Repeat steps for second Skystone	
12) Park Under SkyBridge	

PRUSA I3 MK2 TO MK2.5 3D PRINTER UPGRADE

- In the last meeting of the printer upgrade, Ian added the idler piece with the Bondtech gear to the 3D printed extruder body and also installed the extruder motor with the other Bondtech gear onto the 3D printed extruder body. Then, he also installed the filament optical sensor into the extruder body
- I continued assembling the extruder
    - Andrew helped Ian inserted the E3D hot end and heat break into the 3D printed extruder body.
    - Then, They put the 3D printed extruder cover around the extruder hotend and screwed it the 3D printed extruder body.
    - After that, they installed the square fan to the left side of the extruder as a hotend cooling fan. They also installed the cooling fan shroud, the 45-degree fan support to angle the fan at the right angle for the shroud opening, and the circular fan. This fan and shroud are to cool the filament that was extruded so it can support the next layer of the print.
    - Next, I installed the p.in.d.a probe 2 onto the 3D printed extruder body.
    - Then, I tried to mount the completed extruder onto the 3D printed x-axis carriage by screwing the extruder into the x-axis carriage. But, when I was trying to screw it in the screws were not going in the extruder body and toughening.

NON-TECHNICAL DISCUSSION

- Possibility of competing in a Maryland qualifier to increase competition opportunities
- Future outreach plans and ideas

MEETING SUMMARY

- Finish Preplanning for Objectives
- Brainstorm Autonomous Period
- Start Building Chassis

TUESDAY, SEPTEMBER 17, 2019 MEETING

DATE & TIME: 9/17/19 | 5:00-8:30 PM

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

MENTORS: Mr. Prettyman, Nick, Andrew

AGENDA
Review team members' slides
Look at team role organization chart
Upcoming deadlines
Continue brainstorm/design phase

TIMELINE REVIEW

Brainstorming	9/10 - 9/17 - finish majority today
CAD	9/21 - 10/12
Building chassis	Finished by 9/28

MECHANICAL ACCOMPLISHMENTS

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

SCORING STONES

DEFINE PROBLEM: INTAKE MECHANISM CONSTRAINTS/CRITERIA

Patrick, Aidan, Marcus, and Connor worked on brainstorming the intake mechanism. First, we looked at our goals and criteria.

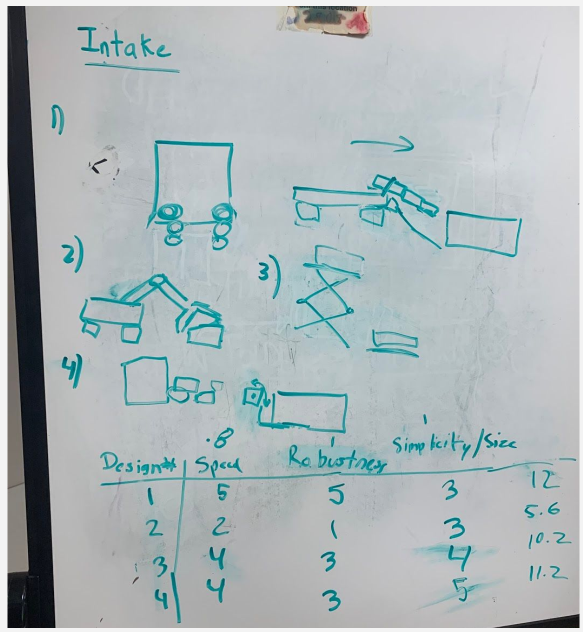
Criteria:	Description:
Speed	Must be fast, smooth harvesting
Robustness	Be able to harvest from different angles, eliminate driver error

Simplicity	Must be simple to construct/fix
Size	Must fit onto chassis

Constraints	Description:
Number of motors/servos	1-2 motors (preferably 1)

GENERATE CONCEPTS: INTAKE BRAINSTORMING

1. Wheeled Intake - Spinning Rollers on the outside of the robot to intake Stones
2. Arm Intake - a jointed arm with a claw at the end that can grab Stones
3. Scissor lift - Align lift underneath stone and raise the Stone
4. Scooping Intake - Align scoop underneath the Stone and scoop into the robot



Using the criteria defined above, we made a design weighted design matrix (seen in Picture above)

Speed we did not weight as heavily (x.8) because we could possibly intake while moving. This means that a faster intake speed does not contribute too much to our overall cycle time.

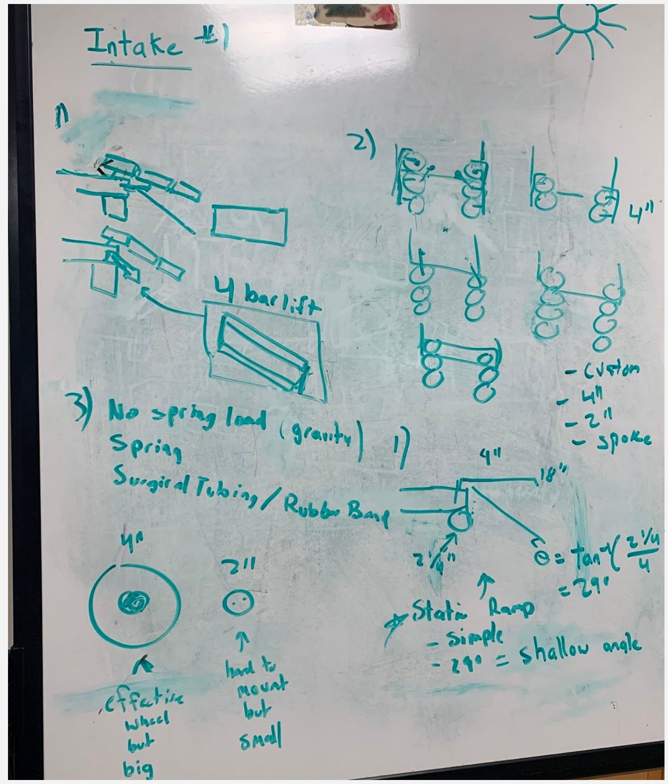
Robustness we defined as how easy it is to harvest the Stones using the mechanism. This contributes heavily to our overall cycle time because drivers would not have to spend time lining up, so we weighted it x1.

Simplicity/Size we grouped together because we decided that size is not as important as a criteria because of the large space we already allocated for it. Simplicity is important so we weighted it x1.

The Wheeled Intake ranked the highest using our design matrix, so we decided to explore this concept further

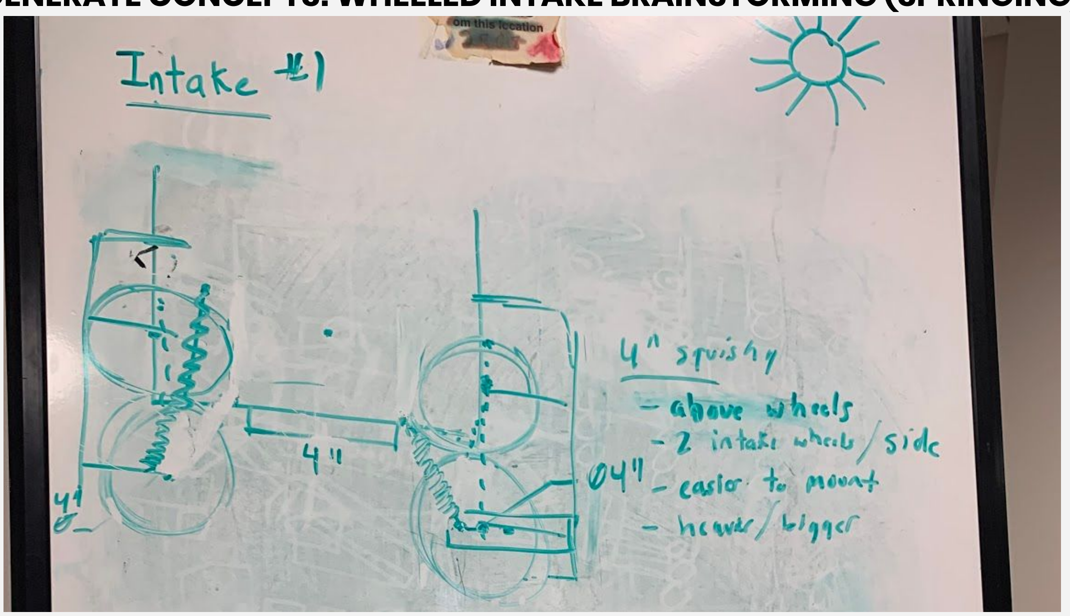
GENERATE CONCEPTS: WHEELED INTAKE BRAINSTORMING

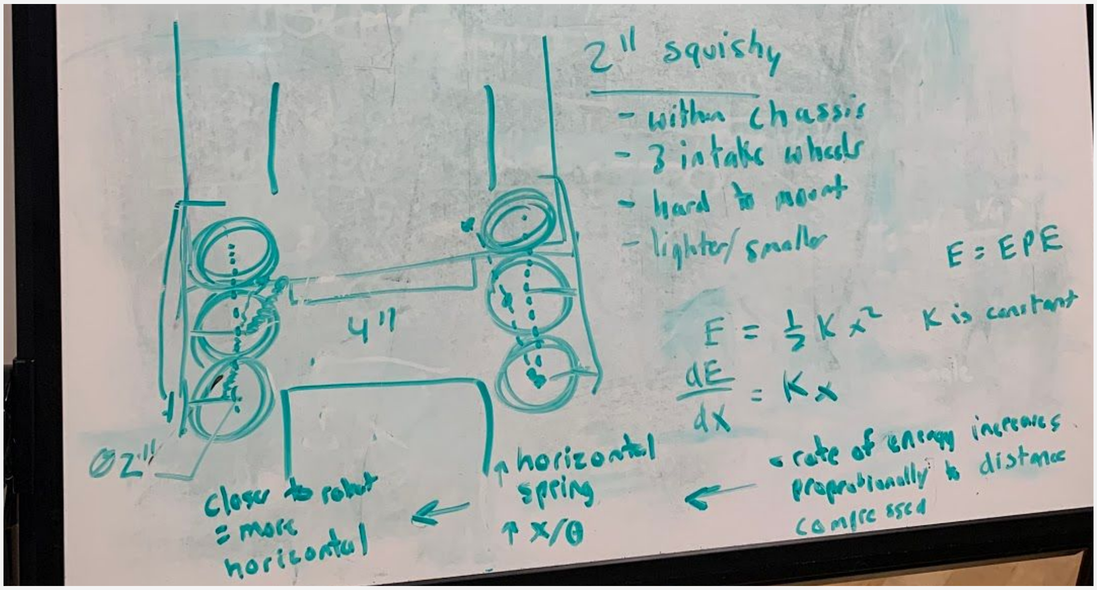
1) **Ramping**
   The Stone starts on the ground, and has to get inside of the robot. To accomplish this, there needs to be a mechanism, passive or active, to assist the Stone's vertical motion. One idea is a permanent ramp. We calculated that the shallowest angle we can have is 29° if the ramp extended out the 4 inches that we allocated for the intake. (math found in picture)
   Another idea is a mechanism, such as a 4 bar lift, that lifts the Stone from the front of the robot and puts it into our robot.
   A third idea is a dead wheel in the front of the robot, so when we harvest, the stone rolls up the dead wheel and into our robot
2) **Wheel Type**
   Different wheels and the number of wheels can drastically change our harvesting ability. We saw that 4" wheels only allow us to have 2 wheels out, but 2" wheels allow us to have 3. We might do a combination of both or use a custom solution for our wheel design.



3) **Springing Type**
   We want compliance when intaking, so a springing mechanism would allow for better robustness. We can use springs or surgical tubing, or just have it gravity-based

GENERATE CONCEPTS: WHEELED INTAKE BRAINSTORMING (SPRINGING)





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

STACKING STONES

DEFINE PROBLEM: OUTTAKE MECHANISM CONSTRAINTS/CRITERIA

The objective is to to bring stones from the robot into a stacked position. To accomplish this, we will need two components.

Overview

- Lift
    - Must transport stone at least 32-47 inches above the foundation
- Placer/Stacker
    - Will likely be attached to the lift
    - Will hold and release the stone

GENERATE CONCEPTS: LIFT MECHANISM BRAINSTORM

Bryan, Isha, Clare, and Jonas began by making a design matrix to help us determine which solution would work the best. After determining weights and requirements, we ranked each option based on each category.

Considerations	Rank #	Weight (pts. out of…)	Requirements
• Max extension/Size • Speed • Simplicity • Consistency*	4 5 2 1	12.5 12.5 17.5 20	- Under 14 inches - Weight? (under 42 lbs) - Fit within chassis - Goal: extension of 32”

• Weight • Prior experience	6 3	10 15	minimum

* Our team experienced many difficulties with our lift breaking last season, so we would like to emphasize reliability and durability.

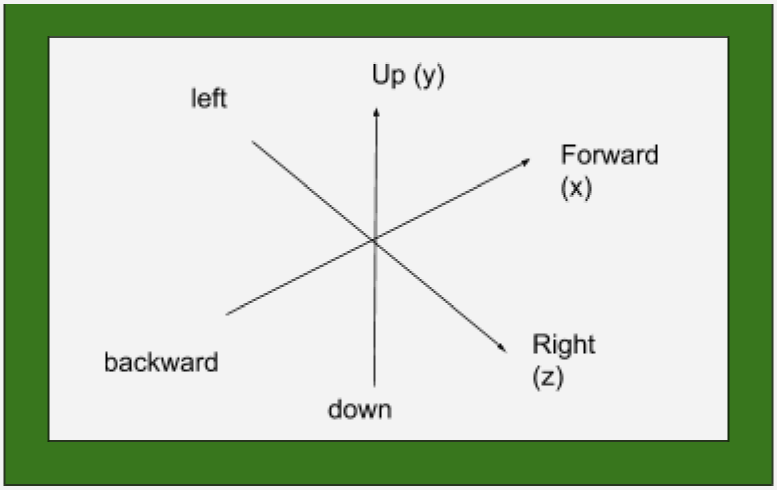
	Arm	Linear Slide	DR4B	Scissor Lift	Rack and Pinion	Linear Actuator	Elevator Lift
Max extension	6	12.5	12.5	12.5	4	3	2
Speed	6	10	9	9	6.5	8	9.5
Simplicity	15	12	8	10	15	17.5	14
Consistency	7	18	15	15	17	20	17
Weight	9	7	8	8	9	7	7
Experience	5	8	4	3	8	9	5
Total	48	67.5	56.5	57.5	59.5	64.5	54.5

The result of the lift brainstorming shows that the linear actuator is the best option, followed by the linear actuator and the rack and pinion. However, we are concerned that the limited lift of both the linear actuator and rack and pinion may make it incompatible with our design needs. This means that we will initially try a design with a linear slide.

GENERATE CONCEPTS: PLACER/STACKER BRAINSTORM

For the placing stacking mechanism, we also brainstormed requirements and wants.

Universal coordinate system:
Up/down: y value
Right/left: z value
Forward/backward: x value



Requirements	Preferences (Nice but not essential)

• Pick up from inside robot
• Rotate the stone (to be able to stack parallel or perpendicular to the robot's orientation)
• Move in x direction (forward/backward)
• Parallel to stack when stacking
  ○ Active pitch OR
  ○ 4 bar
	• Roll the stone (to make stacking at a height easier)
	• Movement in z direction (right/left)
	• Movement in y direction (up/down)
	• Elastically bound grabbing mechanism

PROGRAMMING ACCOMPLISHMENTS

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

PROGRAM SET UP

PRELIMINARY PROGRAM CREATION

To prepare for autonomous coding, Rohan and Karthik created a new program where this season's code will be stored. Afterwards, we imported the basic code structure that we had created last year into the new program, so we would have a basic starting point for this year's code. Karthik decided to connect Rohan and Helen on Floobits, a group coding environment, so the programming team would be synced and up-to-date on any changes made to existing code. Rohan also connected IntelliJ with Floobits to establish a coding environment for him to work in.

In addition to creating the basic program outline, Rohan and Karthik gave Helen a brief overview of the coding process and the main objectives of coding this year.

Karthik wrote some code over the summer to install code faster. Rather than downloading and installing an android application (.apk) every single time we change our code, the code has been split up. The robot controller only has to be installed once, and the opmodes and teamcode can be separately updated every time.

NON-TECHNICAL DISCUSSION

- Mr. Prettyman held the parents meeting today.

We went through our agenda and came up with our plan for the meeting.

- **We reviewed Clare's team role organization chart.**

	A	B	C	D	E	F	G	H	I	J
1										
2						Coaches and Mentors				
3										
4										
5						Project manager				
6						Clare				
7										
8										
9	Design/Build Lead			Integration Lead		Programming Lead		Documentation Lead		Marketing Team
10	Bryan			Rohan		Karthik		Patrick		Helen
11										
12										
13	CAD	Build				Programmers		Notebook		
14	Bryan, Patrick, Jonas, Connor, Isha	Bryan, Patrick, Paige, Ian, Katy, Marcus, Aidan, Suraj		Bryan, Karthik		Karthik, Jonas, Rohan, Isha		Everyone?		Katy, Clare, Helen
15										
16										

- **The Promote Video prompt is…**

"How has *FIRST* changed YOU?"

We would like to have a promote video this year. We will treat this as a side project that we will work on when all essential tasks have adequate team members assigned to them. We would also like to use this to familiarize new team members with leadership and initiative situations outside of the technical parts of FTC.

- **Our primary objective is to complete the majority of brainstorming today.**

We decided to assign team members to work through different jobs.

  - Bryan, Clare, Isha, and Jonas - brainstorm outtake mechanisms
  - Patrick, Aidan, Connor, and Marcus - brainstorm intake mechanisms
  - Karthik, Helen, Rohan - programming
  - Ian - 3D printer upgrade

At 8:10, we regrouped. Each team gave a brief summary of their progress and what they would like to accomplish over the next few meetings.

MEETING SUMMARY

- Intake Brainstorming
- Scoring Stores Brainstorming
- Setup Programming Environment
- Created Prototype Skystone Detection Algorithm

SATURDAY, SEPTEMBER 21, 2019 MEETING

DATE & TIME: 9/21/19 | 9:00 AM - 2:30 PM

STUDENTS: Patrick, Bryan, Rohan, Marcus, Karthik, Jonas, Helen, Paige, Clare

MENTORS: Mr. Prettyman, Arnav, Zach

<table>
<tr><th>AGENDA</th></tr>
<tr><td>Review team members' slides</td></tr>
<tr><td>Notebook/outreach update: Assign unfinished entries to team members to complete this week</td></tr>
<tr><td>Briefly review brainstorming from last meeting</td></tr>
<tr><td>Plan
- Begin making/review CAD designs
- Programmers break into separate group
- Other projects:
    - Post to social media
    - Research outreach opportunities
    - Team bios
    - Business plan?</td></tr>
</table>

TIMELINE REVIEW

Brainstorming	Transition to testing and CADing
CAD	9/21 - 10/12
Building chassis	Finished by 9/28

CAD deliverables: (10/12)

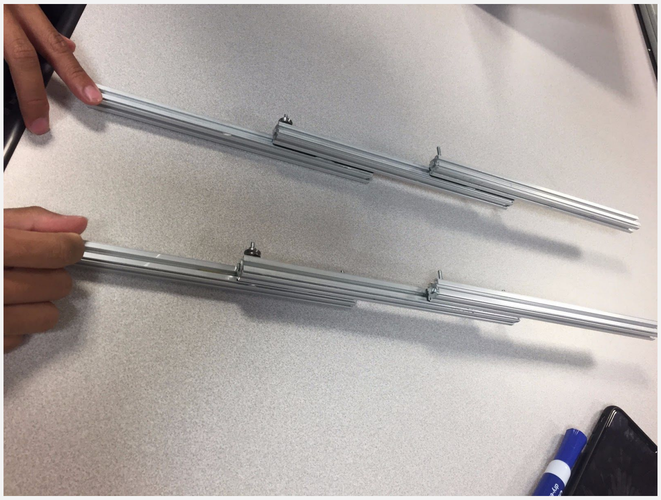
- CAD of everything on programming list
- Allocated space for every mechanism
- Up to date with mechanical progress

MECHANICAL ACCOMPLISHMENTS

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

STACKING STONES

CONSTRUCT & TEST A PROTOTYPE: SYNCING SLIDES



Based off of the brainstorming conducted by Bryan, Clare, Isha, and Jonas last meeting, Connor, Paige, and Marcus worked to prototype an early version of the lift. As supported by our design matrix, we used a linear slide design as our guide.

We built 2 identical REV slides with 2 stages each and connected them at the top and bottom. Then we attached the strings and connected it to a motor. We tested it both extending horizontally and vertically. We did horizontally first because it is the easiest to set up to see if it works. After it worked, we tested it vertically as it will be on the robot. It worked, but needed some extra weight at the top if we want it to retract due to gravity alone.

After adding the extra weight, we wanted to see how retraction and extension worked.
This test was more successful than without the weight because it was able to overcome the frictional force of the slides. These tests showed the feasibility of using linear slides

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

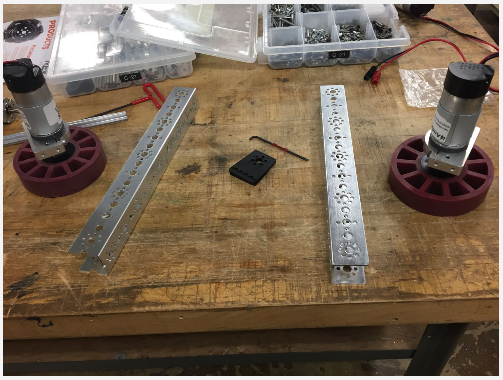
DELIVERING STONES

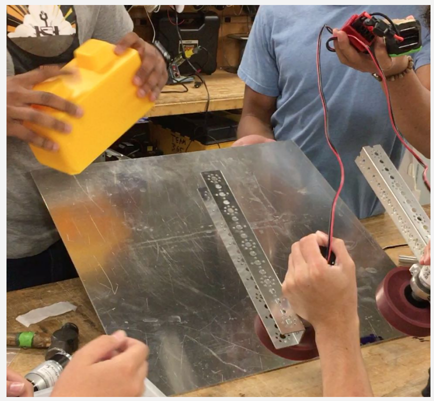
CONSTRUCT & TEST A PROTOTYPE: WHEELED INTAKE

Building on what Patrick, Aidan, Connor, and Marcus brainstormed during the Tuesday meeting, the build team continued to develop an idea for what the intake mechanism should be.

As an initial proof of concept, we first designed a simple test with two rubber wheels each connected to a motor to see how well it was able to reach and harvest stones.

After quickly building the necessary pieces, we decided to test it against a slope. This would replicate the intake ramp we were considering building on our chassis to control the stones after they were harvested.



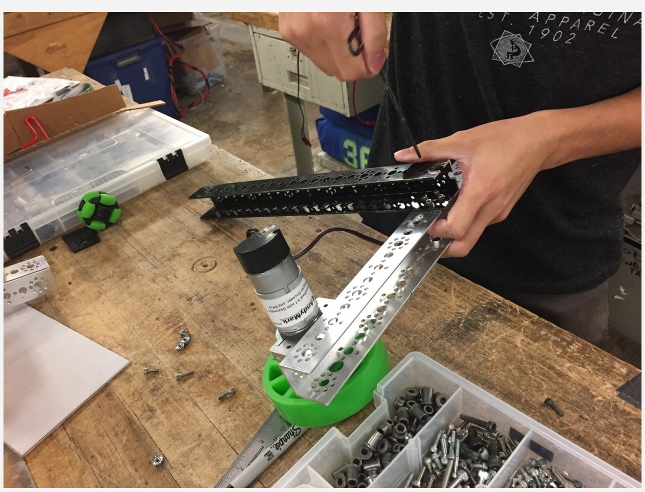


As shown in the rightmost images, this test was very successful - the stones were harvested quickly and easily by the spinning rubber wheels - but it also was not a perfect representation of how this mechanism would perform when on the robot.

The main inaccuracy was how the wheeled intake was being mounted. In the test, we tried to hold them as steady as possible, but on the robot they would be completely stationary with very little flexibility.

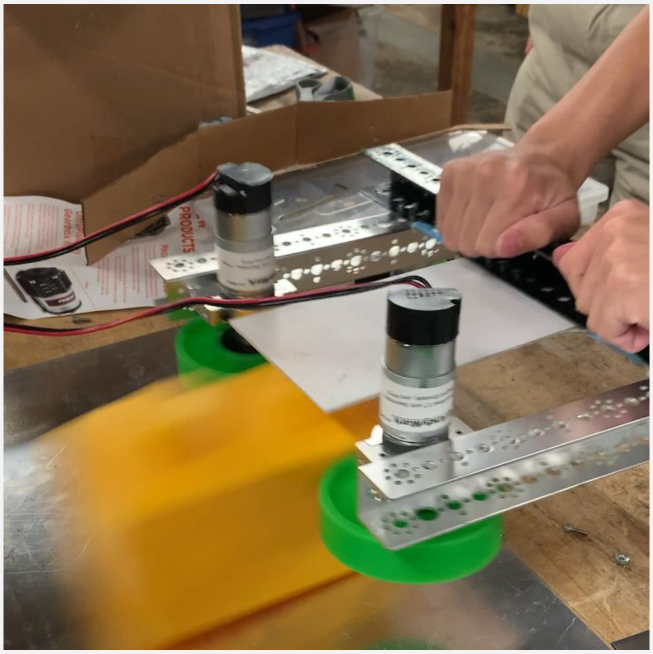
The test was successful in proving that the concept was viable, so we moved onto the next step by using these components to build a more sustainable prototype.

CONSTRUCT & TEST A PROTOTYPE: WHEELED INTAKE



We continued to develop this prototype for a better feasibility test. We wanted to have everything mounted together as one mechanism for more testing. We also switched our intake wheels to be green (because go MOE!!)

We used tetrix to construct this prototype because it is very easy to put together. We used a tetrix beam that put the two intake wheels far enough for the Stone to fit between.
This prototype also does not have any method of spring loading the wheels like our brainstorming included. We can test how the prototype performs when stones are angled.



The images above show different test we did with our prototype. We put a sheet of polycarbonate to help direct the Stone through the mechanism. In our first test, we put the Stone in straight and it went through cleanly.
Now, we wanted to test how it performed with angled stones.
We tested the extreme case of a Stone that is perpendicular from where it should be. To our surprise, the mechanism rotated the blocked to make it fit inside (shown in the second picture). We still may consider using spring loading because we believe this happened because the prototype had more compliance because of how it was assembled.
Lastly, we wanted to test if it would be able to go up into a ramp and into our robot (picture to the right). This also performed very well. One slight problem is the slight angle upward when intake resulted in the Stone shooting a bit upwards, but we plan to lower the power of the motors on our final solution so it is more controlled.

GENERATE CONCEPTS: RIGHTING MECHANISM

We saw that one problem of our intake mechanism is that it has no solution for Stones that end up on their side. We looked at possibilities for making the Stones upright, either inside our robot or outside or robot.

It was clear that we needed to use the two nubs in some way in our mechanism because that is what mainly differentiates an upright Stone and a stone on its side.

We used two straight Rev extrusions for some concept testing.
We explored the possibility of aligning it once it's in our robot but we saw that it was very difficult to make the mechanism work on both the left and right side because of how the stone rotated upright. Its point of rotation is on the corner, so it would be awkward to make it become upright.

On the other hand, an external righting mechanism that could flip out with a button could work. If we turn into the Stone would align with the straight edge and be in a perfect to flip. Afterwards we can move forward and collect the Stone

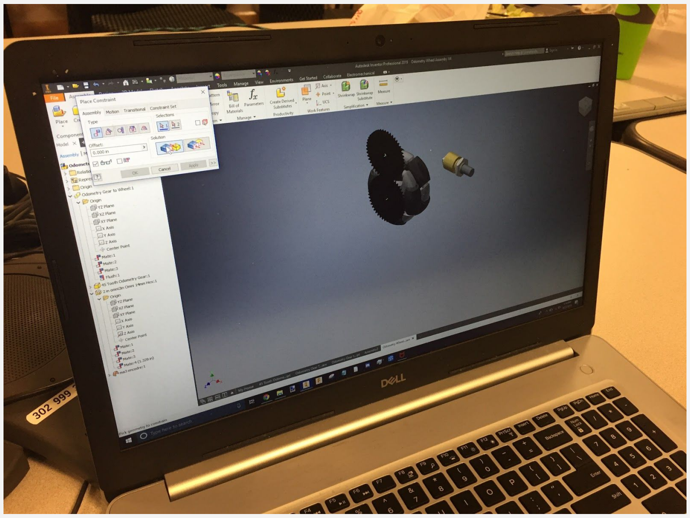
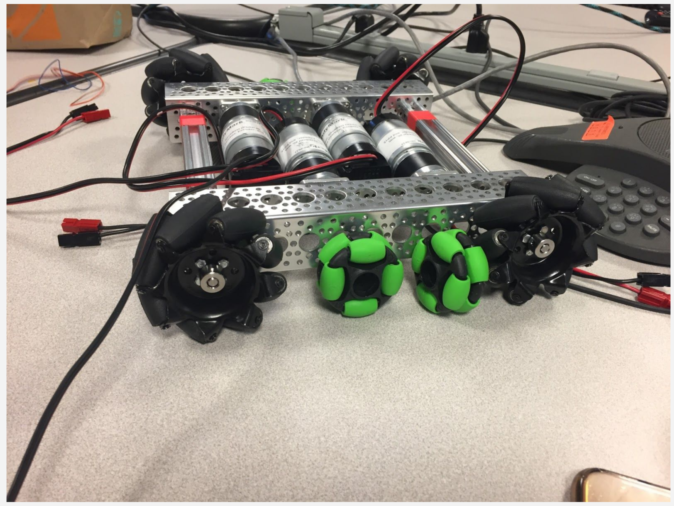
Define Problem	Generate Concepts	**Develop a Solution**	Construct & Test a Prototype	Fabricate and Integrate	Tweak & Evaluate

ODOMETRY

DEVELOP A SOLUTION: ODOMETRY CAD

Bryan and Jonas worked on designing the CAD for the odometry wheels.

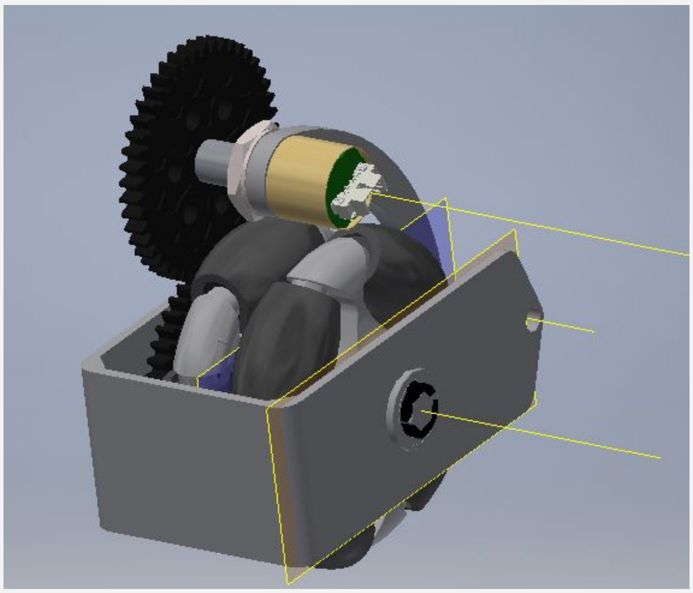
We knew that these were required by the programmers. We decided that it would be important to get them designed early on so that the programmers could begin tuning their odometry localization from early on in the season.

We would like these to be placed outside the frame of the chassis next to the other wheels. This location is secure and stable but will also allow for easy access in case of repairs or tweaks.

The Programmers' requirement was to have a total of 3 wheels, 2 of them being parallel with the drive wheels and 1 of them being perpendicular with the drive wheels. This gives enough data for odometry.

This is what we finished by the end of the week



.

This model was more than 50% less wide, and because of that, two pods were able to fit on one side (in CAD), and the other was able to fit, diametrically opposed to the other parallel pod on the other side. The final width was **1.640748032 in.** It works the same way as the previous models, but the walls were thinner, and we're avoiding the usage of collars by making everything a press fit. We're also printing gears that are thinner, to save space too.

PROGRAMMING ACCOMPLISHMENTS

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

SENSORS

DEVELOP A SOLUTION: CHASSIS REQUIREMENTS

Based off of the brainstorming and objectives we created for the autonomous period, the programming team compiled a list of sensors and requirements needed on the chassis in order to complete these main objectives.

Critical:

Front camera
- On the *front* side of the robot
- Parallel to the *front / back* side of the robot
- Can be on any horizontal location (ie: left, center, right)
- Has to be at least above the tetrix beam forming the chassis

Back camera
- On the *back* side of the robot
- Parallel to the *front* / *back* side of the robot
- Can be on any horizontal location (ie: left, center, right)
- Has to be at least above the tetrix beam forming the chassis

Odometry
- Location cannot interfere with foundation grabbing, harvesting, or any other robot function
- Spring loaded
- 2 “vertical” dead wheels + 2 MA3 encoders
    - Both wheels parallel to the *left / right* side of the robot
    - Diametrically opposed wheels (on the same circle of rotation)
- 1 “horizontal” dead wheel + 1 MA3 encoder
    - Wheel is parallel to the *front / back* side of the robot

Encoders
- 1 for front left drive train motor
- 1 for front right drive train motor
- 1 for back left drive train motor
- 1 for back right drive train motor
- For the 3 MA3 encoders, look at the *Odometry* section

Gyro
- Already on the REV Hub

In order to ensure that the cameras are secure and lined up to the skystone and Vumarks image for detection, the front and back cameras would need to above the tetrix beams. After using 2 odometry

wheels during last year's season, Rohan and Karthik decided that using 3 odometry wheels/MA3 encoders will increase the accuracy of spatial measurements, as well as the use of 4 encoders for the motors.

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

FOUNDATION DETECTION

CONSTRUCT & TEST A PROTOTYPE: FOUNDATION DETECTION

In order for the robot to determine the location of the foundation that matches the team color, Rohan created a flood-fill algorithm that examines each pixel of an image obtained from the camera. Through this algorithm, every pixel that matches the color of the team's specific foundation is identified to generate an outline of the foundation's position for the robot to use while attempting to move the foundation.

To test this, Rohan applied the algorithm to a picture of the red foundation and changed every red pixel identified to grey on a new picture. The grey pixels in the new picture formed the outline of the foundation, which shows that the algorithm worked.

PRUSA I3 MK2 TO MK2.5 3D PRINTER UPGRADE

- Ian continued the extruder assembly by continuing the wire organization
  - Ian completed steps 46 to 47

NON-TECHNICAL DISCUSSION

- **We reviewed the goals and objectives for each subteam.**
  - The programmers need to come up with a list of requirements
    - This will help the mechanical team decide priorities
    - The CAD team will use this list to design the chassis
  - The mechanical team will start prototyping
    - Patrick, Arnav, Zach, and Paige will work on the intake
    - Connor and Marcus will work on the lift
    - Bryan and Jonas will CAD the odometry wheels
  - The documentation team needs to assign any uncompleted entries
  - Promote Video and posting to social media are not high priority but are options if anyone finishes early

- **On Tuesday, Mr. Perrotto is coming to talk about lab safety rules with our team.**

This review happens every year and is critical in making sure that all team members, mentors, coaches, and parents are aware of what the building's rules are and how we can best stay safe while in an environment with heavy machinery.

- **We would like to redo our website next Saturday.**

We have had a team website for a while but have not updated it recently, so we are planning to use a website designed such as SquareSpace to make it easier for us to update and for others to view. Andrew will help us do this on Saturday 9/28.

MEETING SUMMARY

- Lift Prototype
- Wheeled Intake Prototype
- Foundation Detection

TUESDAY, SEPTEMBER 24, 2019 MEETING

DATE & TIME: 09/24/19 | 6:00 PM - 8:30 PM

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

MENTORS: Mr. Prettyman, Nick, Andrew

AGENDA
Review team members' slides
Have each subteam create deliverable + goal (2 week intervals?)
Safety review with Mr. Perrotto (6:30)
Split into subteams

TIMELINE REVIEW

CAD	Finish harvester by Tuesday 10/8
Building	Drivable chassis + motor/servo allocation complete by Tuesday 10/8
Programming	Start pathfinding on Tuesday 10/8

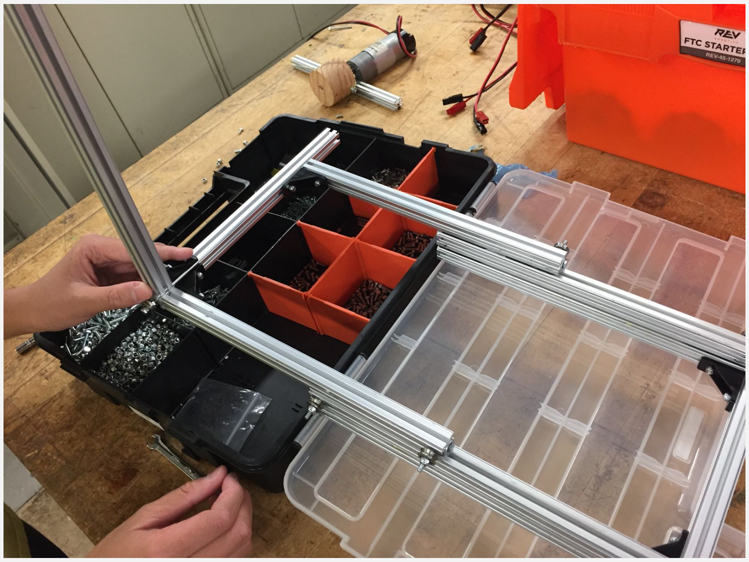
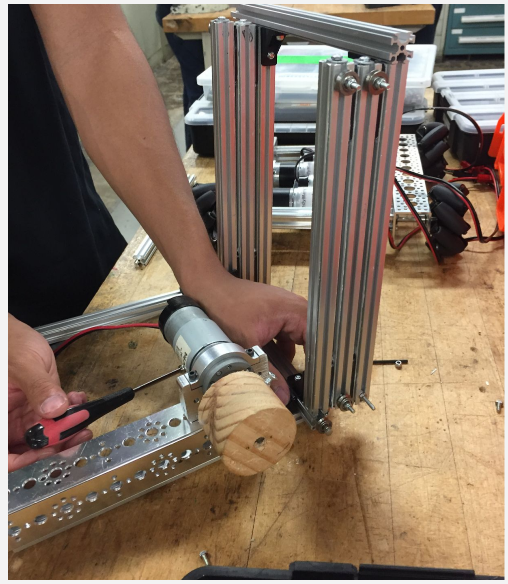
	DESIGN	BUILD	PROGRAM	NOTEBOOK
9/21/19	CAD		begin programming	
9/24/19				
9/28/19		~~Finish both chassis~~		get outreaches up to date
10/1/19				
10/5/19	Finish odometry prototype			Finish team bios
10/8/19	Finish harvester CAD	- Motor and servo allocation complete - drivable chassis	Start odometry pathfinding	

MECHANICAL ACCOMPLISHMENTS

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

CONSTRUCT AND TEST A PROTOTYPE:

Bryan, Jonas, Aidan, and Connor began adding the the lift that Connor and Marcus built last meeting.

We attached the motor to a secure mounting place on the slide so that we would be able to test it with more accuracy. This will be an improvement from just clamping the motor to the table because this first method allowed for a lot of variation between tests.

Then, we attached the thread around the motor and strung it up and down the slides.

PROGRAMMING ACCOMPLISHMENTS

PRELIMINARY SET UP

PRELIMINARY SET UP: PROGRAMMING LAPTOP SET UP

Karthik and Helen finished setting up Floobits and Android Studio for the programming team to code in throughout this season. We continued downloading files to connect each team member on Floobits to ensure that every member of the programming team can stay up-to-date with any changes in the code.

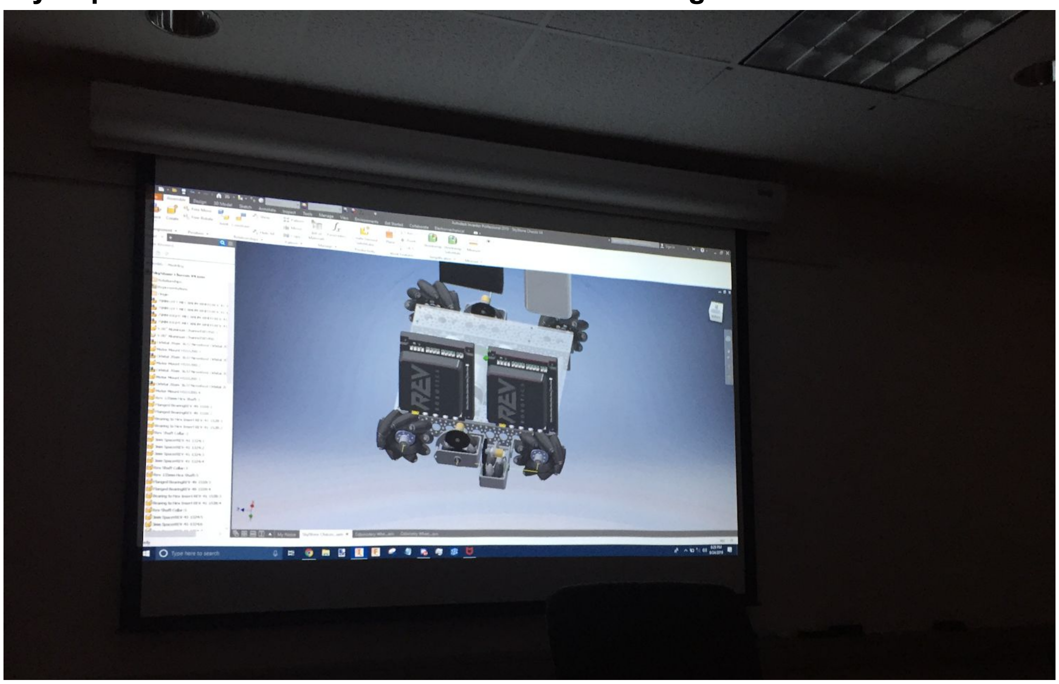
PRUSA I3 MK2 TO MK2.5 3D PRINTER UPGRADE

- Ian continued the extruder assembly by continuing the wire organization
  - Ian completed steps 48 - 51
- Then, Ian started the electronics asembly
  - Ian completed steps 1 - 7

NON-TECHNICAL DISCUSSION

- **We first reviewed team slides**
  - Ian is planning to finish the 3D printer upgrade by this Saturday. His deliverable is to work with Bryan to get the odometry print completed by Saturday 10/5.
  - Clare will finish the team bios by Saturday 10/5.
  - Patrick will make sure that all outreach entries are up to date by next Saturday 10/28.
  - Bryan presented the new chassis design with odometry. Odometry build = 10/5
    - Side panels complete, drivable chassis by Tuesday 10/8
    - CAD of harvester by Tuesday 10/8
    - Motor and servo allocation complete by 10/8

- **Bryan presented his new CAD of the chassis design.**



  This new chassis included three separate odometry wheels. His goal is to work with Ian and the rest of the build team to finish building a prototype of the odometry wheels with 3D printed parts by Saturday, October 5.

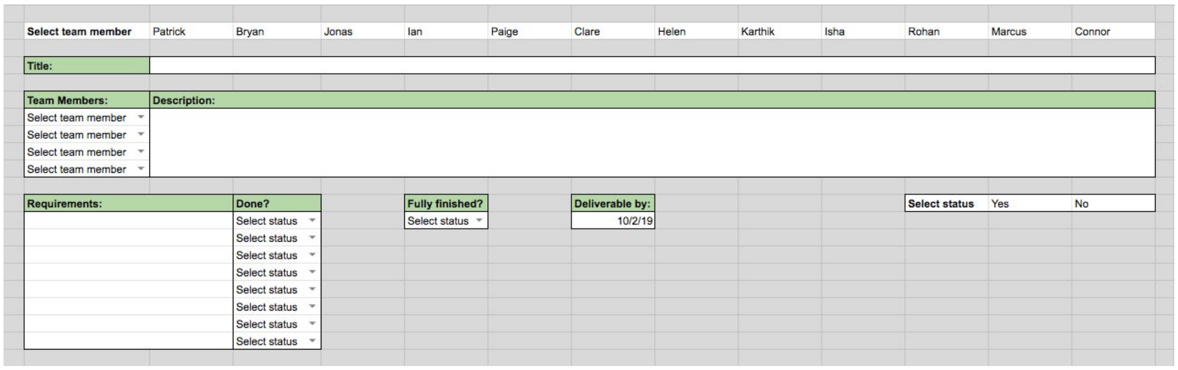
- **Mr. Perrotto gave a safety review in the lab.**
  At 6:30, Mr. Perrotto took our team into the lab and reviewed the safety rules for both the lab and DuPont property

- **We brainstormed ideas for the team website.**
  We would like to potentially use SquareSpace or another website builder to remake our team website. On it, we have a few ideas for things we could include.
  - Links to social media
  - Previous notebooks
  - Promote video
  - Team photos/media

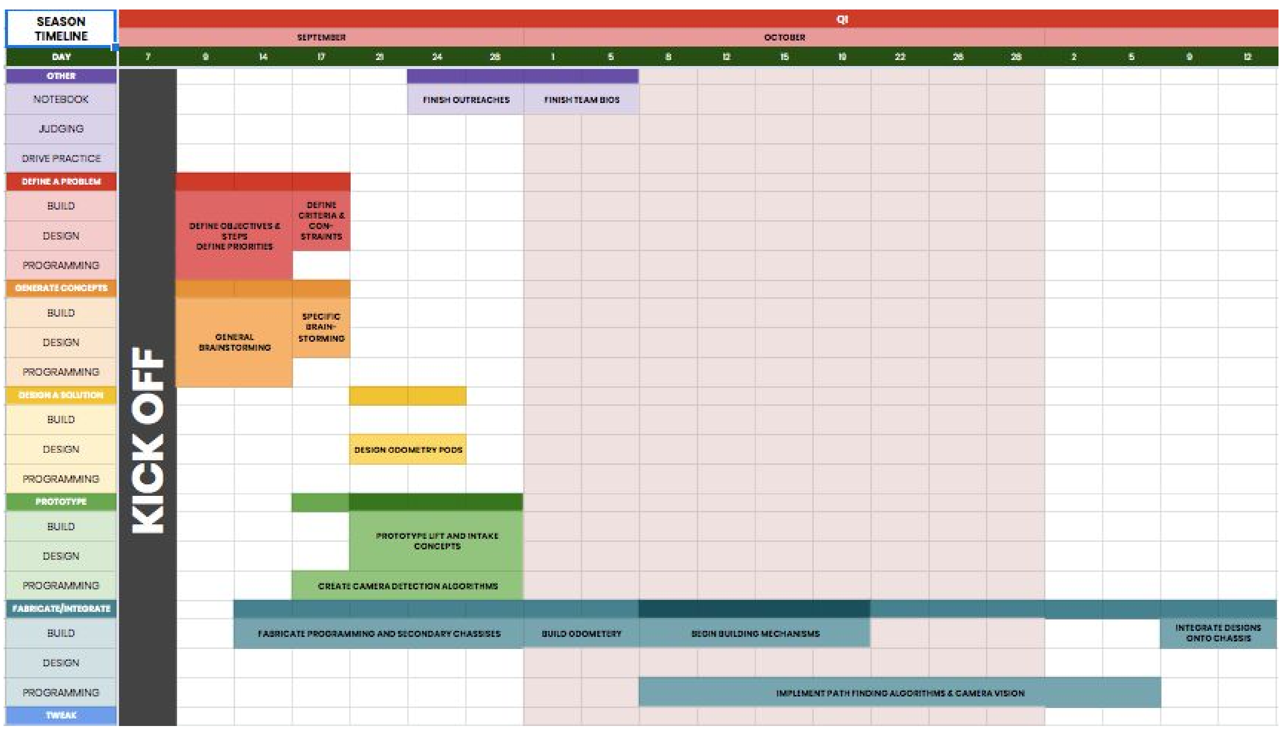
- Business plan

- **We got a new CAD computer**
  Connor will take it home and install CAD software

- **Developed testing plan**
  - Utilized Google Sheets to outline testing details, including title, description, team members, deadline, and requirements
  - Will help organize workflow of team



- **Created Different Timeline format**
  - Added aesthetic and comprehension into Season Timeline
  - Based on Design Process and 3 subsections



Full View (Vertically) of Season Timeline

Compressed View (Vertically) of Season Timeline

MEETING SUMMARY

- Stacking Stones Lift Prototype
- Second Season Timeline
- Team Website Brainstorming

SATURDAY, SEPTEMBER 28, 2019 MEETING

DATE & TIME: 09/28/19 | 9:00 AM - 2:30 PM

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

MENTORS: Mr. Prettyman, Andrew, Arnav, Zach

AGENDA
Create programming timeline
Prototype and Test Lift Designs

TIMELINE REVIEW

CAD	Finish harvester by Tuesday 10/8
Building	Drivable chassis + motor/servo allocation complete by Tuesday 10/8
	Odometry finished: 10/5

MECHANICAL ACCOMPLISHMENTS

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

ODOMETRY

DEVELOP A SOLUTION: ODOMETRY MOUNT

We evaluated the CAD of the Odometry and the concern was that the rotational spring-loading of the perpendicular odometry wheel would not work on the raised center platform because the side of wheel contacted the lip would not ride up the platform and would just harshly hit it. We concluded that no spring-loaded design would work because there was not enough of a lip on the platform for the wheel to ride up and engage the spring.

We decided that we needed to figure a way to disengage the wheels from the ground, but still have a spring-load when the wheels are engaged

We thought of 3 ways of disengaging them:

- Rotational Springload with an elastic downwards with a String to Disengage
- Active Vertical Disengage with an Active Reengage onto a vertical foam spring load

- Mounting on a sheet of spring steel on a rotation, rotating downwards to engage the spring, and rotating upwards to disengage the wheels

The Rotational Springload would work like the currently designed one; however, it would disengage by a spring providing an opposing force upwards using a servo. This kept the solution simple; however, we did not want to rely on a string and a rubber band on something so crucial to our autonomous

The Active Vertical Disengage would use a servo as a linear actuator. It could disengage the module by lifting the entire thing up, but as it pressed down, there would be an intermediate piece of elastic foam in the center. This means that the piece could rock back and forth on the foam and also have vertical compliance. Our main worry was it rolling towards and away from the robot, which would create inconsistent odometry readings.

We chose to mount in on a sheet of spring steel that rotates. When we rotate it upwards, it would disengage from the ground, but when we rotate it downwards, the mechanism would comply to the shape of the ground until the both wheels are contacting the ground.

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

SCORING STONES

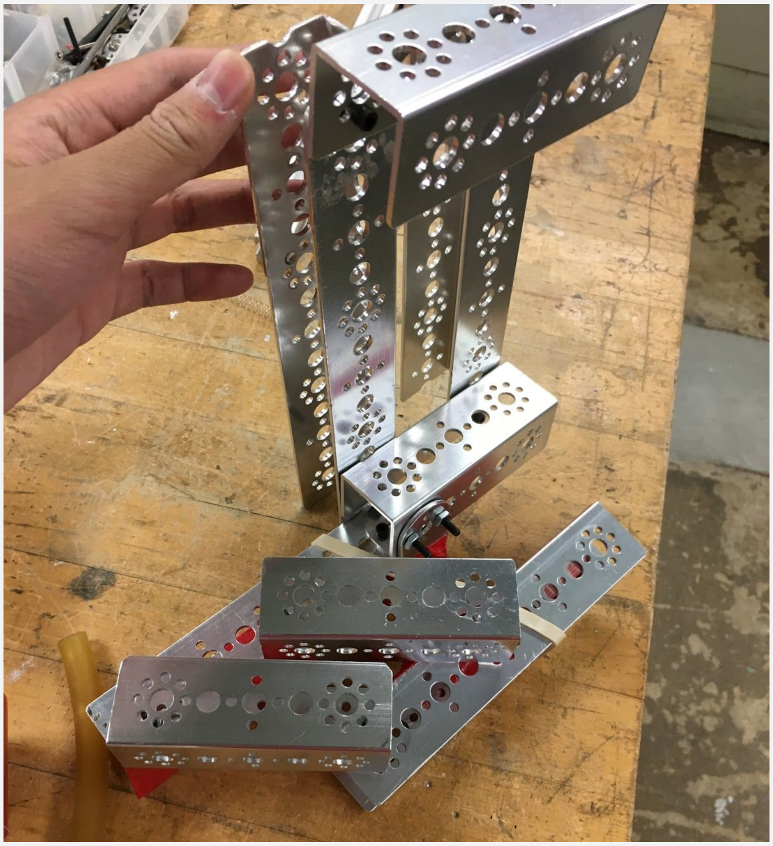
CONSTRUCT & TEST A PROTOTYPE: SKYSTONE MANIPULATOR

The next step of the scoring process after intaking the skystone is to pick up and place it. Our harvester system will make sure that the stone is precisely aligned within the robot to make for an easy and reliable transfer. At a previous meeting we decided what our requirements and wants were for stacking skystones. The next plan of action was to prototype different methods of accomplishing this by finding new designs and testing their strengths and weaknesses.

We were experimenting with a method of picking up the stones by using a clip to push outwards from between the two nubs of the skystone

The green compliant wheels would provide a rubbery surface to grip the slope of the skystones. Eventually decided that this method would take up too much time at the moment to prototype, so we looked into some other methods
Another more obvious way of picking up the skystones would be to grab the nubs, either one or both of them. While trying to make a simple 4 bar linkage, we realized that the motion of 2 parallel bars moving towards each other is the exact motion we needed to clamp onto the skystone.

This discovery resulted in the creation of this device,



which could move horizontally due to a 4-bar that would hypothetically be attached to our vertical linear slide, and clamp on to a skystone if rubber pads were attached.

PROGRAMMING ACCOMPLISHMENTS

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

SKYSTONE DETECTION

DEFINE PROBLEM: SKYSTONE DETECTION

During the autonomous period, each Skystone (maximum of 2) delivered from the quarry through the alliance bridge will earn **10 points if they are the first 2 stones delivered.** Since this point earning system is only in place during the autonomous period, the robot would have to pick out each Skystone from the quarry.

Due to this, we brainstormed and outlined ways for the robot to detect the Skystones using the camera and the images on the stone.

CONSTRUCT & TEST A PROTOTYPE: PIXEL FILTER

We saw that it would be easier to detect a yellow Stone versus the black Vuforia tag on the Skystone. To

do this, we used HSV value thresholds to find yellow pixels.
First, we knew that the range for yellow pixels have a hue from 30º to 60º, so we restricted the hue values to that range.
Next, we knew that values with a very low saturation and value have arbitrary hues. For example, blacks and whites still stay the same color when you change its hue.
To help with detection, we created a threshold at 60% saturation and 40% value.

Instead of looking at all 6 stones, we only look at the 2 closest to the wall because we can imply the rest.

Running our first test, we found that on the left side of our image, we have 339 yellow pixels and on the right side

Helen had the idea only using 2 pixels so the process
By changing the resolution of the image to a 2 by 1 pixel resolution, we can get the average pixel from the left side and the right side. Using the average creates more consistent values.
We tested this on all 3 scenarios and it worked on all of them.

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

CAMERA VISION

DEFINE PROBLEM: FOUNDATION DETECTION

For a reliable autonomous, foundation detection is necessary. When considering other robots that interact with field elements, there is a considerable chance other robots' autonomy or even our partner could interfere with the initial position of the foundation.

To solve this issue, there needs to be a way to recognize the location of the foundation *relative to the robot.* When combined with an odometry-based localization system, foundation detection is a powerful method of creating an autonomous that can align to the foundation regardless of position. If implemented properly, this has implications for not only moving the foundation to the build zone, but also accurately placing stones.

GENERATE CONCEPTS: FOUNDATION DETECTION

To detect the foundation, the following are required:
- Odometry-based localization system
- Camera
- Computer vision algorithms

Combining these three together, a system can be developed either with ***edge detection*** or ***"reverse orthogonal projection"*** - the idea of taking a 2D surface and converting it into a 3D representation, which is analogous to taking a 2D camera image, finding the object of interest, and, finally, realizing the 3D coordinates of that object.

Since edge detection was much more complicated to test, we decided to first go with reverse orthogonal projection on ground surfaces, a much simpler idea to go forward with; however, our camera would have to be in a static position.

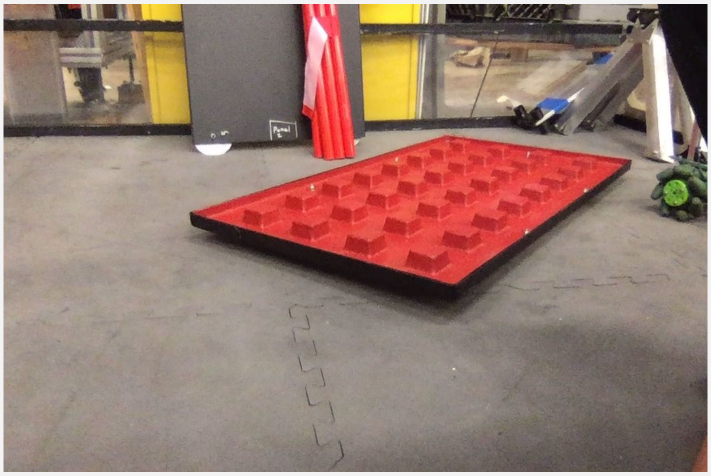
After some brainstorming, we outlined a basic algorithm:

1. Take picture of the foundation
2. Run an RGB → HSV filter for red / blue colors
3. Remove all non red / blue pixels
4. Run a *flood-fill* algorithm to detect clusters of pixels
5. Pick out the largest cluster (which should be the foundation)
6. Find the pixel locations of the four corners of the foundation
7. Map those pixel locations into 3D space - ***"reverse orthogonal projection"***
8. Use robot's current position & orientation to determine foundation's relative position with 3D points

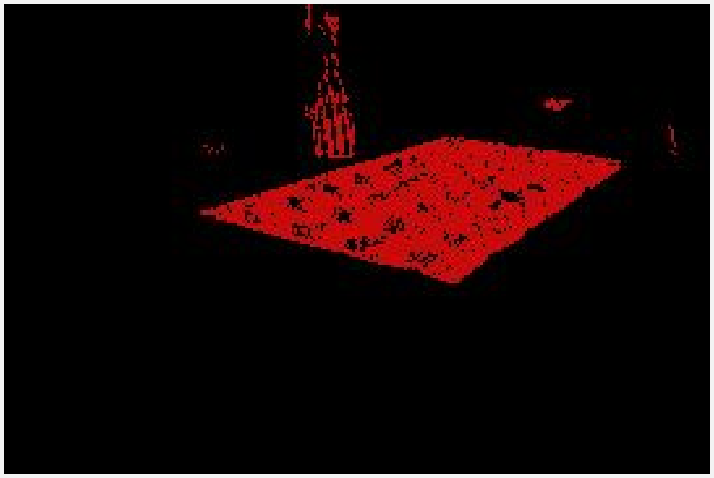
CONSTRUCT AND TEST A PROTOTYPE: FOUNDATION DETECTION

To construct the algorithm outlined above, we first took pictures using a laptop. Then, we wrote a Python script that allowed us to quickly test the idea we had in mind.

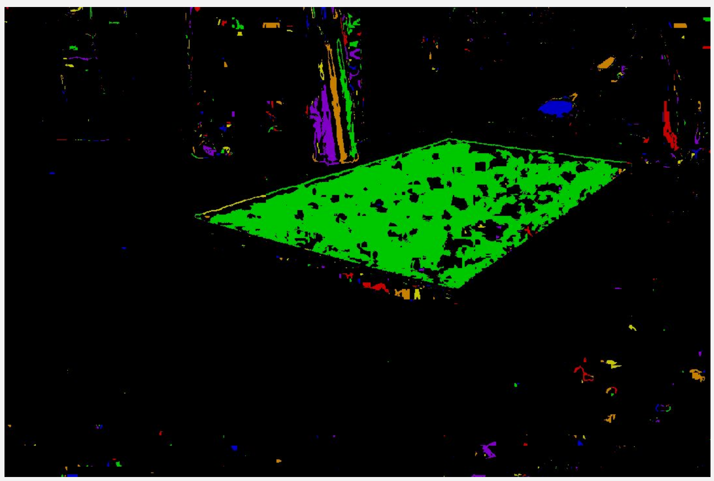
Sequence of images describing foundation detection:



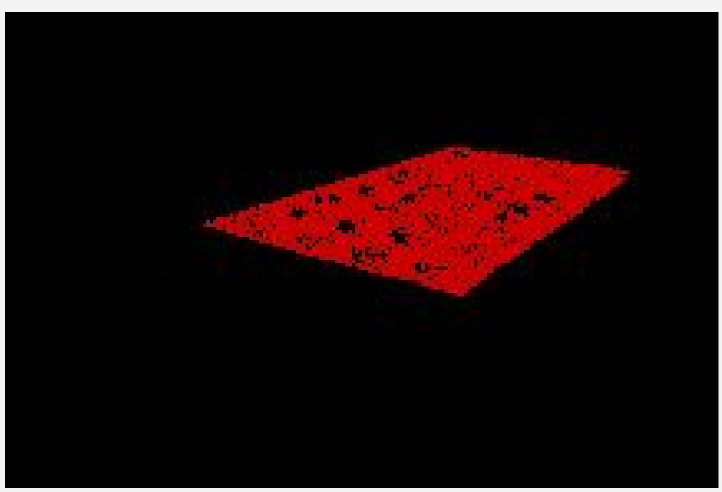
Original image



RGB → HSV filter



Cluster detection (*flood-fill* algorithm): each color represents its own cluster



Pick out the largest cluster

DEFINE PROBLEM: RELATIVE OBJECT-BASED LOCALIZATION

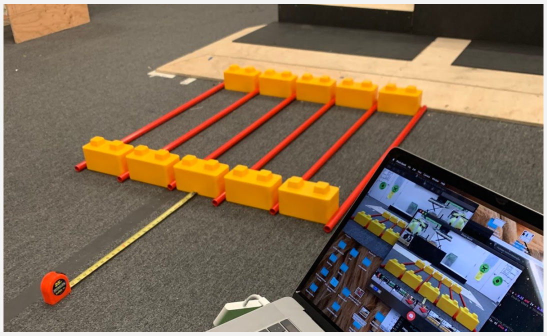
For a reliable autonomous, foundation detection is necessary. When considering other robots that interact with field elements, there is a considerable chance other robots' autonomy or even our partner could interfere with the initial position of the foundation.

To solve this issue, there needs to be a way to recognize the location of the foundation *relative to the robot.* When combined with an odometry-based localization system, foundation detection is a powerful method of creating an autonomous that can align to the foundation regardless of position. If implemented properly, this has implications for not only moving the foundation to the build zone, but also accurately placing stones.

CONSTRUCT AND TEST A PROTOTYPE: "REVERSE ORTHOGONAL PROJECTION"

As a very simple method to develop a reverse projection system we tried to setup many red lines separated by a uniform width. Also, the red lines were of the same length.
Using these lines, since we know their 3D location on the carpet, we can use the 2D location of the all the points on the carpet and create a model that approximately maps a 2D point to a 3D physical location.

Below is a picture of the setup used: (the red lines separated by yellow blocks indicate the calibration setup)



While developing this prototype, we quickly realized that the approach was too naive. Since there is no way to tell height with this model, it would be completely impractical on the actual field. Any object with a non-trivial (not small) height would fail in the algorithm, so we decided to **stop** developing this idea.

PRUSA I3 MK2 TO MK2.5 3D PRINTER UPGRADE

- Ian finished the electronics assembly of the Prusa i3 mk2.5 upgrade
  - I added the door of the electronics box with the hinges attached the printer frame
  - Then, I attached the textile sleeve wrap with the heated bed wires and the spiral with the extruder wires into the Rambo electronics board box.
  - After that, I inserted the wires for the extruder hardware and the heated bed into the Rambo electronics
  - After that, Andrew organized the wires with zip ties to be able to close the electronics door and then closed the door with a screw.
- Then, I did some preflight checks
  - I first checked if the nozzle of the printed touched the back two corners of the heated bed

    - Then, I adjusted the height of the P.I.N.D.A. Probe as the height of one zip tie from the heated bed.
- Then, I installed the Prusa i3 mk2.5 software onto the Prusa i3 mk2.5 printer.
- I started doing calibrations for the printer starting by doing the self-test calibration program on the printer to test if all the hardware is working properly.
    - The self-test program started by testing the side and front fans to see if they work and the side fan was working but the front fan was not working. I found out that this was because the wire for the front fan was not plugged into the Rambo board correctly. Then, it was working when I did the self-test again
    - After testing the fans, the program moved on to testing the x, y, and z motors and end-stops and measuring the distances of each axis. When it was doing the x-axis and going to the end stop to find the end of the x-axis on that side. The extrude and the motor was continuously hit the piece above the x-axis end stop.
        - I look into why this was happening and what is happening is that extruder is hitting the piece above the end stop before the piece of the extruder that is supposed to trigger the end stop hits the end stop. I tried to find a way to fix the problem but I will finish in the next meeting.

NON-TECHNICAL DISCUSSION

We started to design our team website on SquareSpace (still missing pictures)

We hope to use the website to store our past notebooks, photos, team updates, outreaches, and sponsorship information.

MEETING SUMMARY

- Start Website Building
- Reverse Orthogonal Projection
- Lift Testing (Grabbing and Linear Slide)
- Finished Odometry V4

TUESDAY, OCTOBER 1, 2019 MEETING

DATE & TIME: 10/1/19 | 6:00 AM - 8:30 PM

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

MENTORS: Mr. Prettyman, Dave, Nick, Andrew

AGENDA
Review team members' slides
Look at revised season timeline
Get subteam updates from Bryan and Karthik
Presentation from Delaware FTC judge Lena Dillard

TIMELINE REVIEW

CAD	Finish harvester by Tuesday 10/8
Building	Drivable chassis + motor/servo allocation complete by Tuesday 10/8
Odometry	Odometry finished: 10/12

- Bryan has found that he is unable to have the odometry finished by 10/5 because of CAD backup. This deadline is being pushed back by a week to 10/12.

MECHANICAL ACCOMPLISHMENTS

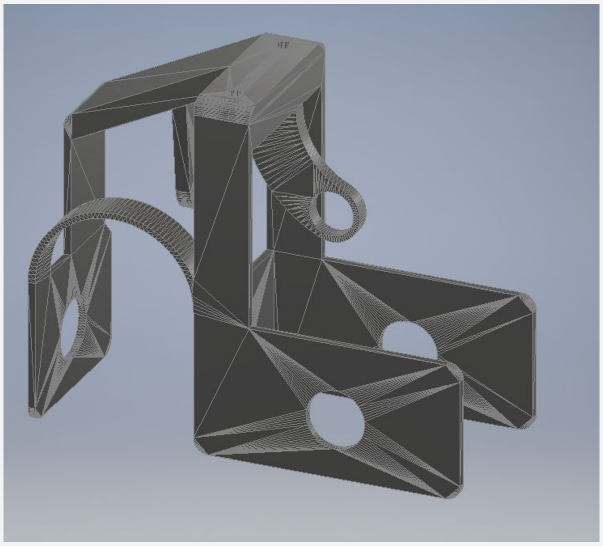
Define Problem	Generate Concepts	**Develop a Solution**	Construct & Test a Prototype	Fabricate and Integrate	Tweak & Evaluate

ODOMETRY

DEVELOP A SOLUTION: ODOMETRY V5

This is the design of the new Disengaging Odometry Wheels. Each pod will house two wheels and will be on both sides, but only three of the wheels will have encoders. The center between the two contact points were found and a super structure was raised there to mount the spring steel. This makes sure that both wheels have even pressure when sprung onto the ground.

We had to push back the odometry deadline because the manufacturer's of the gears we wanted to use. We chose these gears because they were manufactured to press fit correctly, while the print may have problems. However, their measurements did not include the width of the teeth, so we couldn't adapt the CAD to fit them.



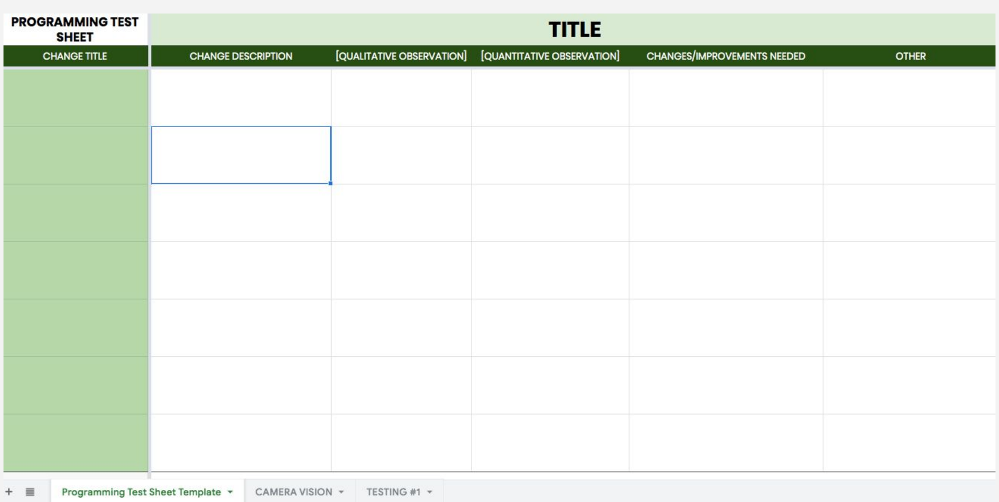
We’re going to print the CAD anyways to make sure the structural integrity is okay, and the next print we will update to fix any issues we find and it’ll also be the correct width.

PROGRAMMING ACCOMPLISHMENTS

PROGRAMMING TEST SHEET

PROGRAMMING TEST SHEET: TEMPLATE FOR TESTS

We wanted consistent and cohesive testing sheets when programming. It may be a bit difficult to know what changes to document and what details to provide, but this test sheet provides a universal method for the programming team to describe their testing.
It includes places to write changes, qualitative and quantitative factors of those changes, and also any needed changes to an iteration.
This simplifies the notebook writing process because our justifications and reasoning would be organized in this spreadsheet, and we an overall summary could be written afterwards.



Most of our programming time is testing many iterations for hours, but we have previously found it hard to document the details. This makes sure our hard work is clearly displayed in a spreadsheet.

NON-TECHNICAL DISCUSSION

- **Ian has finished assembling the 3D printer**
- **Clare and Helen have made significant progress on the team website**
- **Lena Dillard, volunteering with judging for 8th season, gave a presentation on the judging presentation and awards**
    - Intro to Judging
        - Two sides to every event: Competition and Judge Interviews
            - Awards for each side (CRUCIAL FOR ADVANCEMENT)
        - Judging is your opportunity to show off robot, outreach, and team and to WIN AWARDS
            - Team is interviewed by 2-3 Judges and each panel interviews between 4-7 teams.
            - Judges are volunteers with all sorts of professional backgrounds
            - Ten to fifteen minute interview
                - Up to 5 Minutes uninterrupted presentation and 5-10 minutes Q&A
                - It is very difficult to fit all of the season in a 5 minute presentation – it is skillful to reference the notebook and just give highlights — “Elevator Speech”
            - Bring Robot, Notebook, visuals, and handouts
                - Lack of Notebook makes you ineligible for most awards
            - Judges nominate teams for awards based on eligibility (Criteria laid out in GM1 Section 9)
            - Pit interviews and match observation during qualification matches as extra factors for awards
                - Critique - Last year, 16/18 teams were either in queuing or in match play so pit interviews were easily interrupted by match schedules - Mentors suggested that there could be 30 minutes after lunch dedicated for pit interviews
            - Award winners and scripts written
            - Advancement finalized after Match Finals

Pennsylvania FIRST Tech Challenge Tournament Agenda

7:00 Volunteers Arrive & Check-In
7:45 Teams Arrive & Check-in–*Robot & Field Inspection Begins*
8:20 Judges Interviews Begin
- Judges concludes by 10:00 AM and nominate awards

10:30 Drivers Meeting on Competition Field
10:45 Opening Ceremonies
11:00 Qualification Matches Begin
12:30 Lunch Break
1:00 Qualification Matches Resume
3:00 Start Semi-Finals
4:00 Start Finals
5:00 Awards Ceremonies
5:30 Ceremony Complete

Awards

- Inspire Award - Well Rounded
- Think Award - Technical
    - Notebook Award - Quality over Quantity
- Connect Award - Community
    - Technical Community connection - fundraising, education, mentorship
    - Stronger if it is new (from end of last season onwards)
- Innovate Award - Technical
    - Subcomponent has to be documented in notebook
- Design Award - Technical
    - Robot as a whole, engineering drawings with **m e a s u r e m e n t s**
- Motivate Award - Community
    - FIRST Awareness - Mentoring other teams (FTC and FLL), presentation, community workshop, nontechnical outreach, recruitment in FIRST
- Control Award - Technical
    - Programming, sensors, etc.
- Judges Award - Catch-all award for things that don't fall in other awards

Award Hierarchy and Advancement - Note: Judged Awards are Placed higher

1) Inspire 1
2) WAC
3) Inspire 2
4) W1P
5) Inspire 3
6) W2P
7) Think
8) FAC

Benefits of Judging

- Develop Interview Skills
- Improve Presentation Skills
- Build Team Cohesion
- Self-Evaluation
    - FIRST is thinking of adding a feedback system, if at all, by next year.

Business Plan

- Now called a **"Team Plan"** – It could be a business plan, fundraising plan, a strategic plan, or a sustainability plan
    - Critiques for last year - Sustainability plan was great but fundraising plan/financing lacked detail; We had a lot of information last year, but it does not need to be as much
    - SWOT planning - Strengths, Weakness, Opportunities, Threats

Summary Page

- Not required this year (still recommended)
- Define where stuff in the notebook are

MEETING SUMMARY

- Lena Dillard’s Presentation
- Odometry V5 CAD

SATURDAY, OCTOBER 5, 2019 MEETING

DATE & TIME: 10/05/19 | 9:00 AM - 2:30 PM

STUDENTS: Ian, Paige, Suraj, Jonas, Katy, Karthik, Clare, Bryan, Patrick

MENTORS: Mr. Prettyman, Arnav, Zach

AGENDA
Discuss progress from last week
Timeline goals - odometry, building, CAD deadlines
Outreach plans - central focus for this year?

TIMELINE REVIEW

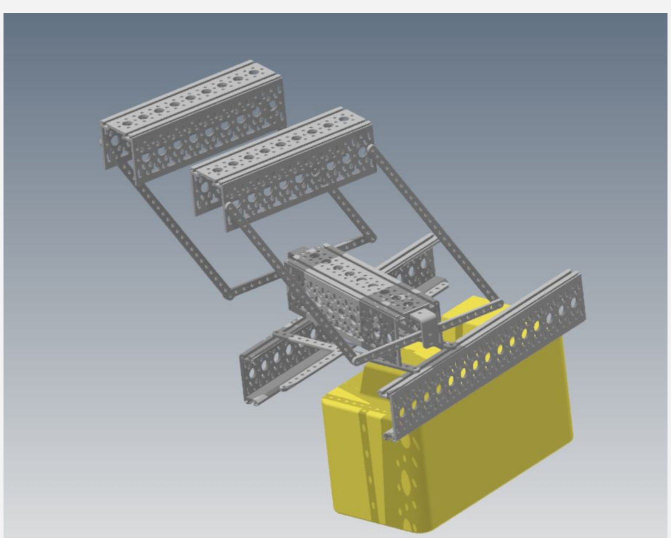
CAD	Finish harvester by Tuesday 10/8
Building	Drivable chassis + motor/servo allocation complete by Tuesday 10/8
	Odometry finished: 10/12

MECHANICAL ACCOMPLISHMENTS

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

SCORING STONES

DEVELOP A SOLUTION: CLAW CAD

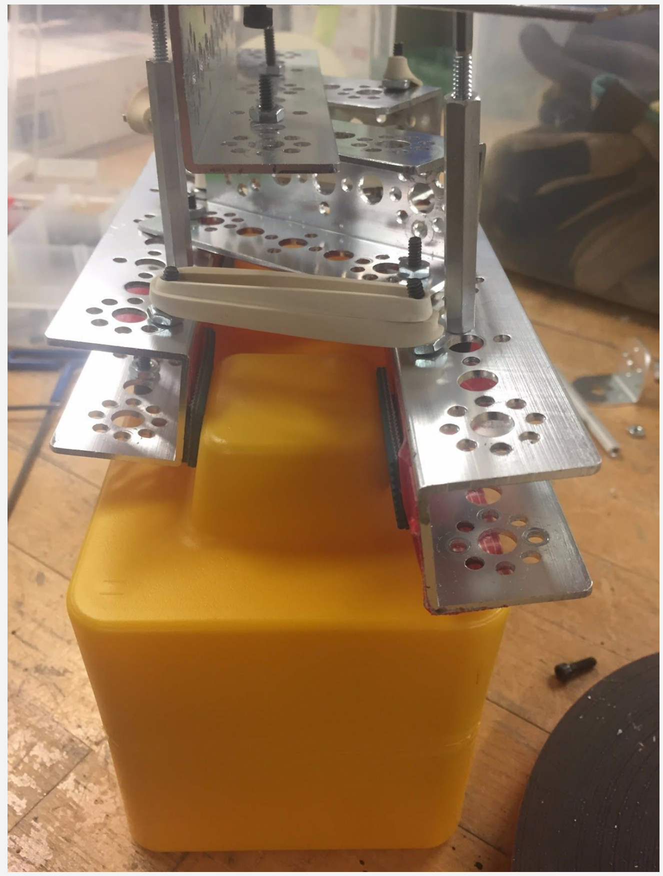


In order to expand on their current prototype, Jonas CADed a basic adaptation of the prototype claw using better materials than the real life version

CONSTRUCT AND TEST A PROTOTYPE: FIRST CLAW DESIGN

Based on the CAD design that Jonas made, Jonas and Katy worked on prototyping a claw design.
Their requirements were:

- Be able to securely hold a stone
- Must be able to move toward and away from the robot
- Must be able to rotate the stone/claw
- Use rubber bands (spring loaded grabber)



In order to get good traction for the part of the claw holding the stone, we planned to use three methods.

- Servo at the point of rotation
- Lining the inside claw with rubber
- Spring loading with rubber bands

Although Katy and Jonas were able to successfully finish their prototype, they ran into an issue with Jonas' CAD where the virtual design where a screw was interfering with the movement of the device. Therefore, they had to alter the design. This resulted in the prototype being more flimsy than intended, but Jonas will correct this before the final design.

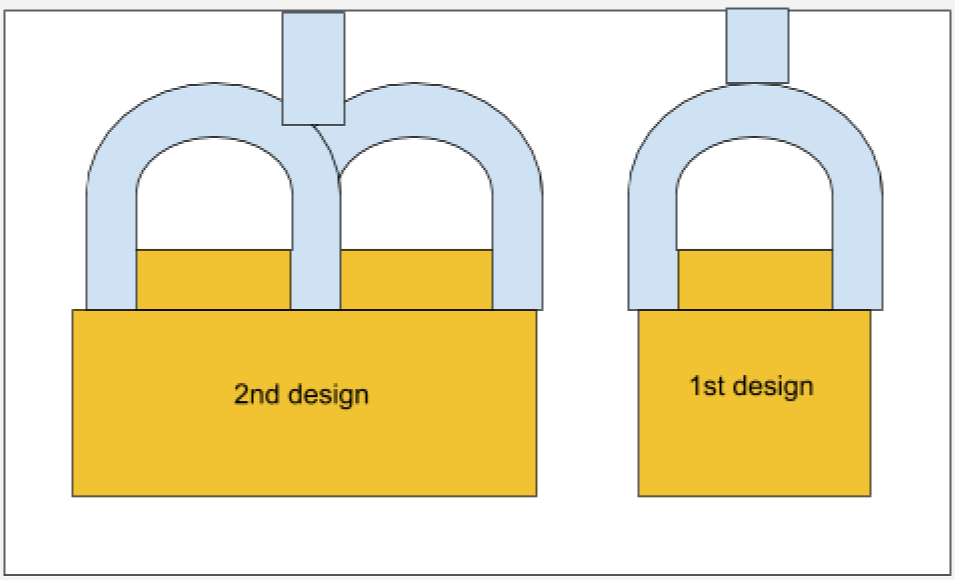
After finishing the prototype, we evaluated it against the original requirements.

Requirement	Evaluation

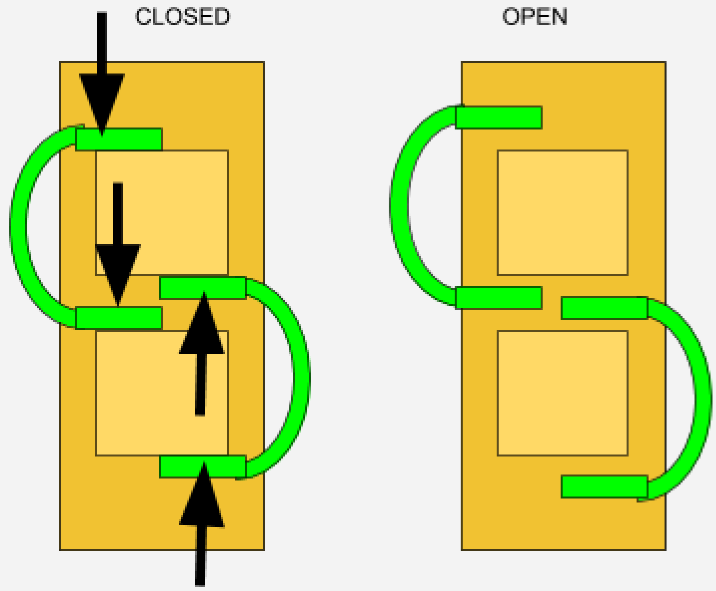
Be able to securely hold a stone	The claw can hold the stone but drops it when the claw is shook. The rubber strips used are not able to grip the stone as securely as we would like.
Must be able to move toward and away from the robot	The design is able to move forward and backward. When attached to a servo, the prototype fulfills this requirement.
Must be able to rotate the stone/claw	The design has the ability to rotate the stone from a point above. It is very loose in its current form but would be able to accomplish this with a servo.
Use rubber bands (spring loaded grabber)	The design uses rubber bands to hold the two claw arms together and pushing in the inward direction.

CONSTRUCT AND TEST A PROTOTYPE: SECOND CLAW DESIGN

We also tested out a second design. Our idea was to grab the stones by utilizing the studs from the long direction, rather than the short direction, as shown below.



We wanted to try a two part claw design that will apply pressure on four parts of the stone. This will allow for more surfaces to be in contact with the stone when the claw is in the closed position. It will also be easier to rotate the stone due to the four points of contact. However, it will likely be more difficult to pick up the stone with this design due to the fact that the two claws will have to fit into the narrow space inside the studs of the stone, rather than just being positioned outside the stone.

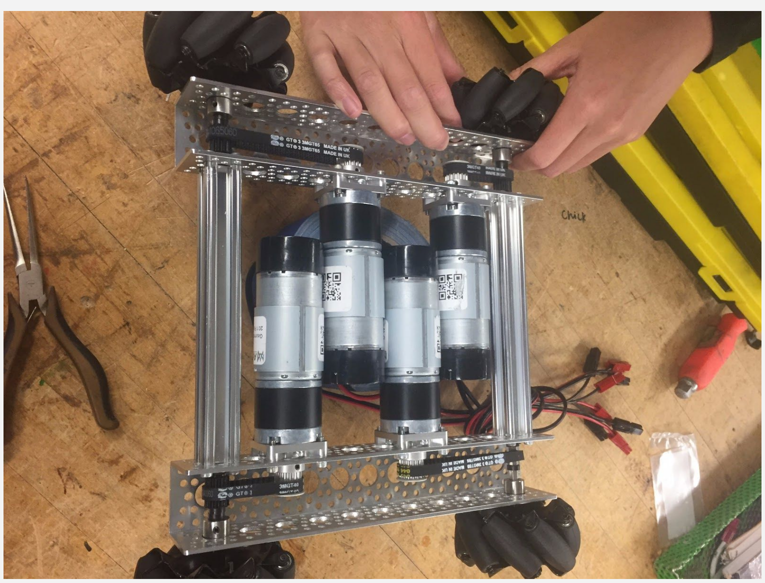


Define Problem	Generate Concepts	**Develop a Solution**	**Construct & Test a Prototype**	Fabricate and Integrate	Tweak & Evaluate

ODOMETRY & CHASSIS

CONSTRUCT AND TEST A PROTOTYPE: BUILDING CHASSIS

Paige, Suraj, and Zach continued working on attaching the belts to the drive train. They quickly ran into the problem that it was very difficult to put the small plastic spacers in place while also fitting the axle back into its hole.



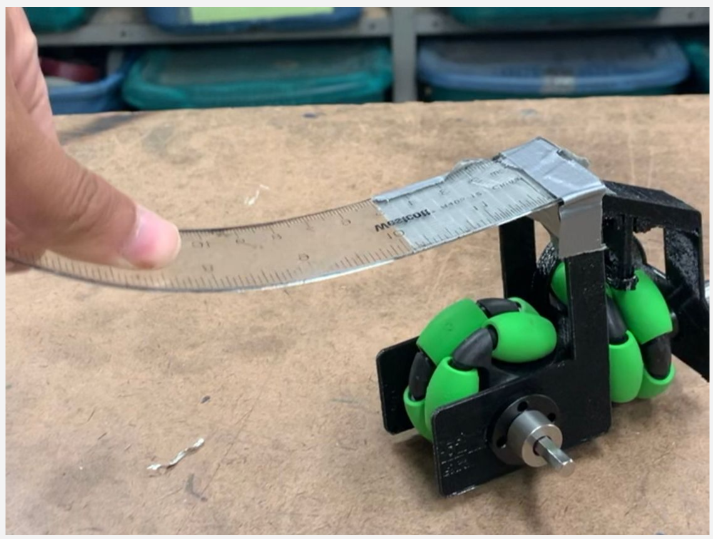
We were using custom 3D printed sprockets on the axles. During the assembly process, we found that one of them was not moving properly with the wheel and had stripped. We will have to print a new one.

CONSTRUCT & TEST A PROTOTYPE: ODOMETRY WHEEL V5

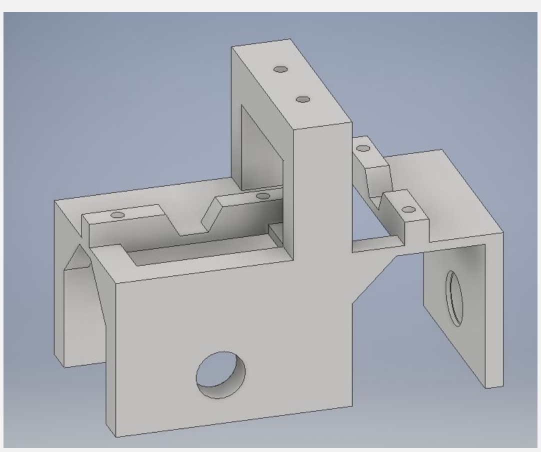
Upon reviewing the 3D print of the Odometry Wheel bracket, parts of it cracked and snapped off. The next edition will have to feature thicker walls. We realized we can do this by making the walls the same thickness as the bearing, that way, it will still be the same width, but the walls will be more structural. Also, the CAD will need a flange for the bearings for it to sit in the hole better.

We're also redesigning the way we are going to mount the encoder. We realized it would be very difficult to screw in the encoder and then press fit the gear on. Then if there were any problems, it'd be very hard to take out. Our new design makes taking the encoder out very easy. Instead, we will use a nylock nut on the encoder and press fit the gear on. We'll attach this assembly by clamping it down to the mount.

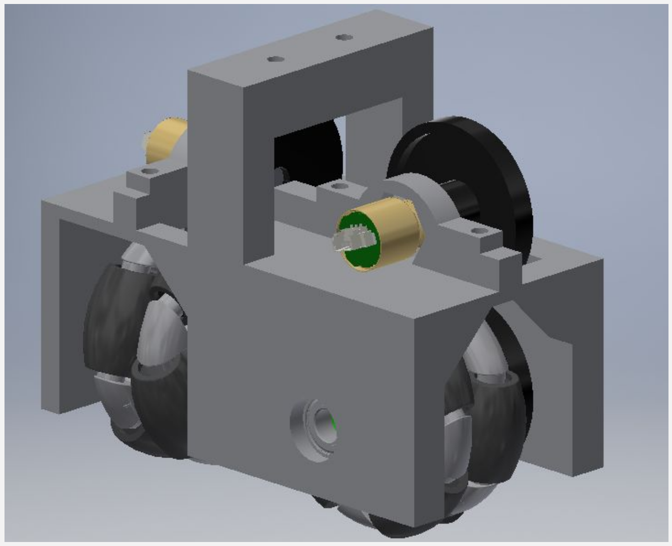
We also wanted to test the spring loading, so we used the broken print to rig up a loose mock-up, and taped it to a ruler to see if both wheels would contact the ground. The test was a success.



DEVELOP A SOLUTION: ODOMETRY V6 CAD



Odometry Wheel 6 now features thicker walls, a counterbore for the flanged bearings, and the new way to mount the odometry. Also, we measured the thickness of the gear to be .185 inches, so the width of the model was expanded to fit that as well.



CAD Model of Odometry V6 with Omniwheels

PROGRAMMING ACCOMPLISHMENTS

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

CAMERAS

GENERATE CONCEPTS: PID AND STEREO-DISTANCE ALGORITHMS

While waiting for the odometry wheels to be finished, Karthik learned about PIDs.

The programmers were trying to find algorithms and mechanism to identify the distance of objects (such as the stones or foundation) from the robot. While looking for any special cameras that could solve this issue, they found the Intel Realsense T265 Camera. Because it had two cameras, they noted that it could possibly identify the distance of objects from the camera using stereo-distance algorithms. However, we were not sure if this device was FTC-Legal. Therefore, we posted a question on FTC Forums. We received a green light on this device, and ordered two of them.

Hi,

We are looking at the Intel RealSense Tracking Camera T265 model, a camera that can perform Simultaneous Localization and Mapping (SLAM) functions. It makes no use of lasers, only two fisheye lenses and embedded electronics that take care of the SLAM computation. The device has a USB cable in which position data is received and has no features that would interfere with other robots' Autonomous or TeleOp routines.

Since the device is only a camera with inbuilt processing (similar to the already allowed Pixy Camera - https://pixycam.com/pixy-cmucam5/), is this allowed for competition use?

T265 Camera:
https://www.intelrealsense.com/tracking-camera-t265

Specs sheet:
https://www.intel.com/content/dam/support/us/en/documents/emerging-technologies/intel-realsense-technology/IntelRealSenseTrackingT265Datasheet.pdf

Thanks,

MOE 365

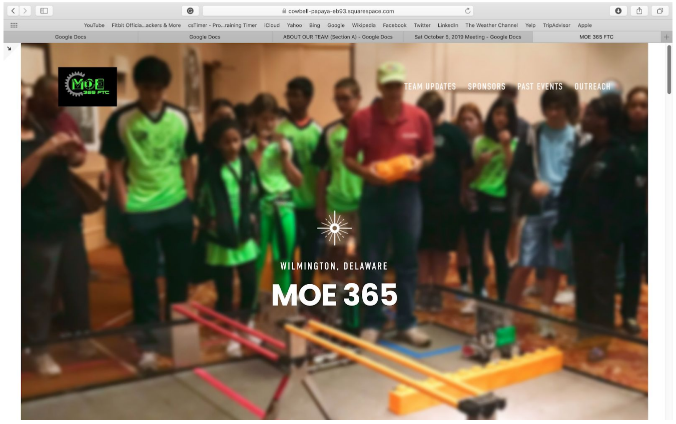
Last year, our robot had problems with accurate turning, but this year we would like to implement PIDs to be able to make turns with less error so that we will be able to make our autonomous programs more precise and consistent.

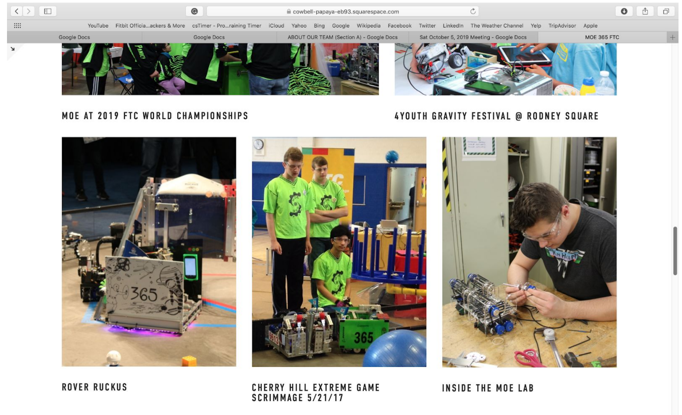
Prusa i3 Mk2 to Mk2.5 3D printer upgrade

- After Andrew and I (Ian) put a piece of tape on the piece of the extruder that triggers the x-axis endstop and now it triggers the x-axis endstop
- Then, I did the self test calibration for the printer and the fans, the x, y, and z axis, the bed heater and thermistor and extruder heater and thermistor were working good.
- After that, I did the xyz calibration, which calibrates the x, y, and z axises of the printer.
- Then, I completed the first layer test on the printer to get the correct the z height of the nozzle to the bed so that the printer prints the lines the right size.
    - The z height I got was -0.6 mm from the bed.
- Then, I did a test print of a test cube to see if everything is working properly.
    - The print turned out pretty good but there was a spot in the print that there the extruder under extruded the filament for that part of the print. This ruined the print and this was happening every time I printed the test cube.

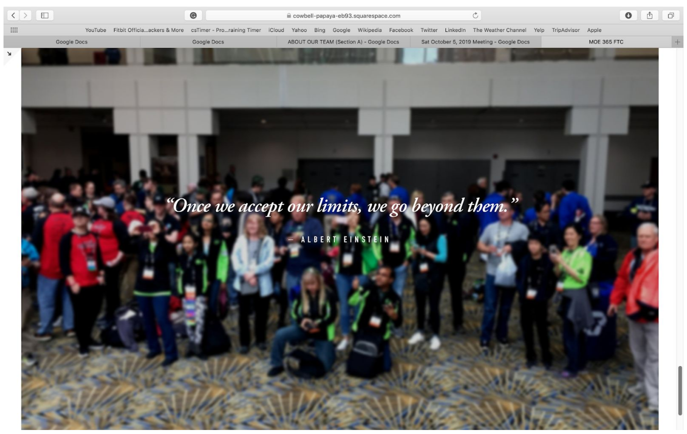
NON-TECHNICAL DISCUSSION

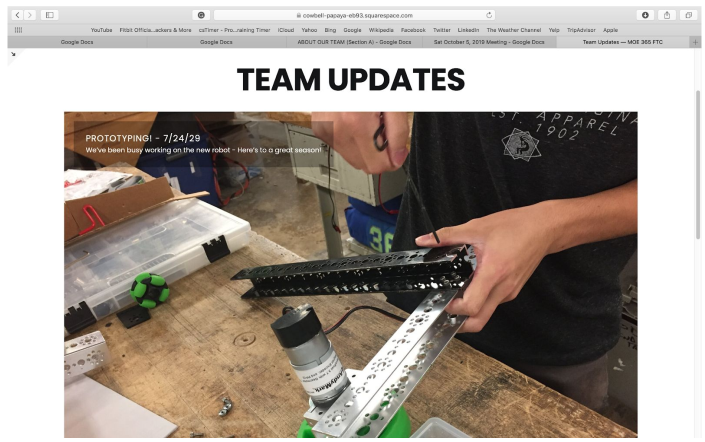
- **Helen and Clare have been working on building the team website.**



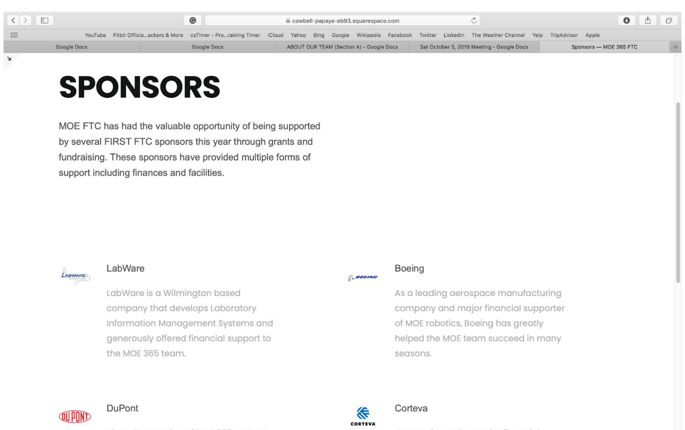


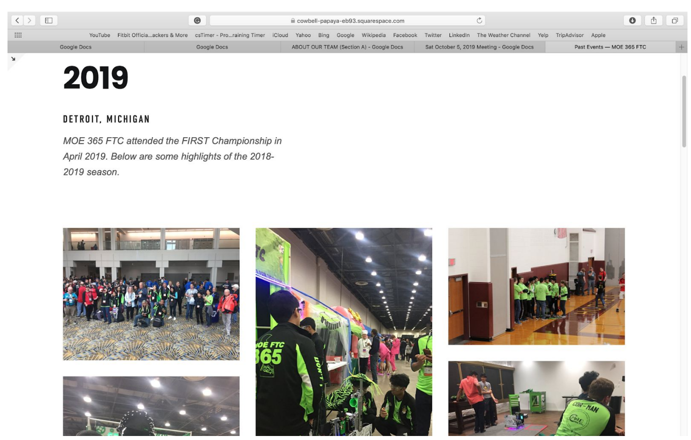
- We included team pictures and past events



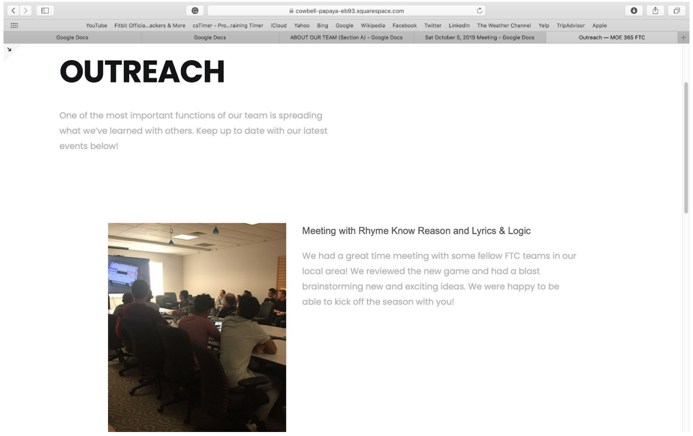


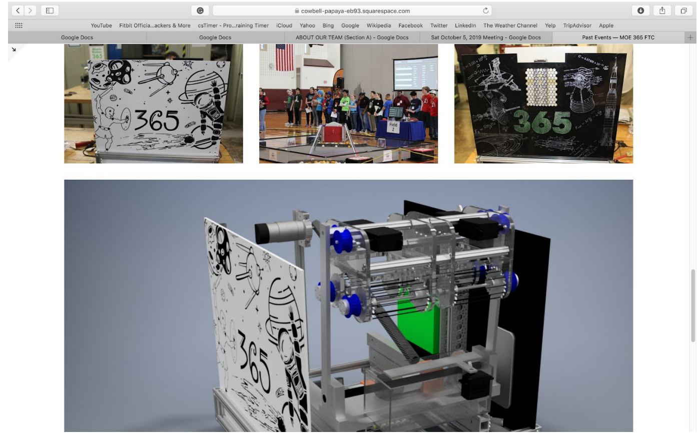
- We have a dedicated page for current team updates and images





- We outlined our sponsor and outreach program





- We still need to add a resource page with our past notebooks, FTC information, and FIRST official websites.

- **An idea for our annual outreach goal is to help transition FLL students into the FTC program.**
    - There is a large amount of local FLL teams but a shortage of FTC teams.
    - We would like to create new teams for FLL teams to join.
    - For example, Newark Charter is a K-12 school that has an FLL program but not an FTC program.
    - We would like to connect to existing clubs in our own schools that share our goal of spreading STEM and demonstrate the impact of FIRST® Robotics.
    - We would like to expand the local FTC community.

MEETING SUMMARY

- Stacking Stones Prototyping & CAD
- Odometry V6 CAD
- Team Website pictures

TUESDAY, OCTOBER 8, 2019 MEETING

DATE & TIME: 10/08/19 | 6:00 PM - 8:30 PM

STUDENTS: Helen, Clare, Connor, Ian, Suraj, Isha, Rohan, Karthik, Jonas, Aidan

MENTORS: Mr. Prettyman, Nick

AGENDA
Reminder: please update availability status on team snap
Review team member slides
Subteam timeline update
Announcement: extra meeting on Friday to finish odometry*

TIMELINE REVIEW

CAD	Four-bar and gripper finished by next Tuesday, 10/15
Odometry	Finished by Saturday, 10/12 *

*Odometry progress is slower than Bryan predicted. To accommodate this, they are adding an extra meeting on Friday. More information can be found below in the Non-Technical/Discussion section.

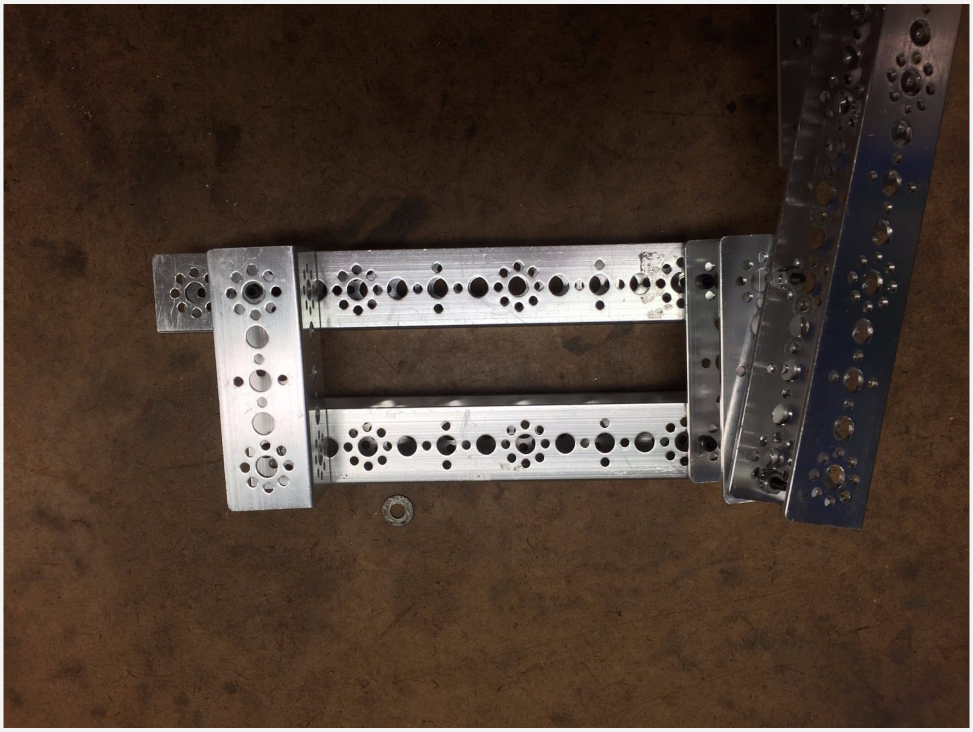
MECHANICAL ACCOMPLISHMENTS

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

SCORING STONES

DEVELOP A SOLUTION: CLAW CAD

Connor and Isha worked together to begin CADing a model of the four bar claw mechanism that Katy and Jonas prototyped last week. Isha CADed half of the model of the four bar claw mechanism, and learned how to measure and extrude parts in CAD.



They didn't finish by the end of the meeting, but they will continue working on this on Saturday.

CONSTRUCT & TEST A PROTOTYPE: CLAW MECHANISMS

We showed our two new prototypes to Nick and some other team members.
We evaluated the designs and came up with some pros and cons of each.

First design - four bar design

PROS

- Grips effectively
- Fewer accuracy requirements due to larger surface area
- Uses elastic tension to pick up block, has rubber lining on the inside to increase friction and stability

CONS

- Clunky (needs to be simplified)
- Forebar restraints, limited degree of freedom is possibly too constrained
-

Second design - scissor pincher


PROS

- Uses effective rubber grips
- Four points of contact

CONS

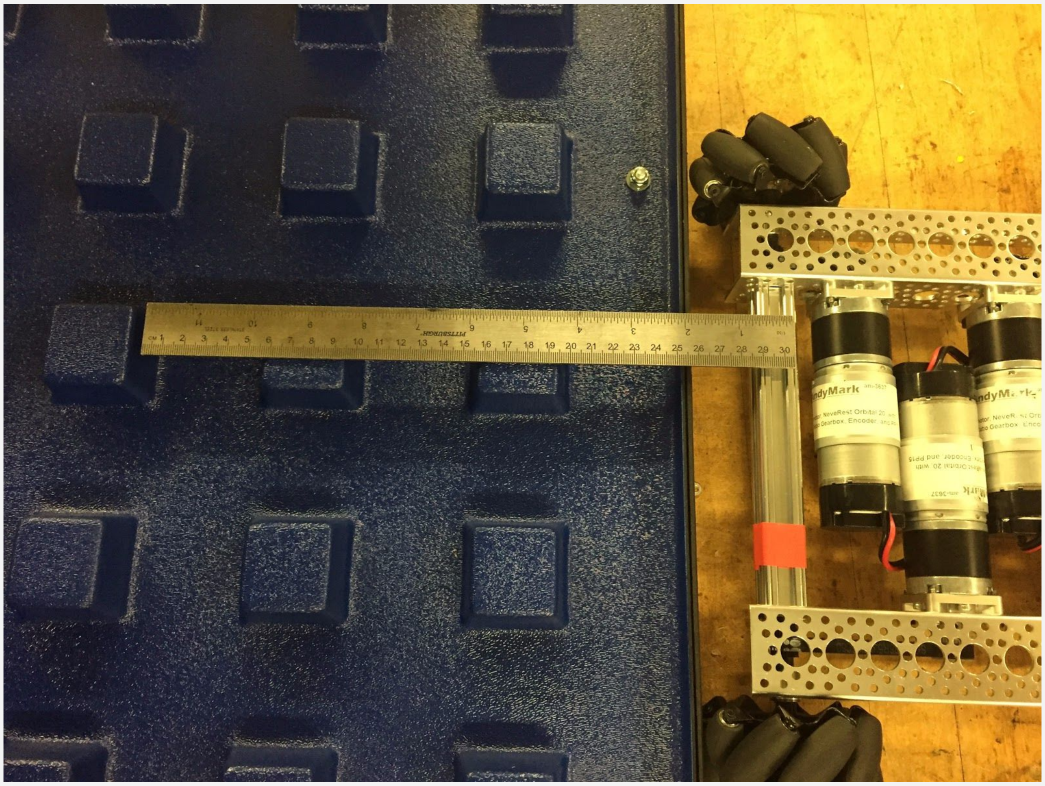
- Scissor mechanism requires a lot of vertical height
- Less room for error when picking up stones

With these ideas in mind, we chose to test the four bar design first because we think it is more stable, will not run into problems with height, and is a more developed idea than the second scissor design.

Jonas and Katy worked with Nick to calculate the geometry needed to see how much reach we would be able to get using our current four bar design and where the points of articulation would need to be positioned.

One of the benefits of our smaller drivetrain structure (10” long) is that we can drive up to the Foundation but still have a mechanism that starts 4 inches.

However, we chose to make a conservative estimate by starting the base of the mechanism directly above the front wheel. If we find that the mechanism will be functional and won’t create an issue with weight balance, we may consider moving it outwards to gain additional reach.



They calculated the reach as 8 inches. This is enough to reach the edge of the second set of studs, but we would prefer for the reach to be greater so that we could position stones in the 2nd and 3rd row from either side of the Foundation.
To lengthen the reach, we tried adding an additional stage to the design.

PROGRAMMING ACCOMPLISHMENTS

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

DISTANCE ALGORITHMS

GENERATE CONCEPTS: DIFFERENT DISTANCE ALGORITHMS

Along with the currently developing localization system, we needed a way to tell the distance of certain objects to the robot. For example, the foundation can move at any point during the game, including autonomous. To have a robust autonomous, we would need to be able to detect the location of the foundation & other objects relative to the robot.

Initially, we tried using a camera-based approach outlined in an earlier meeting - we tried to create a model relating 2D pixel location on a camera to a point in 3D space. However, the approach we used was too simplistic and would not appropriately scale to different kinds of inputs.

Now, we brainstormed different ideas for the algorithm, using expertise from our mentors at Boeing & other mentors. The main ideas from the brainstorming session are shown below:

Distance Sensor 2D Mapping

Methods:
Mount 4 distance sensors on 4 sides of the robot at the same heights
Take a 2D place, slice the field at the above height
Take the intersections between the plane & field objects
Store the intersections
Using current robot location, calculate ideal distance reading for 4 distance sensors
Anytime reading is less than ideal, we know that there is an object in the place

Drawbacks:
Does not work when any object is outside of the very narrow view of the 4 sensors
Hard to tell the bounds of a detected object (ie: only the very small part that is detected is what we know)
Cannot do more than a few sensors because of hardware limitations of REV Hub & competition rules

Camera Edge Detection

Methods:
Use OpenCV “Canny” edge detection algorithm
Gather the edges on an image
Use an algorithm that can convert edges into 3D objects

Drawbacks:
Difficult to implement
Hard to tell if there is a consistent pattern between edge & 3D location

Stereo Camera Vision (GOOD Option)

Methods:
Mount two cameras on the same horizontal axis
Both cameras should be the same distance from the center of the robot
Use an algorithm to compare image data to tell 3D position of each pixel

Drawbacks:
Difficult to implement (but there is a paper - http://dsc.ijs.si/files/papers/s101%20mrovlje.pdf)
Lots of noise in the final data - smoothing may need to be used

In the end, we decided to investigate the **Stereo Camera Vision** algorithm further, due to the ease of building, prior research done, and feasibility.

PRUSA i3 MK2.5 3D PRINTER UPGRADE

- Ian printed the test cube again to see if the printer is still doing the under extrusion thing where there are is gaps in the print where there should not be.
- Then, he and Andrew decided to increase the temperature of the extruder by 5°C, for 255°C to 260°C
  - The cube printed successful and perfectly after making this adjustment to the print settings.

NON-TECHNICAL DISCUSSION

- We would like to have all team members update their availability status on TeamSnap. This will make it easier for us to plan for meetings because we will know the attendance ahead of time.

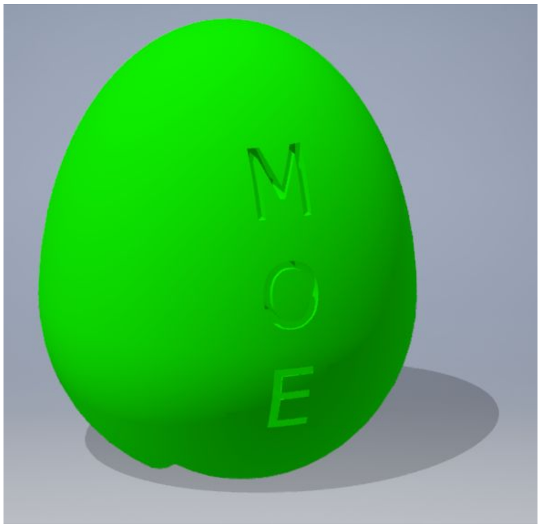
- We may attend some New Jersey qualifiers in November. This provides an early checkpoint for us to focus our progress.
- Pennsylvania, Maryland, and New Jersey state championships are the end of February.
- Delaware State Championships is on March 14.

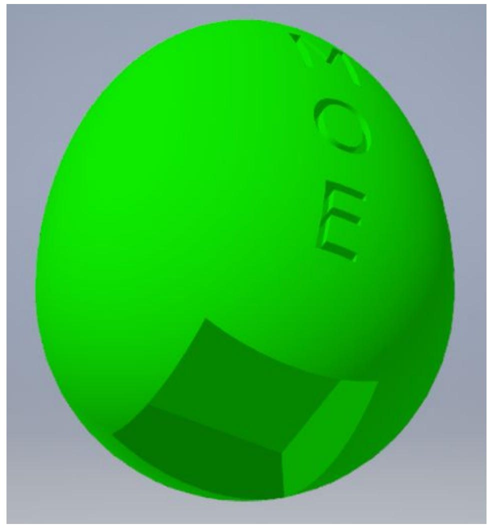
- **Odometry is scheduled to be finished by Saturday. We are adding an extra meeting.** The odometry wheels are not as close to being finished as we would like. This is a high priority, as the programmers are highly limited in their progress until they can have a chassis with odometry wheels. Bryan and Patrick will come in on Friday to work with Arnav and Zach.

- **We have a few ideas for upcoming outreaches.**
  - Jonas, Karthik, Helen, Rohan, and Isha go to Newark Charter School, which has a FIRST Lego League program for middle school students but does not currently have an FTC program. We would like to visit their FLL teams and provide them with information and support to potentially start an FTC team in the future.
  - A local nonprofit called Code Differently hosts an after school coding program for students in the urban Wilmington area. We would like to partner with them to bring in our robot and potentially start an FTC or FLL team with some of their students.
  - We received an invitation to attend the National Chemistry Week event at the Independence School on November 2. We have done this event for many years and would like to also attend this year.
- To prepare for these upcoming outreaches, we need to repair the BatterBot.
- Aidan and Suraj worked on fixing it today.

- **We published the team website!**
- Helen and Isha made a new social media post today, featuring Carl and Uniquesha!

- Connor downloaded 1.3 GigaBytes of CAD files from Tetrix, Rev, and more. Thanks to the new internet sticks, this only took about 20 minutes. However, they download as STEP files. Autodesk inventor only uses ipt and iam files. Connor used Autodesk Task Scheduler to automatically convert all these to Inventor files. This will take about 130 minutes. The process is automated so it can run in the background or even be paused and resumed later. He hopes it will run while the computer is in sleep mode and finish before the Saturday meeting. While this was happening Connor made an egg capstone. It has the little square hole in the bottom so it can fit on the blocks. By the end of the meeting the Task Scheduler was 36% done.





MEETING SUMMARY

- Stacking Stones Prototyping
- Distance Algorithms Brainstorming

FRIDAY, OCTOBER 11, 2019 [EXTRA] MEETING

DATE & TIME: 10/11/19 | 4:30 AM - 7:00 PM

STUDENTS: Patrick, Bryan

MENTORS: Zach, Arnav

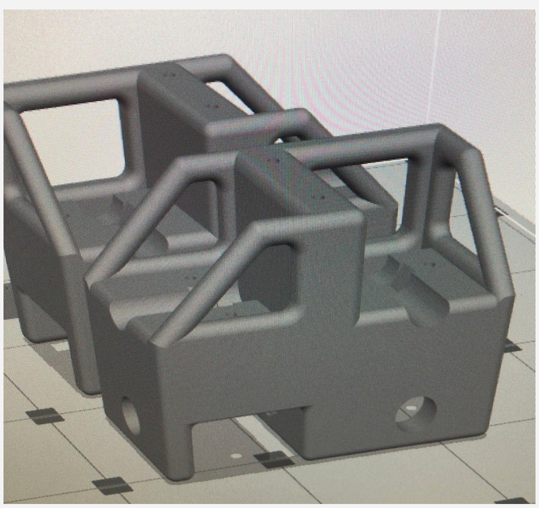
AGENDA
Start and Finish Odometry V6 Fabrication

MECHANICAL ACCOMPLISHMENTS

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

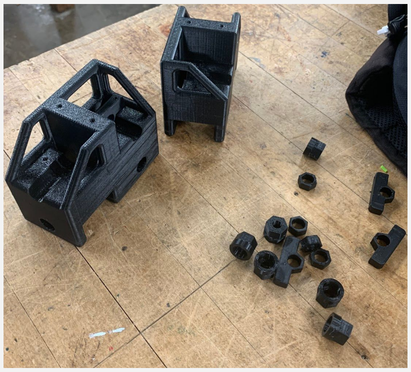
ODOMETRY

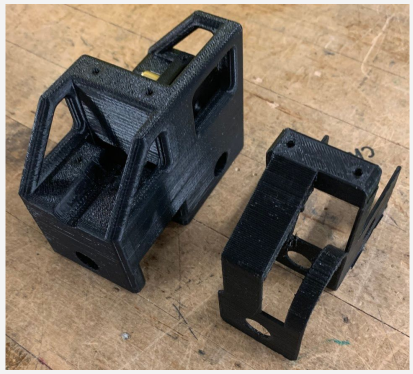
DEVELOP A SOLUTION: ODOMETRY V7 UPDATE



To update the odometry design, we used the approach of starting with a block and then cutting away for spots we needed for the wheels, gears, etc. We did this so that it could have as much material as possible to keep it stable. This is the design we ended with. We also had weight saving holes at the top and also to have some visibility of the encoder. The Encoder is also now threading into a plastic bracket that clamps onto the rest of the assembly. This way it is constrained in all directions, one axis of translation and one axis of rotation by being screwed into the small plastic bracket, and the rest of the axes of translation and rotation by being screwed into the rest of the assembly. This also gives us the ability to quickly unscrew the encoder to troubleshoot for problems or to replace any part of the encoder assembly (gear, plastic bracket, or the encoder itself).

FABRICATE AND INTEGRATE: FABRICATE ODOMETRY PODS

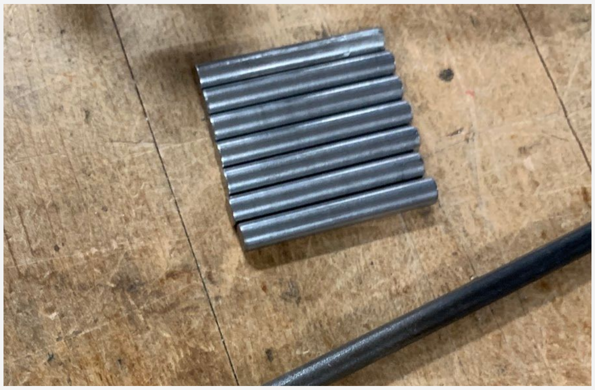




We printed the CAD design in ABS using the 3D printer at the University of Delaware. The printer is an industrial grade printer so it has the ability to print dissolvable supports. This makes it easier to print the complex geometry of the odometry pods. (Picture on right shows Odometry V7 next to V5)

The encoder press fits into the module and the gears press fit on to the encoder and onto the wheel. We used flat surfaces to help distribute the force when press fitting.

We used Actobotics bearings so the axles can move with less friction. Sadly, the hole we created for the bearing was slightly too small, so we used a half-inch drill bit to clear it out. We had to arbor press the axles in to make them as flush as possible so we used a bolt that could drop through one side and a file as a flat edge to safely arbor press each bearing in from the inside.

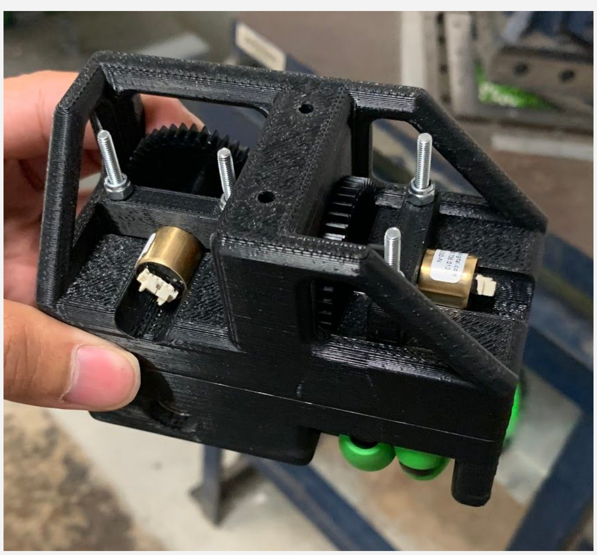


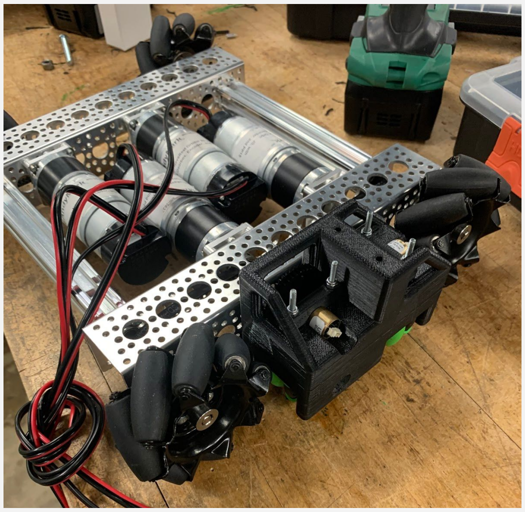
Next we needed axles, and we had a 17.5" long steel axle that we were going to cut into 4 pieces. Conveniently, we already had axles of cut to the correct size for a summer project we were doing, so we decided to use those instead.

Finally we needed to arbor press the axles in.

We only need three encoders, but we need 4 wheels for the pod to be stable. We did not print the parts for the fourth wheel to be added, but we can print it tonight and assemble it tomorrow.

When making the second odometry pod, the wheel did not spin as well as the first. This was because the plastic was touching. To fix this, we used a space to create distance for the wheel to freely spin.





We put the odometry pod where it would relatively be on the chassis to see how it fits. It fits with enough tolerance to accommodate the changes in terrain we might experience when driving the robot over the central ramp.

We hope to keep the robot under 14 inches so that it can receive points for passing underneath the lower ramp with Stones, but we may drive over the center ramp when returning back to the quarry.

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

CHASSIS

FABRICATE AND INTEGRATE: REBUILD CHASSIS

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When looking at the two chassis we have, one had a broken tap in the x-rail and the other one was missing a pulley. We got removed a pulley from the former so we could have a complete chassis for the programmers

We also added more spacing between the wheel and the chassis so we could fit side panels on. The side panels are where we put our electronics.

NON-TECHNICAL DISCUSSION

- We wanted this extra meeting so the programmers can have the odometry wheels and the chassis for all of Saturday, earlier than planned. Autonomous progress has been bottlenecked by the lack of odometry and a chassis with electronics, so we highly prioritized the fabrication of these modules and finishing the chassis.

MEETING SUMMARY

- Odometry Pods’ Fabrication

SATURDAY, OCTOBER 12, 2019 MEETING

DATE & TIME: 10/12/19 | 9:00 AM - 2:30 PM

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

MENTORS: Mr. Prettyman, Andrew, Zach, Arnav

AGENDA
Update on timelines: programming, CAD, odometry
Team snap reminder - please update availability
Task assignments (many team members = opportunity for productivity!)

TIMELINE REVIEW

CAD	
Odometry	Finished by Tuesday (worst case: Saturday)
Programming	Start odometry localization on Saturday 10/19

MECHANICAL ACCOMPLISHMENTS

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

SCORING STONES

DEVELOP A SOLUTION: FOUR BAR CAD

Connor and Isha continued CADing the four bar mechanism from Tuesday.

The CAD computer did not run Task Scheduler while the computer was in sleep mode. When Connor opened the Task Scheduler, it was still 36% complete. He will continue running the Task Scheduler until it is complete. It seems to be running quickly as in the first 30 minutes of the meeting it went up to 56%. However, he will not be able to do CAD until it is complete. Task Scheduler finished around an hour and a half into the meeting. While it was running he helped Isha CAD the mechanism. Isha finished CADing the mechanism around 11.30. Then Connor started CADing the mechanism.

Because we already had a version of the design that Jonas and Katy had prototyped, this made for a good practice exercise for Isha to get experience with the CAD software. She and Connor made the design in CAD.