# Team 4327
# Strategy Development & Engineering Process

# This Is How We Robot.

**Mission Statement:**
To cultivate intergenerational connections, employable skills, personal empowerment and community engagement in Battle Creek via STEAM innovation and the principles of FIRST.

**Vision Statement:**
An established program both in structure and in physical manifestation for students to experience and be inspired by robotics competitions.  Each new cohort of students learn from the former and are mentored in each field by dedicated professionals serving as mentors.  Q Branch Robotics will be a consistent competitor on the world stage as well as a significant source of positive change in the Battle Creek community.

# Strategy Development

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***Gameplay***

1. **Who is playing on Einstein?**
   Think of the game playing at its highest level. What alliance of three robots would accomplish the tasks the best? This is not always a triple threat of do-it-alls. Sometimes there are pinch points where game pieces can only be accessed by one area or scored by one partner at a time. The other robots need something to do which could also be slowing down the other alliance.
2. **Is it worth your time?**
   Which tasks are worth the most points against the necessary time to accomplish them? Which tasks are worth their risk of repeatability? FRC games are often about cycle time. The total amount of "teleop" time divided by the time necessary to complete a task from start to finish will give you an idea of the number of scoring cycles possible in a match. A low point task which can be done several cycles in a match may be a better strategy choice than a high point cycle which can be done only once per match.
3. **What is explicitly stated by the rules?**
   Tasks which earn your team points are well defined. Do not do more than necessary as there are no style points in FRC. For example, in 2013 to earn 10 points at the end, the robot had to simply be off the ground. Anything from a sheet of paper off the ground to about three feet was all worth 10 points. Why do more than you have to?

***QFD (Quality Function Deployment) - credit seminar from Team 3641 at 2013 MSC***

1. **Identify all scoring opportunities.**
   This includes all stated and unstated by the rules (usually defensive strategies). All of the ways in which your team can gain points or cause your opponent to not score points. FRC challenges are all about the "delta" or the difference between your alliance's score and the opposing alliance's score. Winning one match by 100 points is worth as much as winning by 1 point. We would rather win 12 matches by only 1 point each (go undefeated) than have the highest score the whole event, but lose 11 matches.

   This also includes laying out all of the necessary subtasks to scoring. For example, to score a game piece, the robot must first obtain the game piece, then hold onto the game piece, then score the game piece. Getting a game piece is useless of the robot will lose the piece when hit or turning at high speed. Being the best at getting and holding a game piece means nothing if you miss every shot when another robot drives in front of you.

2. **Identify all robot functions.**
   Including driving, describe all of the attributes of a robot which would allow your team to complete the scoring opportunities listed in part (1). Keep this generic in regards to attaining or scoring game pieces. Terms like "hopper", "grabber", "kicker", "shooter" can be used season after season with some small tweaks to fit each challenge.

3. **Assign strategic value to the scoring opportunities.**
   Rating from 1 (not important) to 5 (cannot win without this), give a numeric value to each and every scoring opportunity. After playing the game as humans, the team should know the general import of each scoring opportunity. Only those which are absolutely critical should be assigned a 5. This would mean that without this aspect of gameplay, the team is highly unlikely to win any match, let alone the entire event. Those at a one or two are those which are flashy, but not necessary for most teams (see "Fuel" from 2017).

4. **Assign Effort-to-Impact value to the robot functions.**
   Rating from 1 (really hard and not worth many points) to 5 (really easy/well-known and worth many points), give a numeric value to each every robot function. This requires some level of wisdom and works best as institutional knowledge is gained. If a "floor grabber" for a game piece is really easy and would really benefit the team strategy, then go ahead and give that a five. If the team has never developed a "floor grabber" before, then perhaps this would be more challenging and there is an easier way to obtain the game piece.

5. **Highlight.**
   Highlight the top X rows for percentages on strategic importance. Highlight the top Y rows for percentages on effort-to-impact. Where these overlap are the aspects of the robot which are critical to your desired gameplay.

6. **Stick to the plan of QFD.**
   As the robot designs begin to flow, checking across the team QFD will help provide an objective, numeric rubric by which designs can be compared. Most personal feelings are gone away from argumentation and students understand what the mentors are looking for in a "good" robot design. The process of developing the QFD guides student thinking and keeps the team focused on the realistic gameplay of the challenge as opposed to what would be simply "cool" or "neat" to see on the field.

***Build Season***

1. **Focus on doing one thing well instead of two things poorly.**
   FRC is played two alliances of three robots each. Not every robot needs to complete all tasks available equally well to succeed. Being really good at one scoring task is a great way to ensure you are playing and sometimes picking for the eliminations.

2. **Be realistic with resources.**
   Time is a resource. Dedicated mentors are a resource. Team experience is a resource. Money is a resource. Passion is a resource.

   Be realistic with what resources the team has to execute a plan. Plan to keep the final week of build season open for testing to know what is wrong with the robot before getting to the first competition. If any of the resources listed above are scarce, then keep the robot as simple as possible. A simple, reliable and tested robot is better than a half-built expensive bot which was attempted by an overly ambitious team.

3. **Details matter.**
   Sloppy wiring? Tear it out. Saggy bumpers? Throw them away and start again.

   Do it right the first time. Dedication to the details shows dedication to a good plan and well executed robot plan. If your team does not have the time to do this well, then your team does not plan properly.

# Strategy Development

**Evidence from 2019 season.**
**On 1/5/19 after kickoff our team played a human player version of the game.**

# 2019 QFD

| | | | | Column # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Direction of Improvement (Rev. only) | | | | | | | | | | | | | | | | |
| Row # | Weight Chart (Calculated) | Relative Weight (calculated) | Strategic Importance (Team Sets 1-5) | Max Relationship (Red is Negative) | Capabilities & Features / Scoring Opportunities & Necessary Attributes (Explicit and Implicit) | SPEED | PUSHING POWER | MECANUM DRIVE | TANK DRIVE | SLIDE DRIVE | SUCTION CUPS | VISION / CAMERA | AUTON MODE | ELEVATOR | INTAKE | BIG ARM | SHOOTER | LIFTER | BUDDY BARS | HOPPER | DOWNFALL |
| 1 | | 8% | 5 | . | Sandstorm Bonus 1 | ○ | | ○ | ○ | ○ | | ○ | ○ | | | | | | | | |
| 2 | | 7% | 4 | 9 | Sandstorm Bonus 2 | ○ | | ▽ | ○ | ▽ | | ○ | ○ | | | | | | | | ● |
| 3 | | 8% | 5 | 9 | Hatch Panel Bay/Low Rocket | ● | ○ | ○ | ○ | ○ | ● | ● | ○ | | ● | | | | | ● | |
| 4 | | 8% | 5 | 9 | Hatch Panel Med/High Rocket | ● | ○ | ○ | ○ | ○ | ● | ● | ○ | ● | ● | ● | | | | ● | |
| 5 | | 8% | 5 | 9 | Cargo Bay / Low Rocket | ● | ○ | ○ | ○ | ○ | ○ | ● | ○ | | ● | | ○ | | | ● | |
| 6 | | 8% | 5 | 9 | Cargo Med / High Rocket | ● | ○ | ○ | ○ | ○ | ○ | ● | ○ | ● | ● | ● | ● | | | ● | |
| 7 | | 5% | 3 | 9 | Defense | ● | ● | ▽ | ● | ○ | | | | | | ○ | ○ | | | | |
| 8 | | 8% | 5 | 9 | END HAB 1 | ● | | ○ | ○ | ○ | | | | | | | | | | | |
| 9 | | 8% | 5 | 9 | END HAB 2 | ○ | | | ○ | ○ | | | | ○ | | ○ | | ● | | | |
| 10 | | 8% | 5 | 9 | END HAB 3 | ○ | | | ○ | ○ | | | | ○ | | ○ | | ● | | | |
| 11 | | 8% | 5 | 9 | HAB RP | ○ | | | ○ | ○ | | | | | | | | ● | ○ | | |
| 12 | | 5% | 3 | 9 | Partner HAB 3 | | | | ○ | ○ | | | | | | | | ● | ● | | |
| 13 | | 7% | 4 | 9 | Precision | ▽ | | ● | ▽ | ● | ○ | ● | ○ | ○ | ○ | | | | | | |
| 14 | | 0% | | | | | | | | | | | | | | | | | | | |
| 15 | | 0% | | | | | | | | | | | | | | | | | | | |
| 16 | | 0% | | | | | | | | | | | | | | | | | | | |
| | | | | | Target (What we want) | | | | | | | | | | | | | | | | |
| | | | | | Max Relationship (Red is Negative) | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 3 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| | | | | | Difficulty Rating (Impact vs. Effort) 5=High impact/Little effort | 5 | 3 | 2 | 5 | 4 | 4 | 5 | 3 | 4 | 5 | 3 | 4 | 4 | 3 | 5 | 3 |
| | | | | | Technical Importance Rating | 593220 | 745762 | 542372 | 694915 | 711864 | 372881 | 186440 | 779661 | 372881 | 542372 | 864406 | 694915 | 457627 | 186440 | 508474 | 1016949 |
| | | | | | Relative Weight | 14% | 4% | 6% | 8% | 8% | 6% | 10% | 4% | 6% | 8% | 6% | 3% | 7% | 2% | 8% | 2% |
| | | | | | Weight Chart | | | | | | | | | | | | | | | | |

**Students and mentors create a QFD for the Deep Space game on Kickoff.**

# Strategy Plan

Based on the mock game play and QFD our team has decided on the following strategy:

**Autonomous**: Due to the removal of a necessary autonomous period, this regular portion of gameplay is drastically altered. Instead there was a "Sandstorm" period in which the drivers would not be able to directly see the field. Instead of relying on an autonomous program which in the past proved to be less than 100% consistent in performance, we would dedicate driver practice utilizing a camera to maneuver our robot.

**Telop:** Shooting for all levels of the rocket and the cargo ship for cargo and hatch panels. Ranking high is our priority and we have the resources to tackle this portion. Gathering and shooting a single ball was the goal in both 2014 and 2016 thereby we have the team knowledge to accomplish this relatively confidently and quickly.

To score the cargo, a hatch panel must be in place. Thereby the hatch panel is top priority followed by the cargo. Placing null hatch panels prior to the sandstorm period would help in this regard, but do not count for any points. To maximize points, we want all opportunities to do so.

In playing several strategies, there appeared to be an advantage regarding the flow of traffic to have two "rocket specialists" and one "defender". This not only maximized the alliance points, but slowed the cycle time of the opposing alliance.

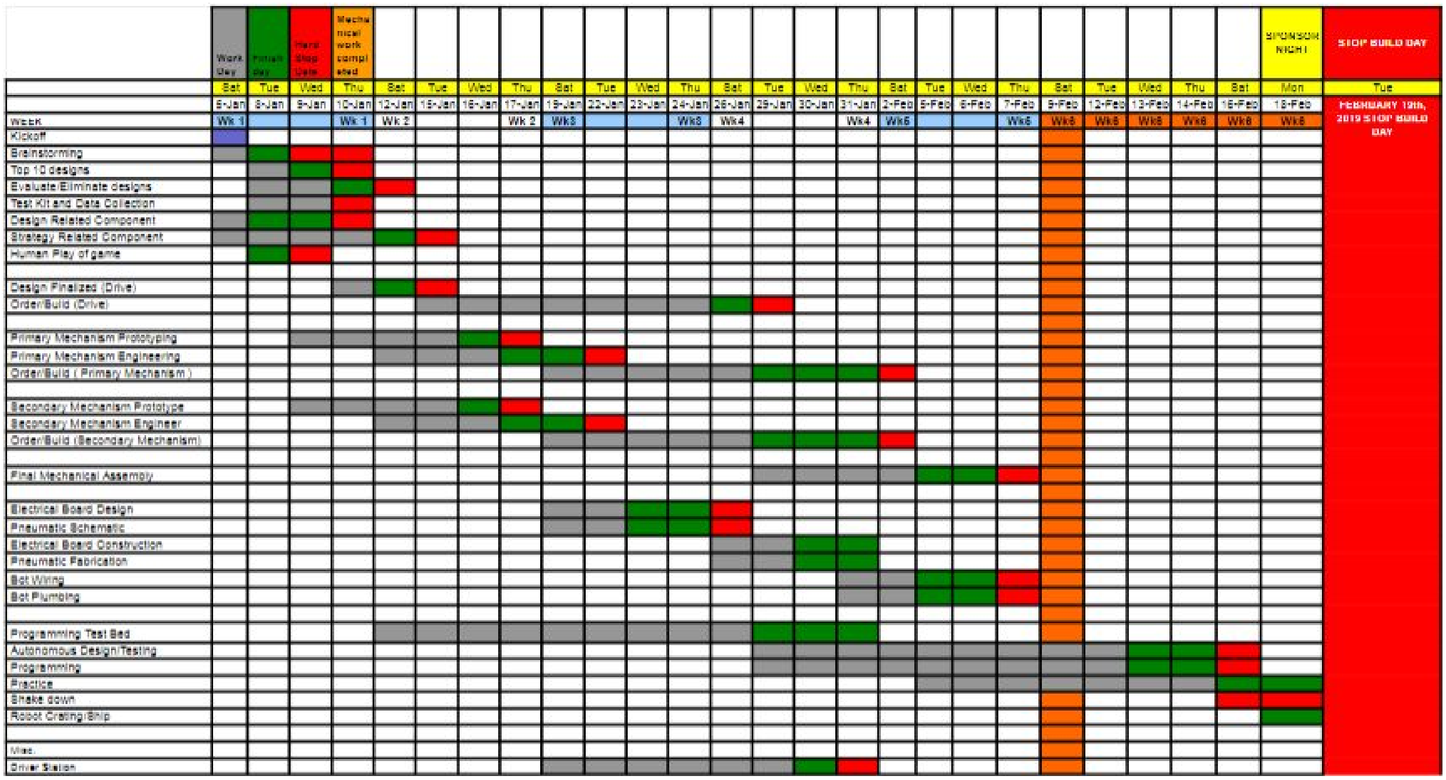
*Goal:* Complete a full rocket for ranking point alone. At worst, this then allows the team to bounce between earning 1 and 3 RPs instead of 0 and 2 RPs. This would put a team who went 6 wins - 6 losses on par with another team who went undefeated, but never scored the extra ranking points.

**End Game:** Get on third level of HAB. To earn another RP, if one robot is on HAB 3, then another robot only needs to get onto the ramped surface of HAB 1. This could be done at the last second giving them the chance to score an additional panel or cargo before helping earn the final additional 3 pts as well as the ranking point.

In order to do this our robot will need to have the following features:

(1) Lifting Mechanism
(2) Intake Hatch
(3) Intake Cargo
(4) Robot Lift System

# Engineering Process




Throughout the build season and engineering process a Gantt Chart is followed to set daily goals. These goals are communicated to the team through daily agendas and progress checks.

**Student Sketches:**
After completing the QFD as a team, students break out into teams and list/sketch ideas of what they think a successful robot will look like. Then then bring these ideas to the whole group and present them to the whole group. The whole group evaluates pros and cons of each system to decide what the best options are.

Image 1: Demonstrates student ideas including an arm which can go both directions, tank treads, and suction cups to manipulate the cargo and hatch.

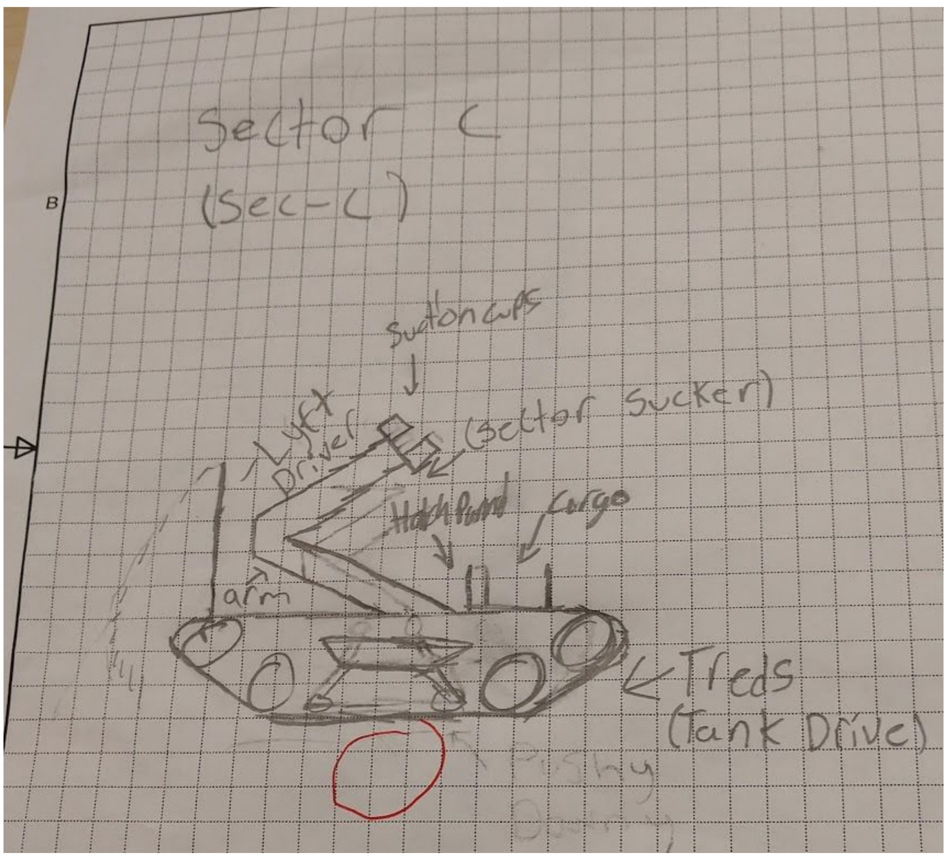


Image 2: Demonstrates a list of student ideas which demonstrates a velcoro intake with pistons for the hatch, tank drive, suction cups to control the cargo, and vision tracking.

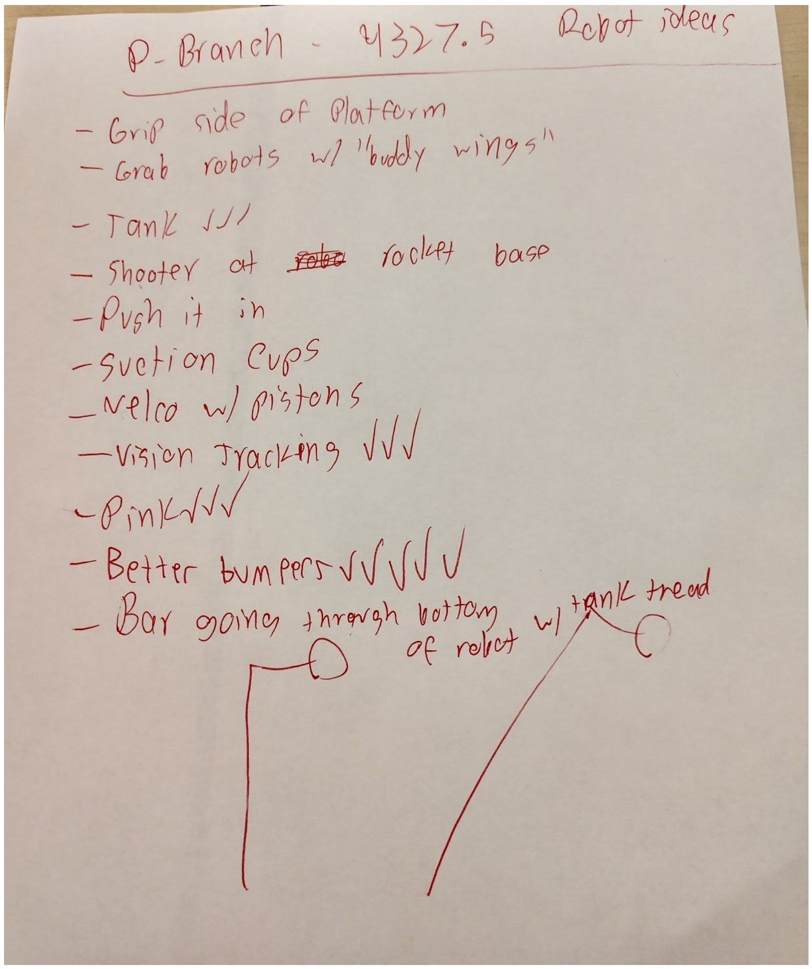
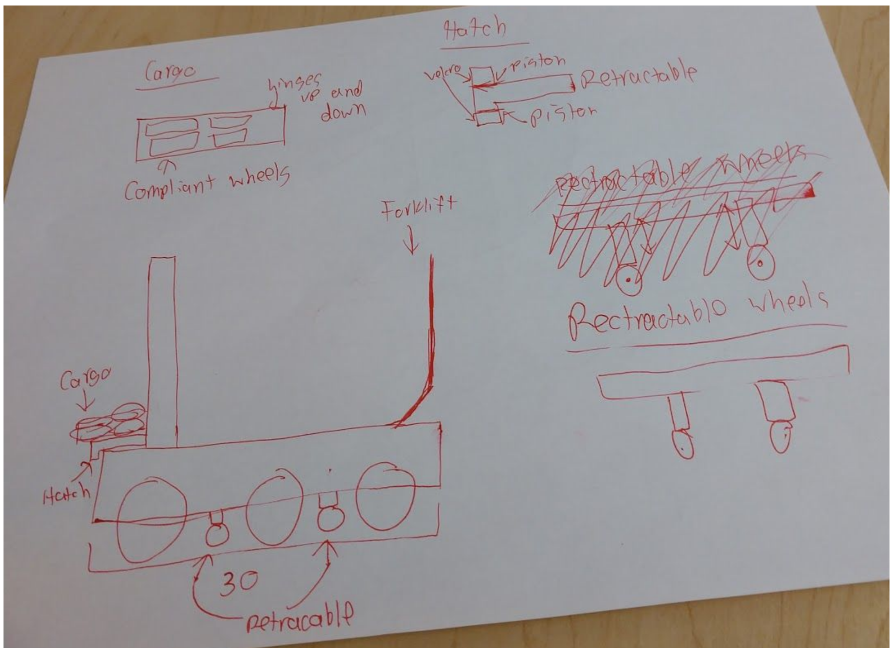
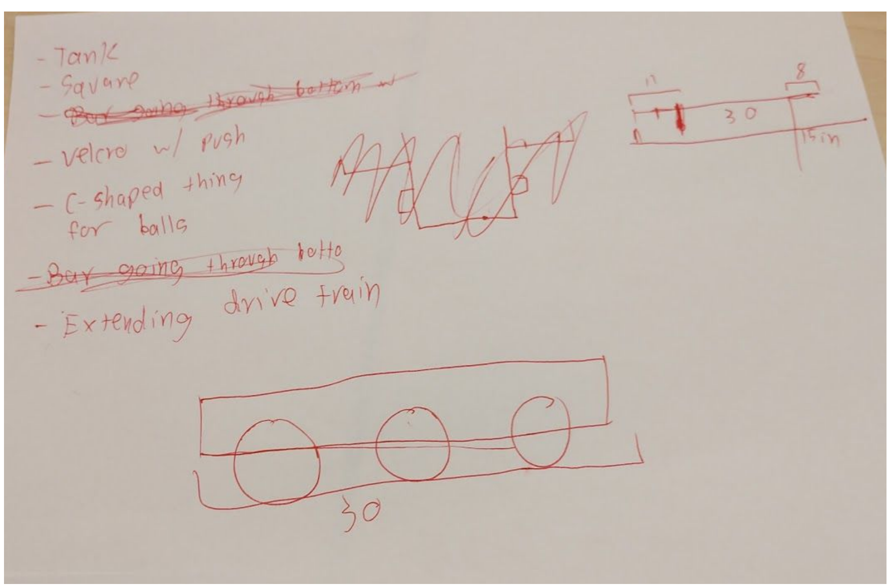


Image 3 & 4: Demonstrate a groups ideas to use pistons to eject the hatch and a wheel intake for the cargo with complaint wheels. This system is attached to an elevator system in this drawing. This group also suggests a retractable system to lift the robot to HAB 3 in the end game.

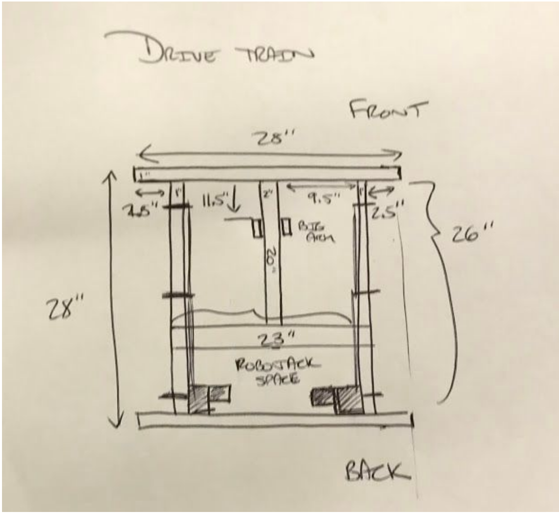


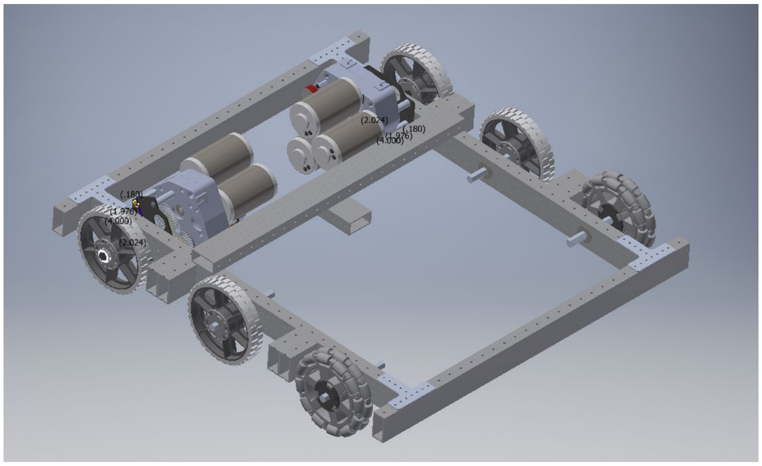
# Chassis Development

| Date | Idea | Pro | Con |
|---|---|---|---|
| 1/8/19 | 8 Wheel Drive | Greater amount of contact with playing surface.<br>More even distribution of weight on cantilevered axles. | More wheels, chain, and sprockets mean more weight.<br>Less space between wheels means the support of bumpers along the exposed side will be tricky. |
| 1/8/19 | 6 Wheel Drive | Simple support of bumpers along exposed side.<br>Less weight. | More stress on each axle.<br>Possible "beaching" on the ramp. |

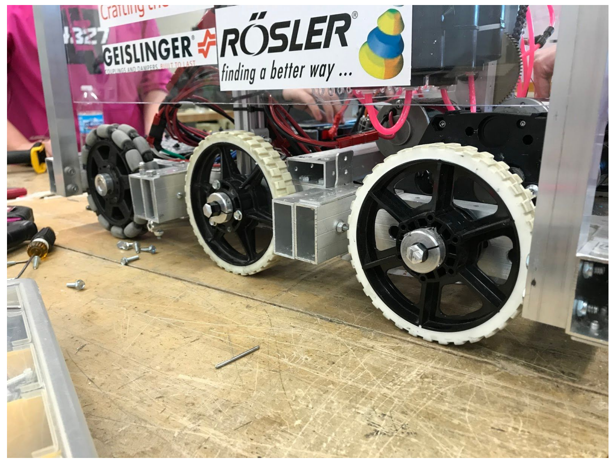
**Sketch of Concept:**




**CAD:**



**Build/Final Build:**

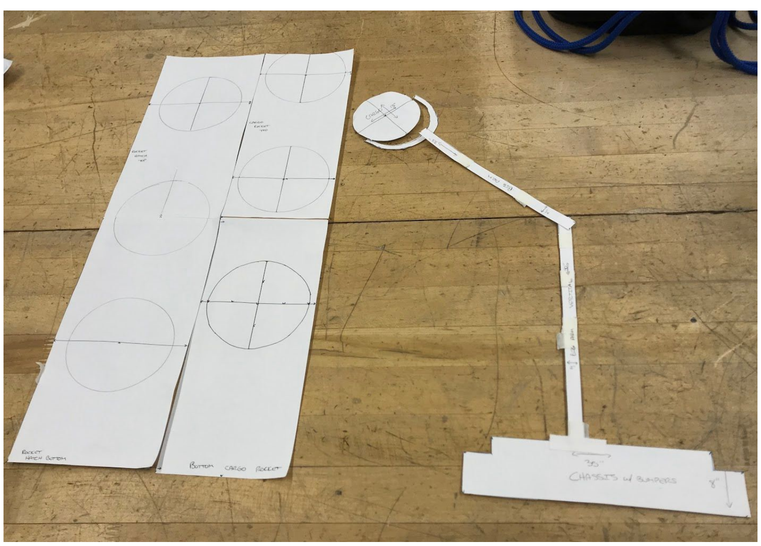


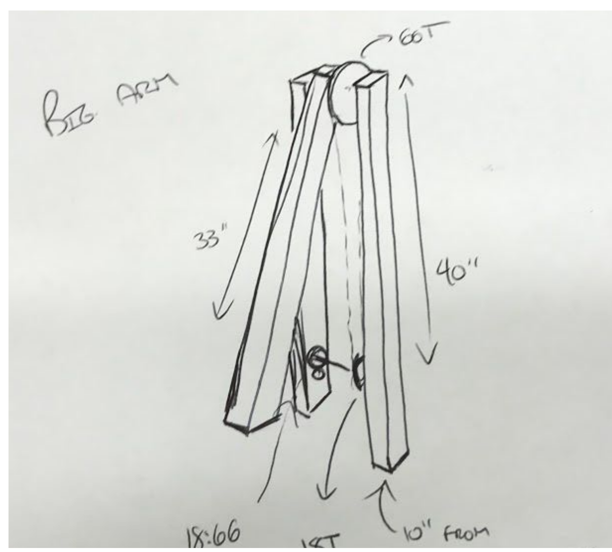
# Superchassis Development

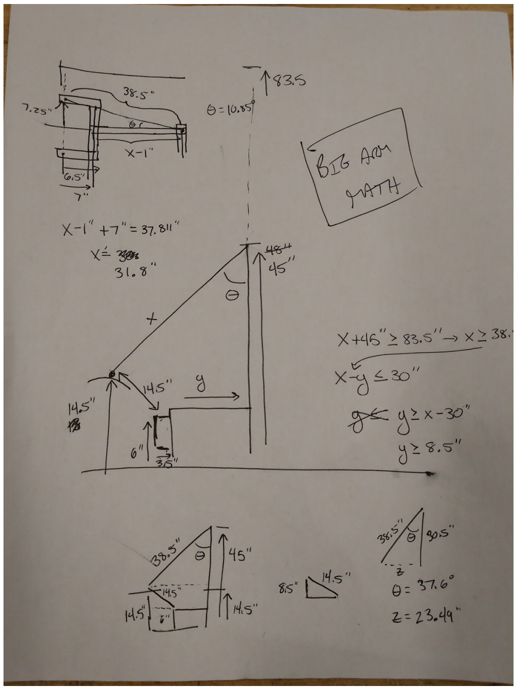
## Lifting Mechanism

| Date | Idea | Pro | Con |
|---|---|---|---|
| 1/8/19 | Big Arm | Over-the-back reach - Allows us to eliminate the need to turn the robot 180 degrees to score.<br>Few moving parts.<br>Lock-in positions using encoders on axles. | Stress on axle.<br>Torque limits the payload maximum weight for the intake mechanism.<br>Exposed mechanism outside the bumper zone. |
| 1/8/19 | Elevator | Known quantity (used an elevator in 2017).<br>Already have some parts available.<br>Eliminates variable of horizontal location of scoring element. | Limited reach (a defender can get between us and rocket).<br>Known failures (slipping string, bearing blocks…) |

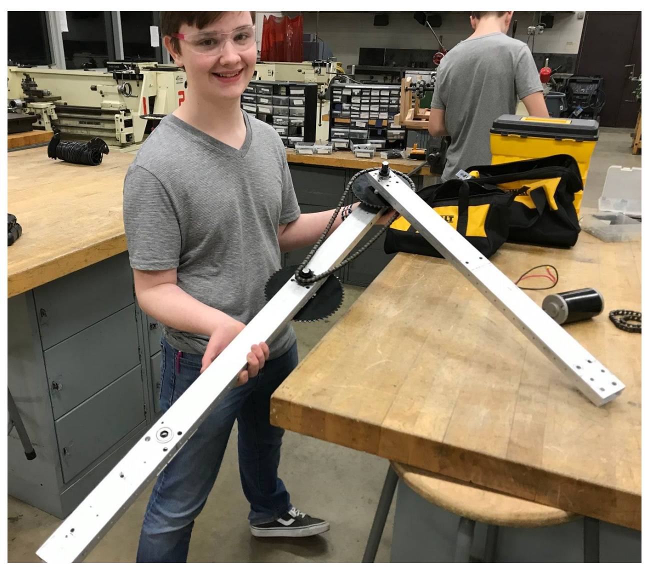
**Sketch of concept**



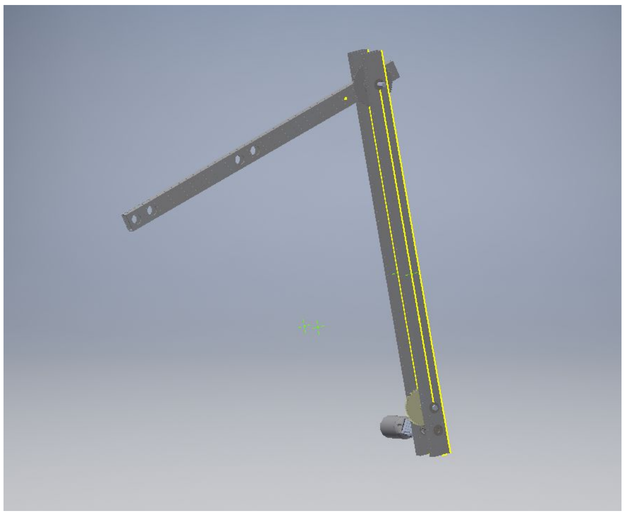




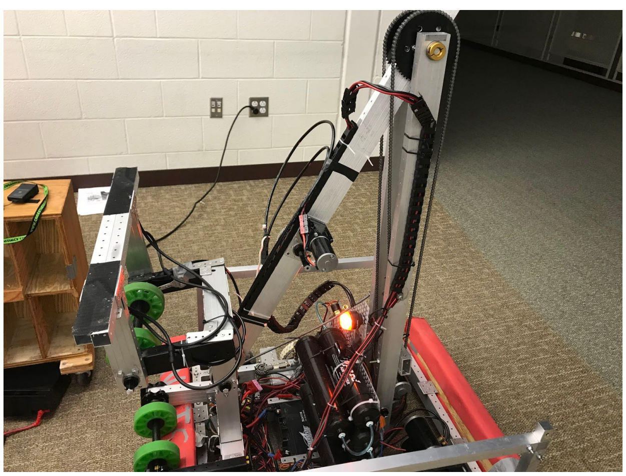

**Prototyping**

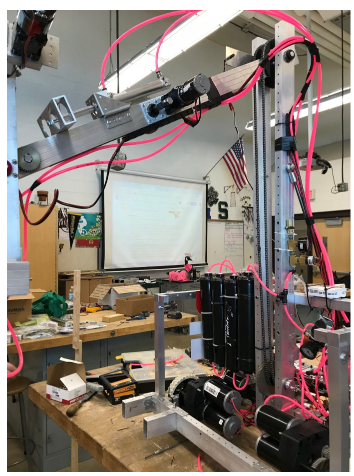


**CAD Model**



**Build/Final Build**

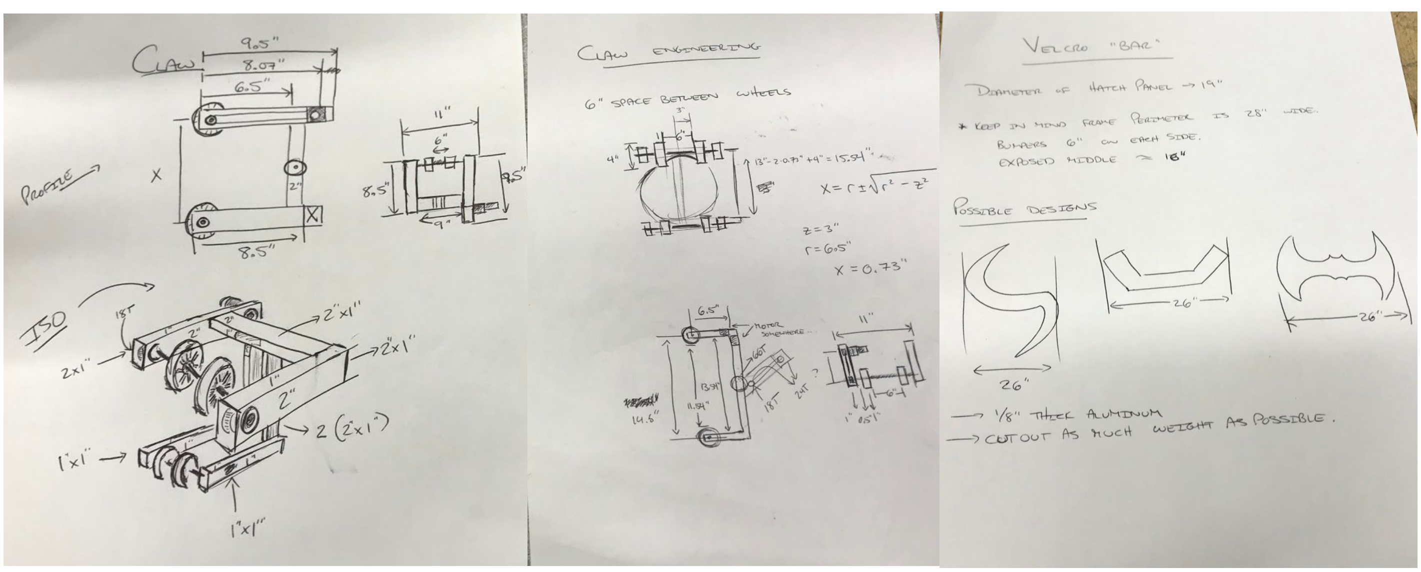




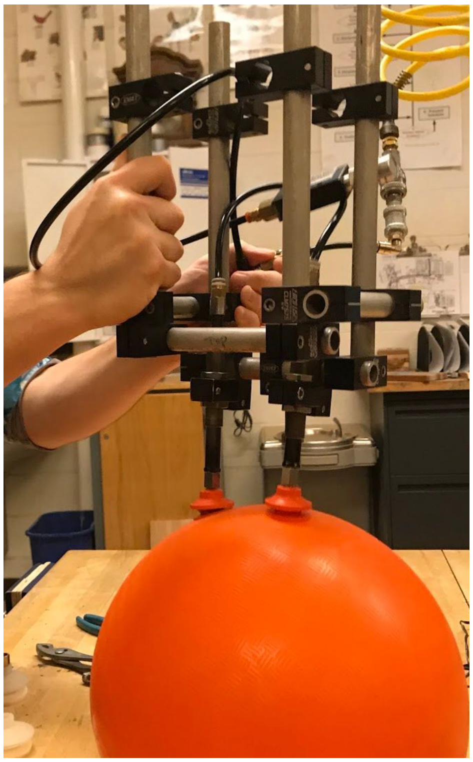
## Intake System (Cargo & Hatch)

| Date | Idea | Pro | Con |
|---|---|---|---|
| 1/8/19 | Suction Cups | No motor required.<br>Lighter weight. | Requires use of Venturi pump (unknown quantity).<br>Requires large draw from pneumatic system.<br>Passive release of game piece. |
| 1/8/19 | Wheels/ Velcro | Powered release of game piece.<br>Known quantity.<br>Have materials to use. | More weight.<br>Requires electrical wiring all along arm. |

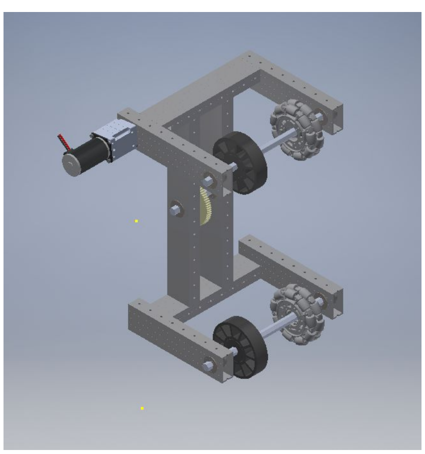
**Sketch of concept**



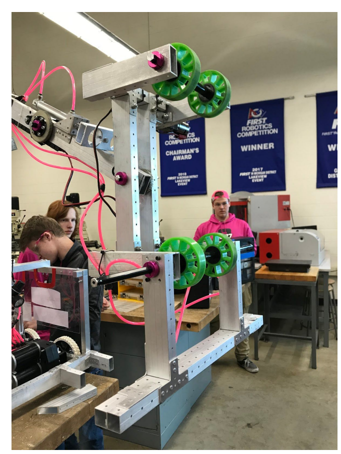
**Prototyping**




**CAD Model**



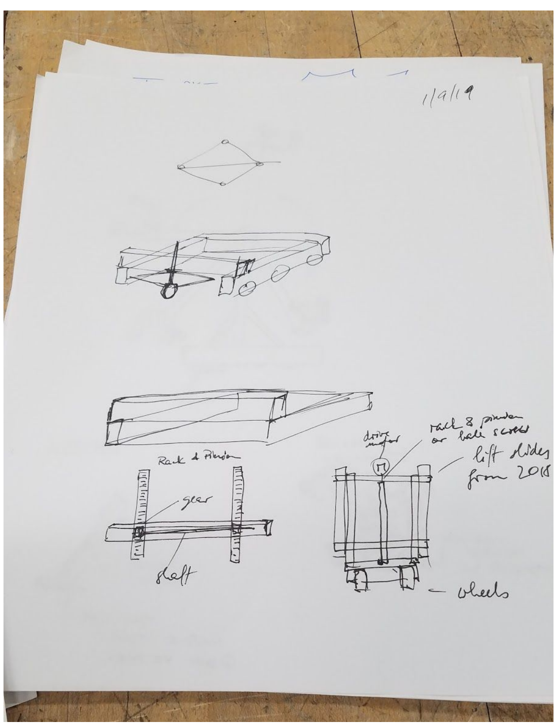
**Build/Final Build**

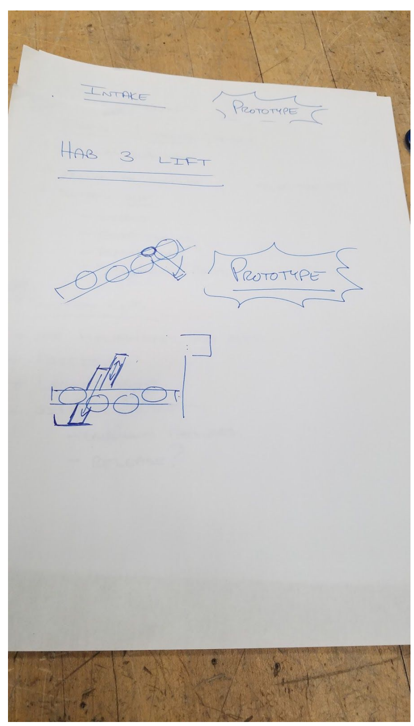



## Robot Lift System

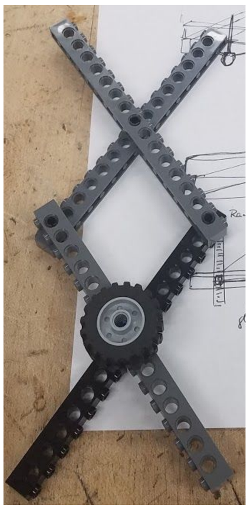
| Date | Idea | Pro | Con |
|---|---|---|---|
| 1/8/19 | Car Jack System | Compact design vs. pison legs. Can be repaired if damaged. Gives desired height with shorter stroke of piston. | Unknown quantity. Requires strong pistons. Needs system integration with drivetrain. |
| 1/8/19 | Piston Legs | Simple movement (in or out). Fast acting (quick release of air). LImited manufacturing (just buy the pistons). | Costly (big piston = $$$). Shafts do not like to flex or bend. Irreparable damage. |

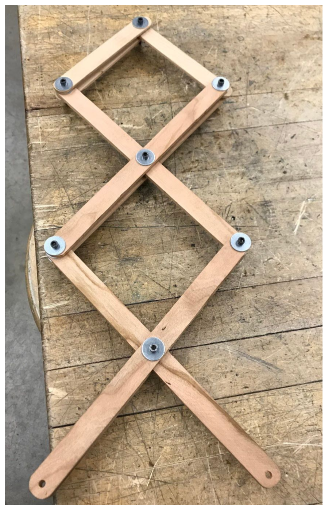
**Sketch of Concept**

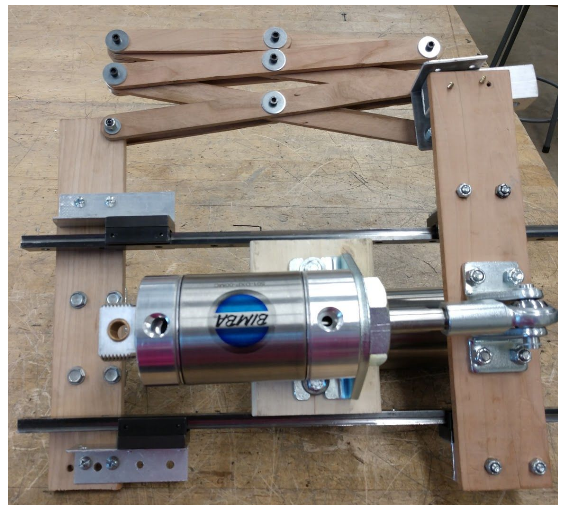


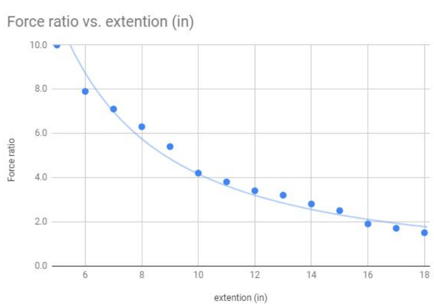



**Prototyping**

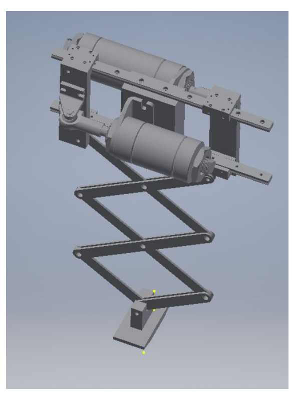









**CAD Model**



**Final Build**