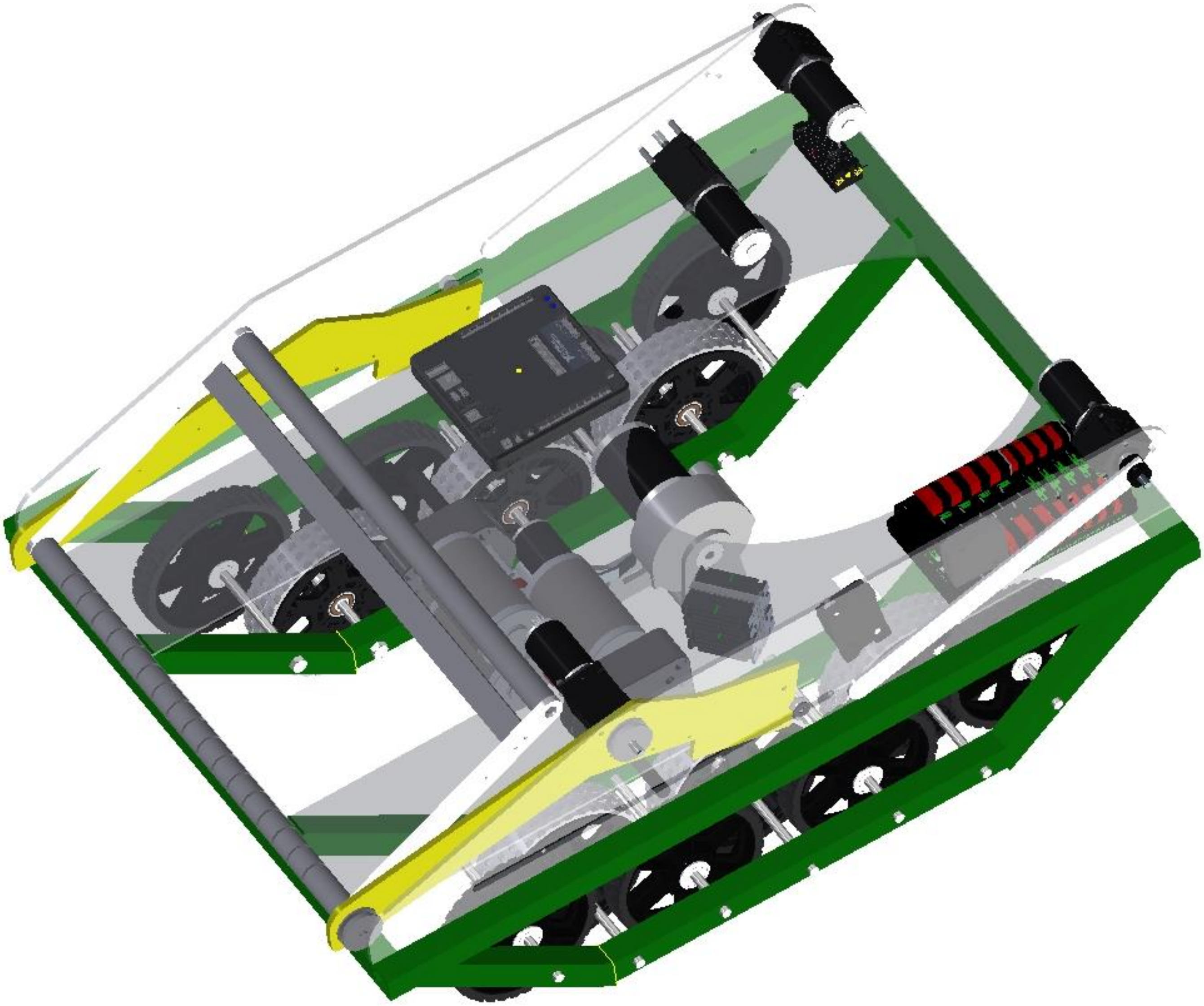
Pearadox

Robotics Team 5414



Contents

Competition Breakdown and Analysis

The Field

- The Field is a 26’7” by 54’1” rectangle separated into three main sections.
- **The Neutral Zone:** The Neutral Zone, located in the center of the field, is aligned with no single team. Robots are allowed to move freely throughout it with the exception of the secret passage exit, which only the team aligned with the passage is allowed to enter.
- **The Courtyards:** A Courtyard is located on either side of the Neutral Zone and belongs to the team placed closest to it and contains that team’s tower which they are defending. The Courtyards are separated from the Neutral Zone with a line of defensive structures.
- **The Secret Passages:** running along the left side of the team they’re aligned with, allow an easy crossing for the team aligned with them through that team’s defensive lines and contain its team’s human player station. While enemies are allowed to cross into Courtyard sections of the opposing team one at a time to steal balls from their human player station, a severe penalty is issued to them should they attempt to cross their enemies defensive line using that team’s secret passage. All entrances to the secret passage is off limits to the opposing team in the neutral zone section of the secret passage.
- **The Defensive Lines:** a line of four dynamic defenses with one static defense separating the Courtyards from the Neutral Zone. Their purpose is to hinder the opposing team’s crossing into your team’s Neutral Zone so that they cannot shoot on your tower for more points.

Point Distribution and Strategy

Points can be earned in two ways different ways in this competition, through crossing and breaching defenses and by shooting on and challenging the tower of your opposing team.

Through breaching it's possible to earn points by crossing and breaking down defenses. Should you prove to be successful in breaking down four of the five defenses, your alliance earns a breach, which awards them 20 additional points along with a ranking point. You can also earn 5 points on your first crossing of each defense. These crossing points are doubled should you manage it in autonomous mode, you can also earn 2 points by reaching a defense during autonomous.

The other way to earn points is by shooting on tower, you earn 2 points for shooting into the low goal and 5 points for scoring in the high goal, which 5 for low goal and 10 for high goal should you manage it in autonomous mode. The tower you're shooting on also has a health bar of sorts, after taking 8 successful scores the tower becomes open to being challenged or scaled. Should all three robots challenge the tower you can earn 15 points for your alliance, 5 per robot. This scales to 15 points per robot for each on that manages to lift itself above a line on the tower.

With the way this is set up it allows three main possibilities for roles a robot can play. You can play as a breaching robot, whose focus is to knock down the defenses as quickly as possible and earn a ranking point. You can also play as a defensive player, who bullies shooters by bumping into them and blocking their line of sight to the goals. Finally, there is the aforementioned shooter, whose goal is collect a ball and score it as quickly as possible to weaken the tower and open it for challenging.

Strategies discussed after Kickoff

Defensive strategy

• One of the strategies we discussed was to focus on playing defense on the opposing alliance and less on breaching the defenses and scoring boulders. While this strategy had many benefits, such as improved vision for the drivers, we found that this strategy relied too much on who we would get paired with in alliances to score points and we would end up ranking lower overall.

Breaching strategy

• Another strategy discussed was to focus mainly on breaching the defenses rather than trying to collect the ball. This was because we found that the collecting and shooting the ball would a more difficult task than designing a drivetrain for overcoming the defenses. This meant, the robot design would be simpler if we mainly focused on the drive train rather than having a complex collector and shooter.

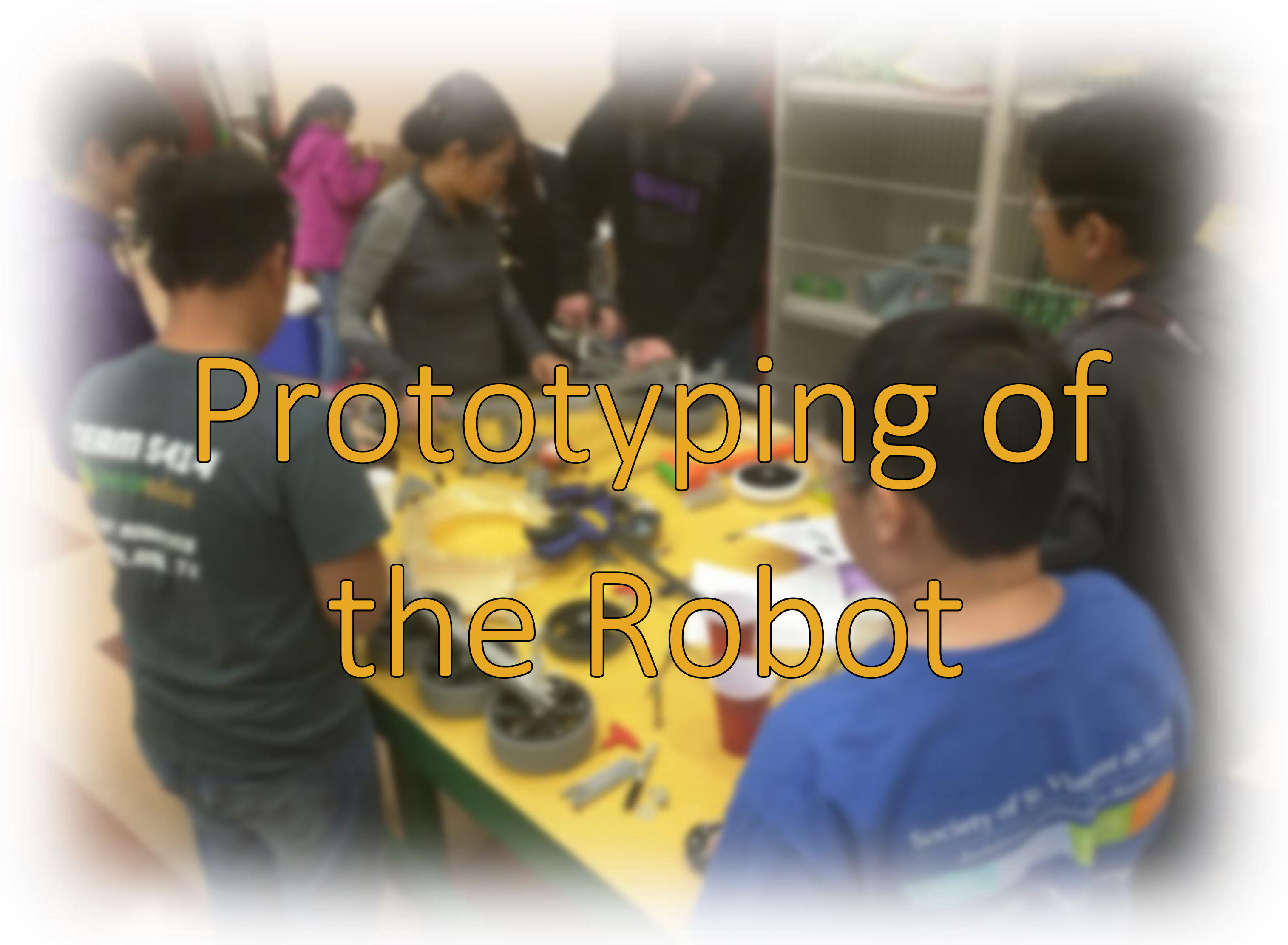
Boulder scoring strategy

• The final strategy discussed was to focus on was mainly scoring balls in the high goal. This strategy would drive under the low goal to collect a ball and then come back under to score it in either the high or low goal. However, the design of the robot would become more complex and it would take more time to score a ball in the goal. We estimated it would take 10 seconds to go collect a boulder, and 10 seconds to score, which would not be enough to capture a tower by ourselves.

Pearadox's strategy

The final design the team decided upon was a hybrid between the second and third options. This would allow us to earn the ranking point for breaching even if we ended up having problems scoring boulders.

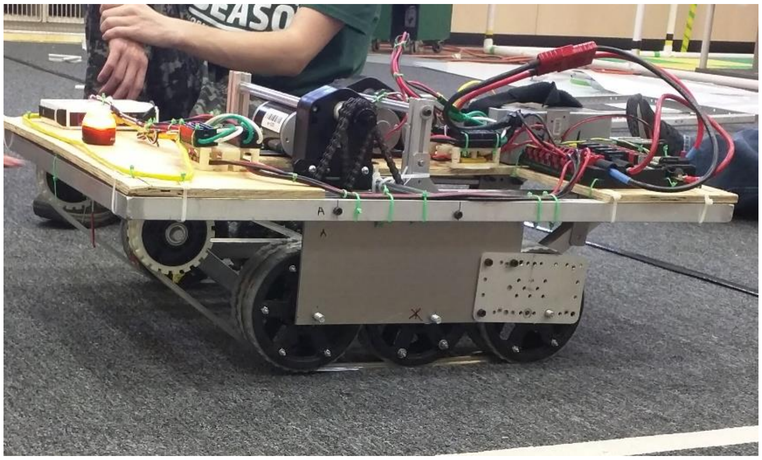
Prototyping of the Robot

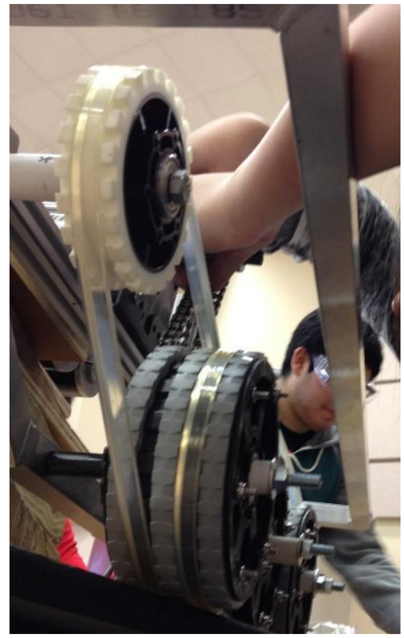


The team did some brainstorming and prototyping of several designs for each of the key robot subsystems:

- Base – must be able to overcome all defenses that don't require a manipulator
    - Tank with v-belt
    - Large wheels
    - Smaller wheels with an offset in a tank configuration
- Collector: must have a wide feed mouth, low profile, and collect the boulder from many angles
    - Wheeled Intake
    - Polycord Roller
- Shooter – must be able to eject a boulder for a low goal shot and be low profile
    - Linear Puncher
    - Flywheel
- Cheval De Frise – must fit on existing robot and be light
    - Two independent arms
    - Two linked arms
    - One arm pushing on one ramp

Tank Design





Pros:	Cons:
Provides constant traction	Hard to get the V-belt taut
Unique design	A lot of machining needed
Potentially less complex design (less chain/sprockets and fewer wheels)	Slipping or snapping of V-belt
Less chain making it lighter	

Large Wheels

Note: This is from Day 2 of Spectrums (FRC 3847) build blog. We opted to not build up a prototype

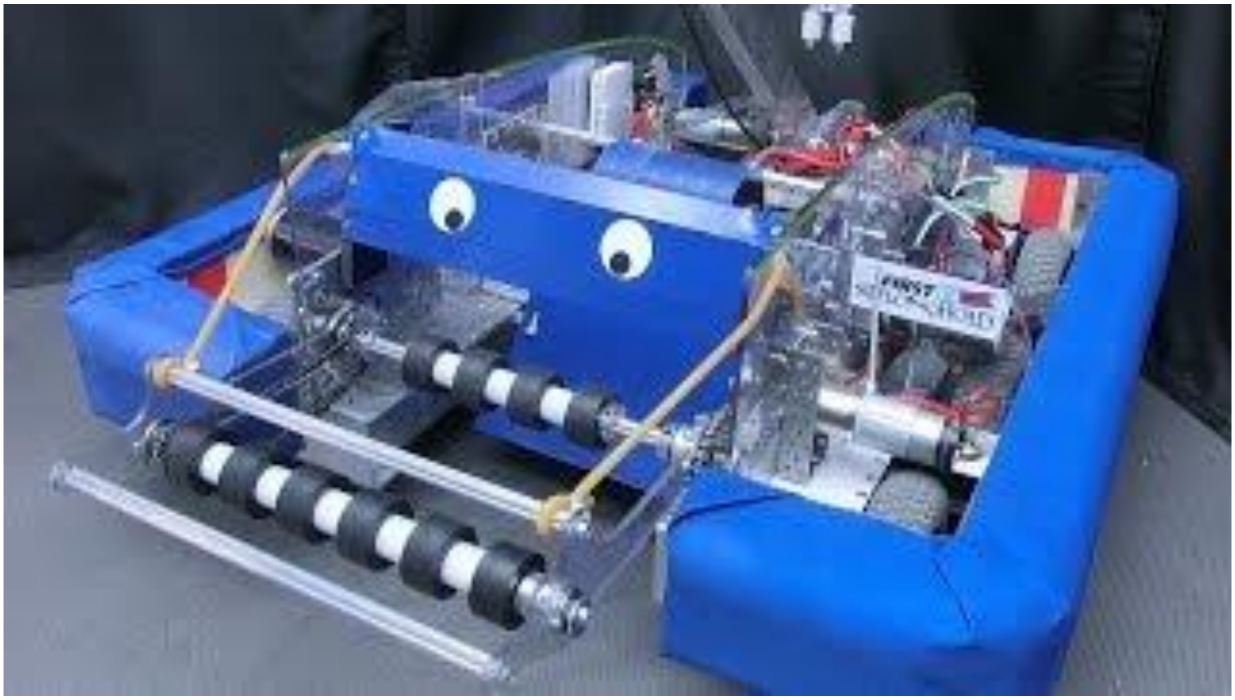
Pros:	Cons:
Simplest design	Takes up more vertical space
Allows the ability to go over all obstacles	Slightly heavier
	Parts availability

Smaller Wheels in Tank Configuration:

Pros:	Cons:
Capable of obstacles	Heaviest
Experience with similar design	Most wheels
Confidence of success	Most complex chaining
	Space consuming horizontally

The final result was a mix of options one and three, with offset and raised wheels that would help function as tank tread. We effectively have six wheel drive.

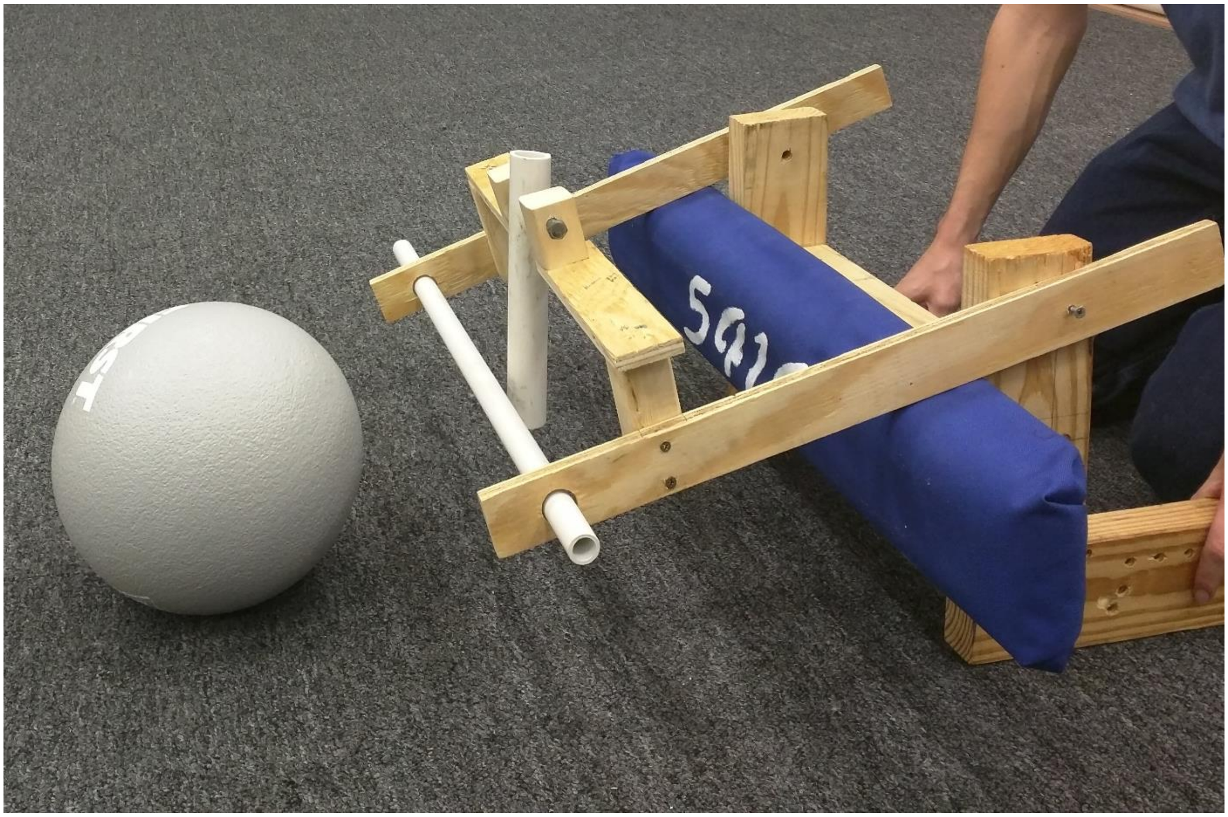
Wheeled Intake



Note: This is a picture of Team Indiana's Robot in 3 Days, but depicts the concept

Pros:	Cons:
Could collect a boulder	Limited intake angle
Potentially simpler design	Doesn't meet requirement of wide feed mouth

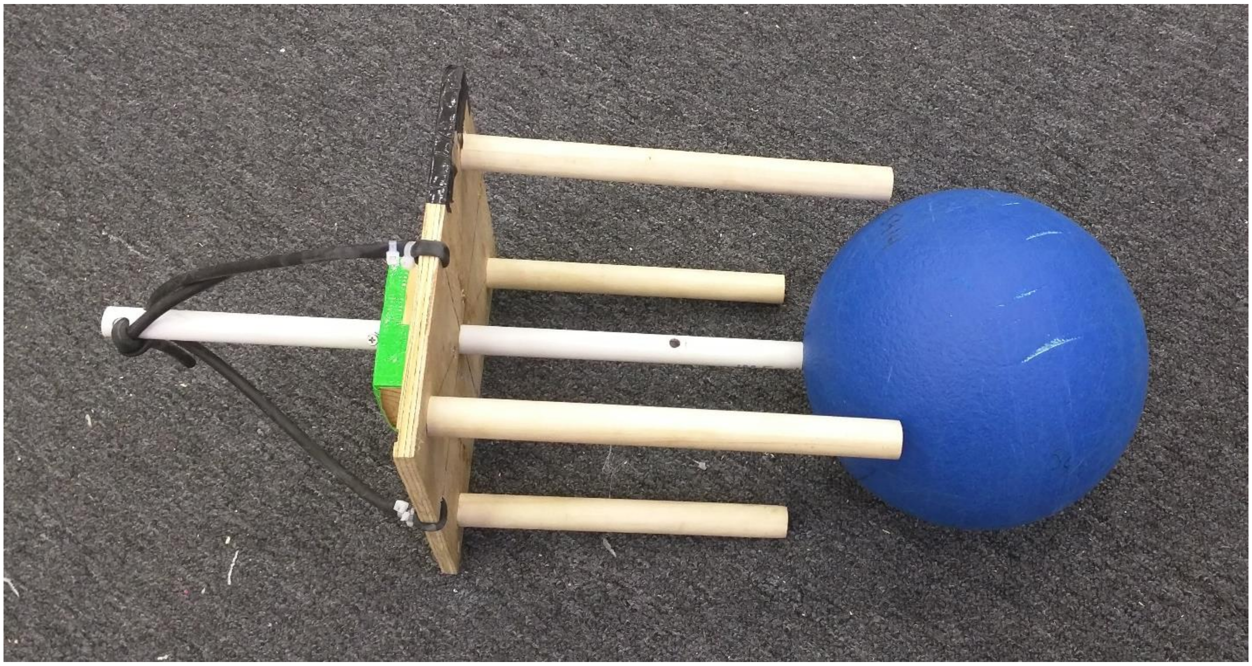
Poly-cord Roller



Pros:	Cons:
Meets all requirements	Complicated pulley system
Wide intake angle	Heavier design
Able to prototype unpowered model for Australian team	

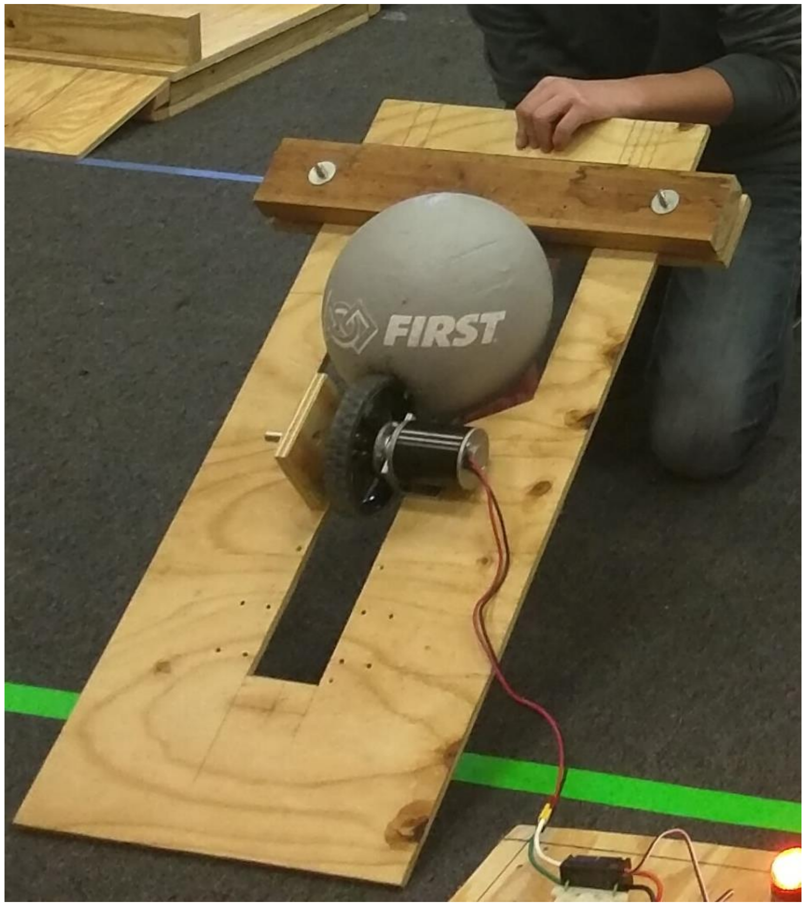
After brainstorming, we decided on the roller intake and began CADing the necessary parts.

Linear Puncher



Pros:	Cons:
Simplistic design	Requires a lot of power
Easy to fabricate	Lots of wear and tear on system
	Requires lots of space to function

Flywheel



Pros:	**Cons:**
Achieved all requirements	Not entirely consistent (due to boulder compression)
Compact design	Takes longer to shoot
Generally reliable	
Fairly simple design	

Cheval De Frise

We didn't add a Cheval de Frise manipulator until after our first regional. Due to this, we evaluated different designs for how to incorporate them into our existing robot rather than prototyping a bunch.

The criteria of our Cheval De Frise are the following

- Needs to be efficient and fast
- Can't interfere with other components of the robot
- Must keep Cheval ramp down long enough for robot to cross

Three variants of the manipulator were debated

- Two arms on either side
- One arm in the middle
- One long bar across the robot

Two Arm Manipulator

Pros	Cons
Effectively stays clear of other components	Requires two motors
Clears Cheval De Frise	
Easily Made	

Middle Arm Manipulator

Pros	Cons
One Motor	Blocks Collector
Easy to Aim	Unreliable

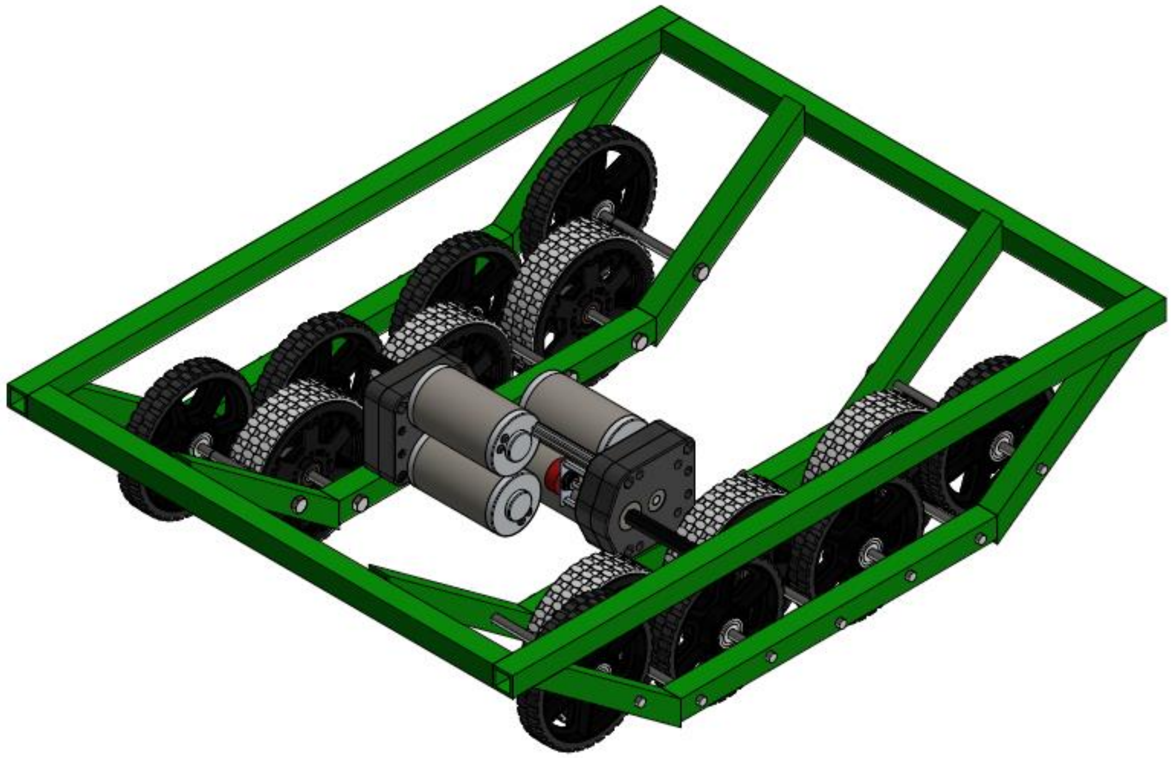
Long, horizontal bar Manipulator

Pros	Cons
Very easy to aim	Heavy
Clears Cheval De Frise	Blocks Collector
Simplistic	
Reliable	

We decided having two independent arms worked best for our robot.

Final Design

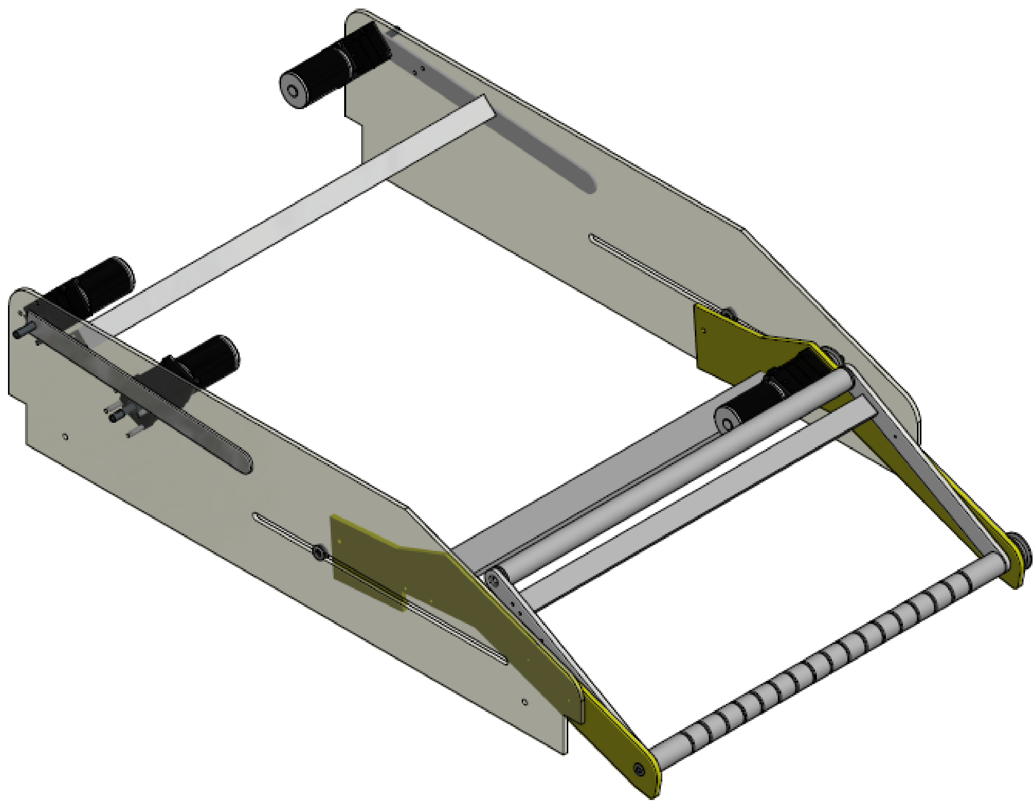
Base



Allows us to drive over all non-mechanical obstacles.

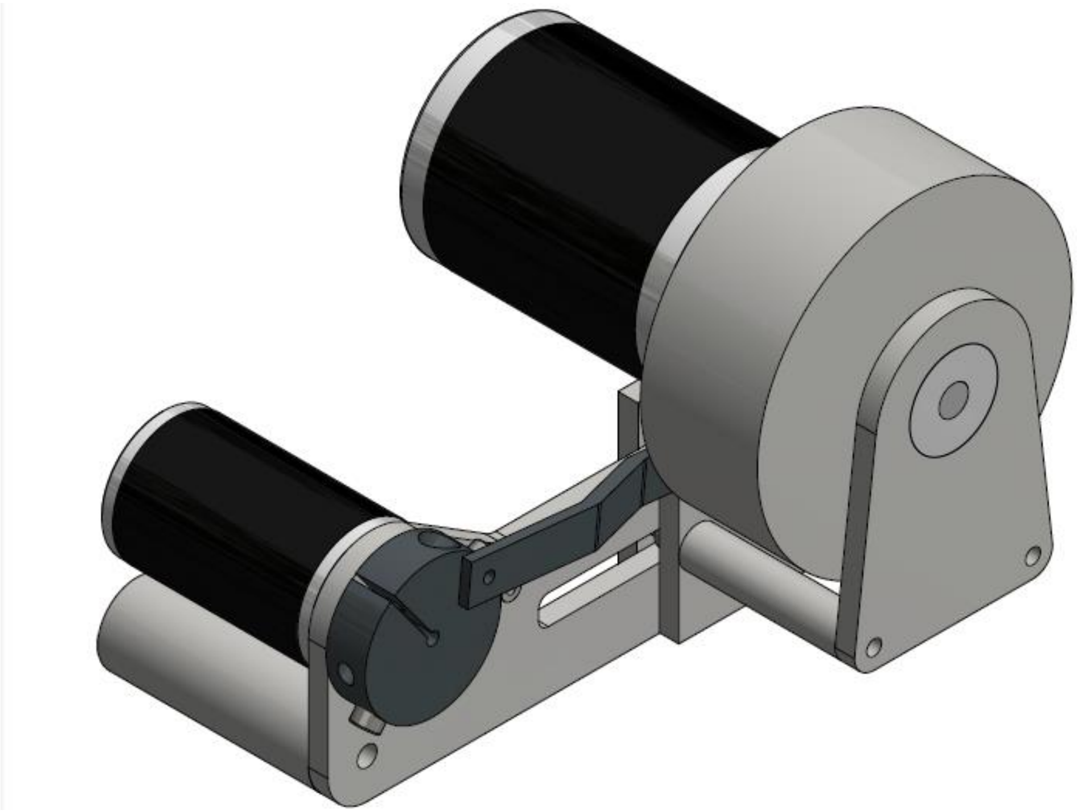
- 14 wheels
    - Two different types of six inch wheel were used, one thicker than the other
    - The thicker wheels were at ground level. The thickness was used to keep the wheel from getting stuck in the blocks of the rough terrain.
    - The thinner wheels were elevated and staggered to help get the robot over an obstacle initially and later to keep the obstacles from getting stuck in between the wheels at thground level.
- Driven by four CIM motors
- Chain driven
- 6 wheel drop center
- Structure is welded 1”x1”x1/8” wall aluminum tubing
- Symmetrical for going over most obstacles in either direction
- Raised front and back wheels for climbing over tall obstacles
- Gearbox-
    - 6 feet/second output speed
    - Single stage double reduction (40:12 followed by 40:14 followed by a 22:12) overall, 17.46:1

Collector



- Has front intake with a wide collecting area, which extends past the robot during game play.
- Rollers with 3mm poly-cord tasked with collecting a boulder
- Pivots on front bar to allow a boulder to enter the system while remaining low profile when not collecting a boulder
- Extends and retracts via slots in an Lexan side plates
- Intake roller is powered by a 21:1 Versa Planetary gear box with a bag motor
  - Gear speed chosen to optimize ability to collect a boulder
- Extension and retraction is powered by a 49:1 Versa Planetary gear box with a bag motor
  - Gear speed chosen to allow the system to move back and forth if an outside force was applied
  - Motor has a custom machined steel pulley on the output shaft
- Pulley system-
  - Steel cable with custom machined pulleys (Delrin)
  - Steel cable is in a figure eight pattern so that both right and left sides push and pull together

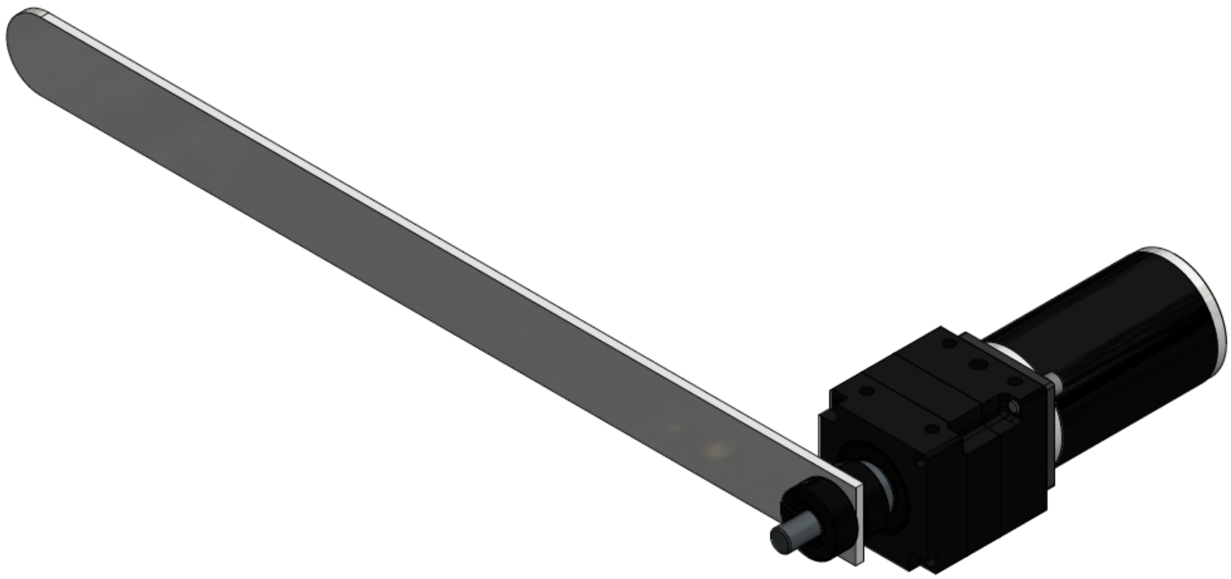
Shooter



A four inch diameter wheel which actuates into the boulder.

- Machined 5 lb. steel wheel
- Mini-CIM motor with a CIM coder to measure the wheel’s speed
- Triggering mechanism is a bag motor with a small lever
    - When the bag motor spins a half turn, a push rod moves the wheel assembly into the boulder
- Hard stops on bag motor

Cheval De Frise Manipulator



A thirteen and a half inch long arm bar placed on either side of the Collector Side Plates.

- Each arm connected to a single BAG motor
- 10:1 gear ratio implemented in a versa planetary gear box
- Spaced to push down the two raised ramps on outer sides of plates to allow clearance for other robot components

PID & Control Loops

The Shooter

- Closed looped PID control on the Talon SRX
- Velocity-Speed control with a feed forward value
- Feed Forward is set at 2.3 and P Gain is set at 2
- A CIMcoder is being used as the velocity sensor
- Whenever the shooter wheel is being powered, the roboRIO dynamically changes the mode from coast mode to brake mode. This is so that when the wheel is stopped, it will stop quickly. However, to take advantage of the large inertia of the wheel, we change to coast mode via a CAN command while it's powered

The Vision Alignment

- Using a dead band to align with a proportional control
- Uses off board processor (Kangaroo PC) for vision processing
- LED ring turned on/off with the Pneumatic Control Module
- Uses network tables to communicate

Distance measuring using encoders

- Created methods that allowed us to input a distance in inches and have it stop within a few inches of the specified distance
- Only uses proportional control
- We used the digital Greyhill encoders to measure distance

Control Loops: Loops that actuates based on a control

Cheval De Frise Manipulator

- The manipulator actuates at full power, holds the position for a set period or until a button is released and then automatically returns to its original position upon button release at a slower, more controlled speed.

Shooter Trigger

- The trigger actuates for 400 ms at full speed (stall) and then immediately resets at full speed for 400 ms.

Vision Processing

Our vision processing software is a setup with minimal complexity. A high brightness light is shined on the retro reflective tape the camera captures the tape. Our offboard vision processing computer (a Kangaroo PC) takes care of our vision processing and searches for contours that appear on the retro reflective tape using GRIP (a program built by other FRC members). A contour report is outputted over the network tables to the RoboRIO which is then used to find the position of the robot based on the contour report. Our code is setup such that we do the following steps:

1. Find if there are any contours in the view (Check for a value in the array)
2. Find the contour with the largest area.
3. Rotate the robot until the CenterX associated with the maximum contour (Horizontal contour value) is with tolerances