1241

2016 ENGINEERING BINDER

THEORY 6
TEAM 1241

Analysis of Game

Brainstorming Process

After the game was released, our team split into small groups to go over the manual with a mentor. As we understood the rules of the game completely, we discussed possible strategies to base out this year's robot upon. The strategy that we decide to go with would become the guidelines for our robot design to follow.

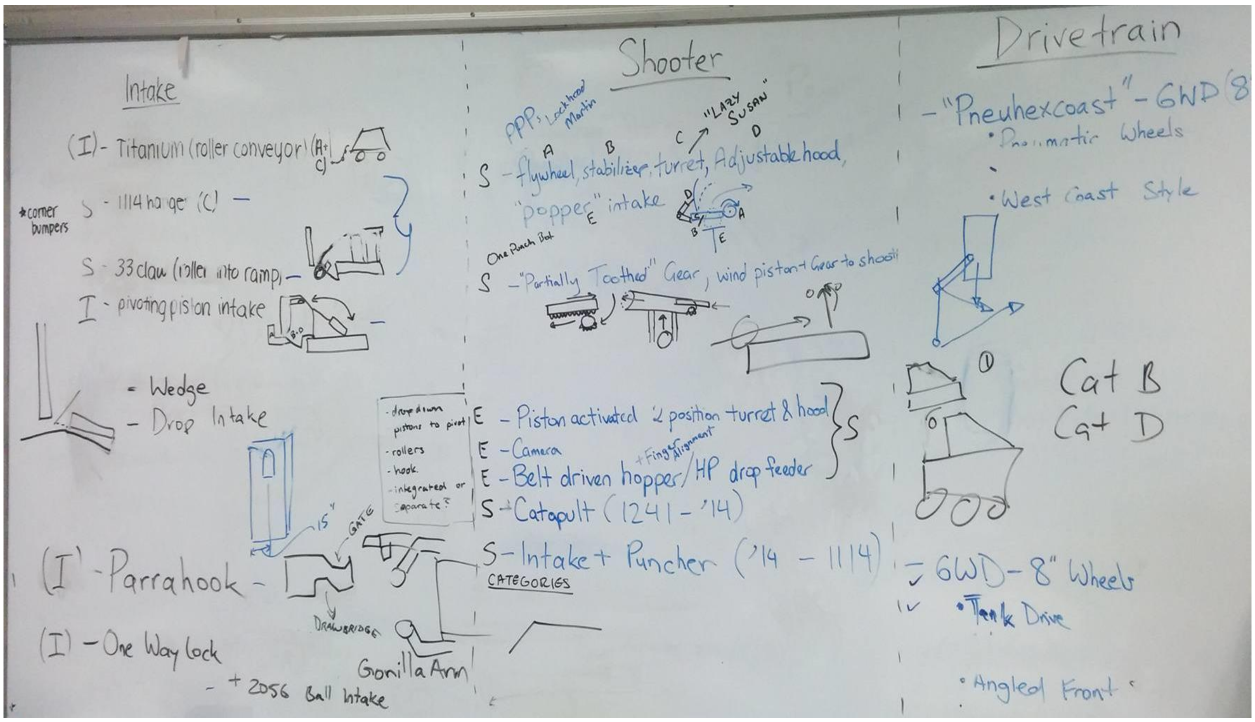
Possible Strategies

(A-E) 100% Breach + Low Goal	High Goal + 40% Mobility Breach (B+D) + Hang
High Goal + 60% Breach (B+D+A/C) + Hang	(A-D) 80% Breach + High Goal

Strategy

- Strategy Chosen by comparing pros and cons to each option
- **Chosen Strategy:** (A-D) 80% Breach + High Goal
- Allows earning additional ranking points individually
- Only 3 Subsystems needed
- Resources focused on each subsystem

Brainstorming and Ideas



This year our team decided to do things differently for this stage compared to previous years. We decided to prototype only one design out of all the ideas for each subsystem in order to focus our resources and have a clear view of our final design to begin with. The team split into small groups and started brainstorming ideas, and specific designs for each subsystem. And after this brainstorming, the designs were presented, discussed and grouped if needed. All the ideas were carefully looked upon and none of them were shot down.

Requirements and Priorities

Intake:

- Intake while driving backwards from any angle
- Category A and C
  - A
    - **Portcullis**
      - Pick up under gate with 5 in. gap
      - Lift 5lbs worth of load from bottom edge
      - Cannot be wider than 3 ft. 8 in.
    - **Cheval**
      - Lift intake 9-5/8 in. in air
      - Apply 1lbs worth of force
      - Hold down ramp while driving
  - C
    - **Drawbridge**:
      - Robot can't be bigger than 3 ft. 6 in. wide (42 inches)
      - Intake must reach 37 in. in height
      - Requires 2lbs of force to move, then 5lbs of force to push down
    - **Sallyport**
      - Robot can't be wider than 3 ft. 6 in.
      - Mechanism must reach 2 ft. 1 in. height
      - 1.5lbs of force applied on outer edge to open
- Low goal

Drivetrain:

- Category B and D
  - B
    - **Ramparts**
      - Drivetrain must overcome 3.09 in. height and 1 ft. 10 in. depth
    - **Moat**
      - Drivetrain needs to traverse over two 2.5 in. high x 1.5 in. wide bumps (separated by 1 ft. 8 in.)
      - Traverse over ramp
  - D
    - **Rockwall**
      - Bump is 4.5 in. high x 4.5 in. in depth
    - **Rough Terrain**
      - **Mechanism help drivetrain traverse a 3 in. bump
- Defense: robots, defend, control midzone

Shooter:

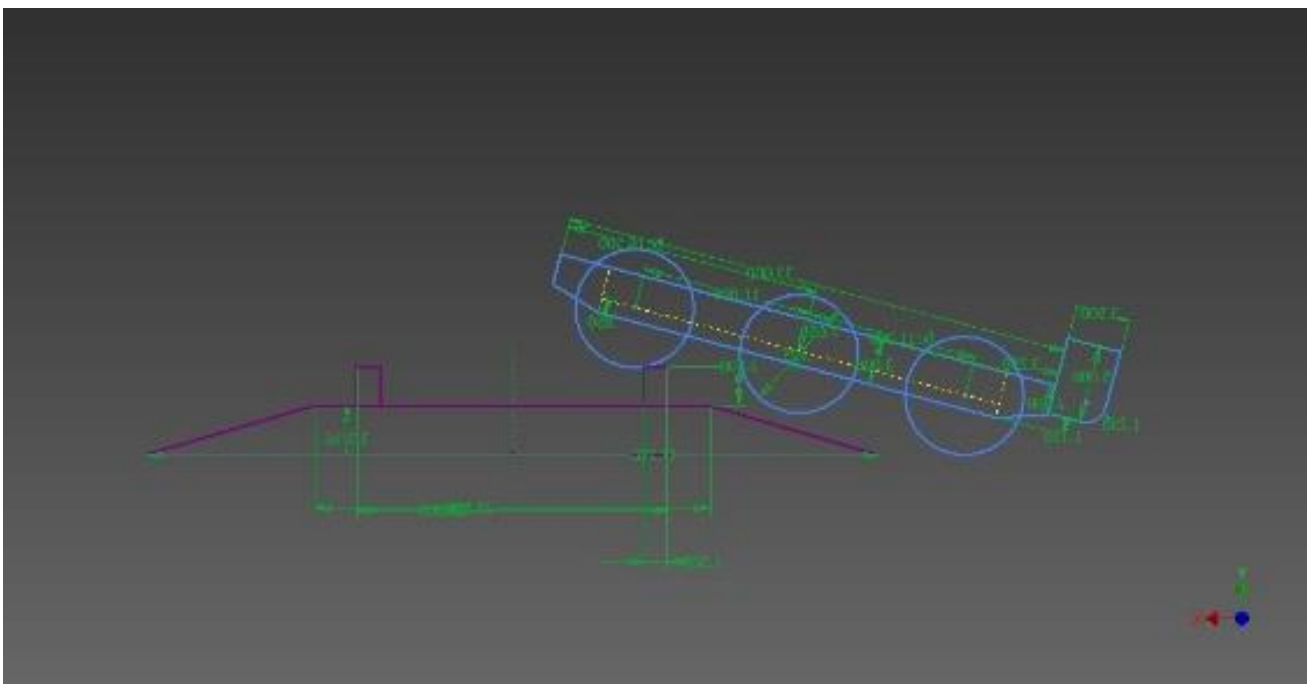
- High goal
  - Compensate for 10 in. ball size
  - Must be able to shoot from tower wall and from batter edge (tower shot and fender shot)
  - Must be able to shoot into a 2 ft. tall x 1 ft. 4 in. wide goal (7 ft. 1 in. from the ground)
  - Camera tracking
- Turret
  - Popper to lift ball
  - 2 position shot – spy and tower

Drive

Parameters/ Variables:

- Wheelbase
- Wheel Size ϕ
- Wedge Angle
- Axle Height
- Center Drop
- Chassis Length
- Bumper Height

Parametric Studies

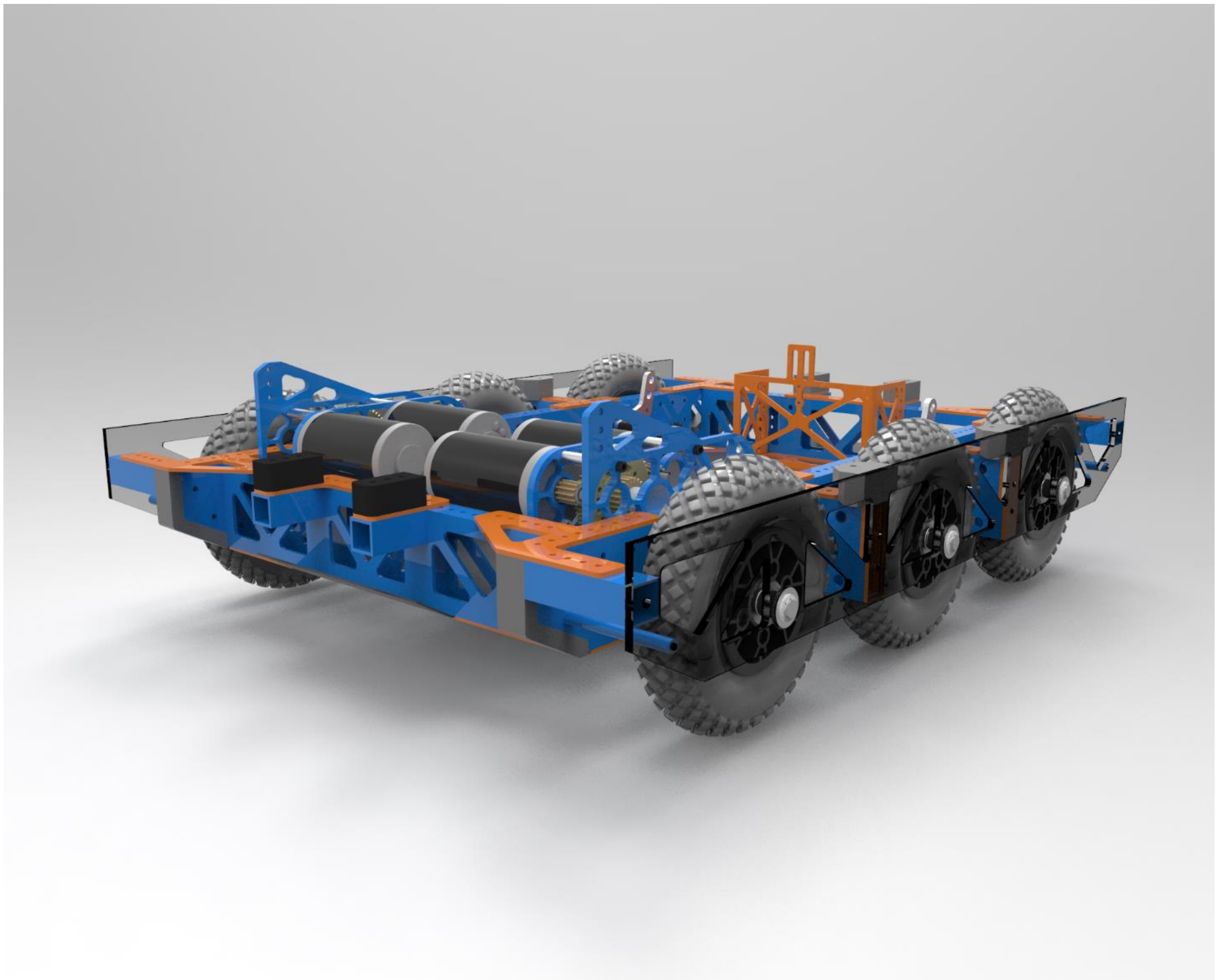


- Drive parametric study for moat

Final Prototype

- 6 Andymark 8”ϕ Pneumatic Wheels
- Custom Vex thunder hex shafts
- 2*4 lumber chassis screwed together with wood screws
- Angles on the front and back to help traversing mobility defences

Final Design



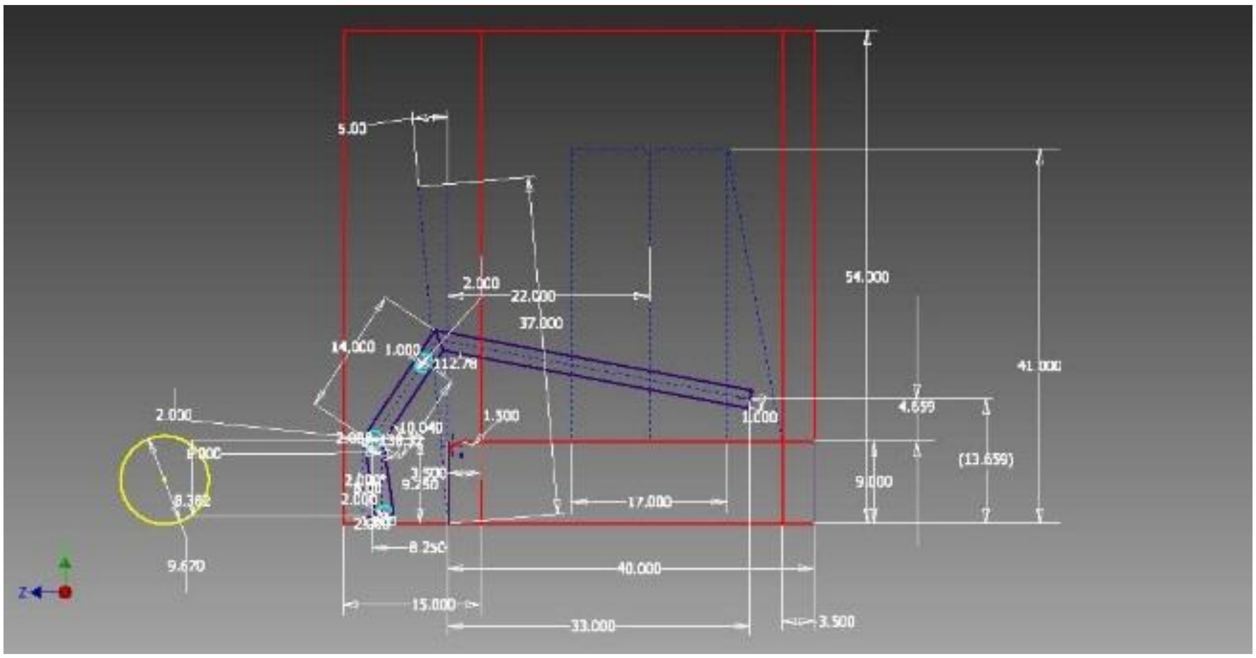
- 6 Wheel drive with 8" pneumatic wheels driven through custom gearbox with approximate top speed of 11 ft/sec
- Rectangular 3&x1& extrusion/gusset structure with CNC'd plastic wedge inserts to go over all mobility defenses
- ABS Bellypan with flanged ends angles to cross over defenses
- 2 CIMS/gearbox with a reduction of 13.3 to compensate for big wheels
- Gearbox mounted at front of robot to create a balanced center of gravity
- Drivetrain Using 1 encoder on each side, and Nav6 gyroscope

Intake

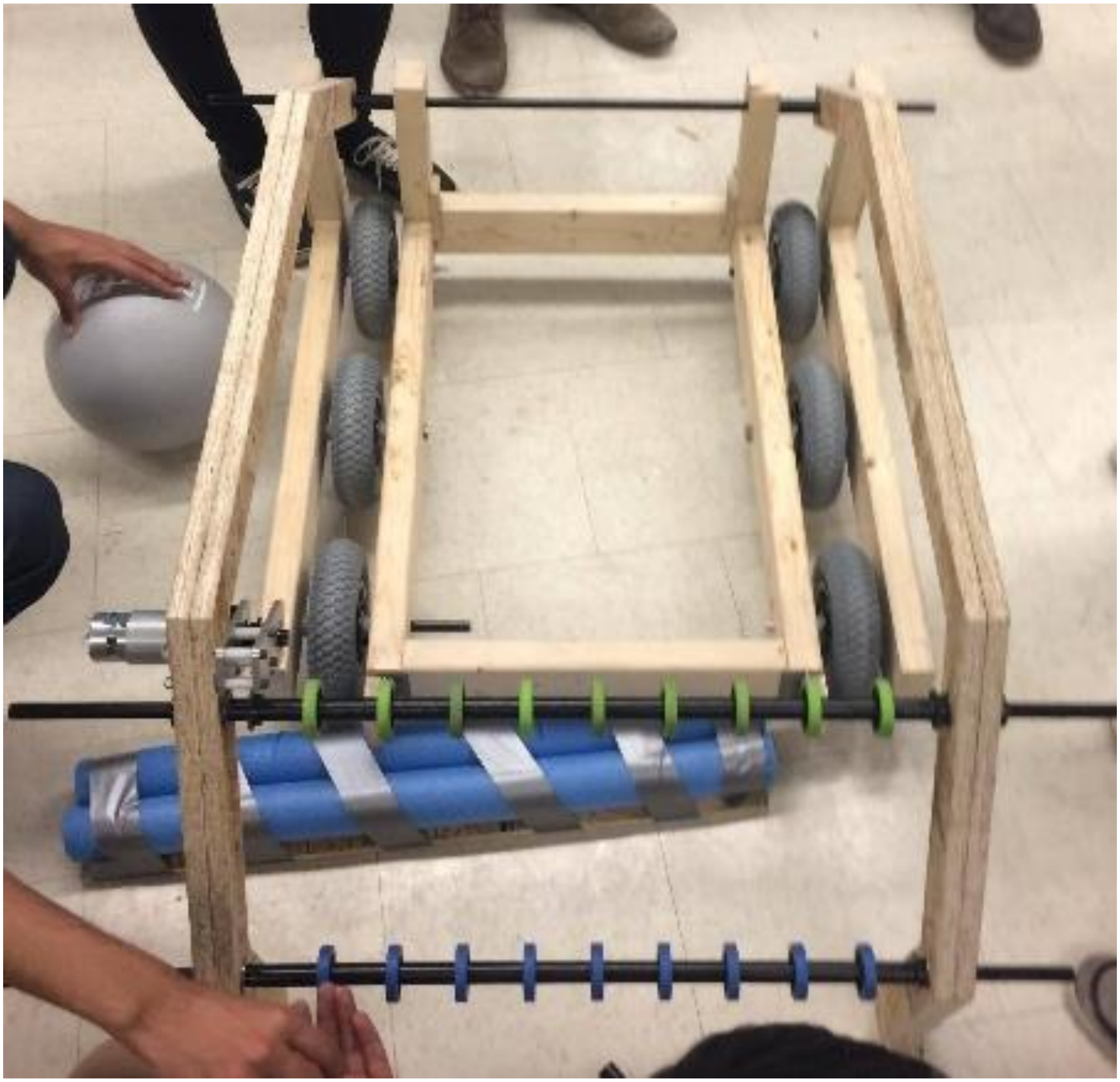
Parameters/ Variables:

- Pinch sufficient to consistently pick up a ball in all situations
- Extend no more than 15”
- Ability to do portcullis, sally door, drawbridge, cheval
- Has to be able to lift the robot as a precaution
- Over the bumper
- No dead-zone between the two rollers
- Linear speed faster than that of the drive, so if we drive backwards right after intaking it would still work

Parametric Studies



Final Prototype



- 10 - 1.875ϕ Banebot Wheels on each roller spaced 1" apart
- Gorilla arm design
- Used 1 Banebot RS775 motor with a vex versaplanetary 7 : 1 gear ratio
- Parahook design to traverse defences

Final Design

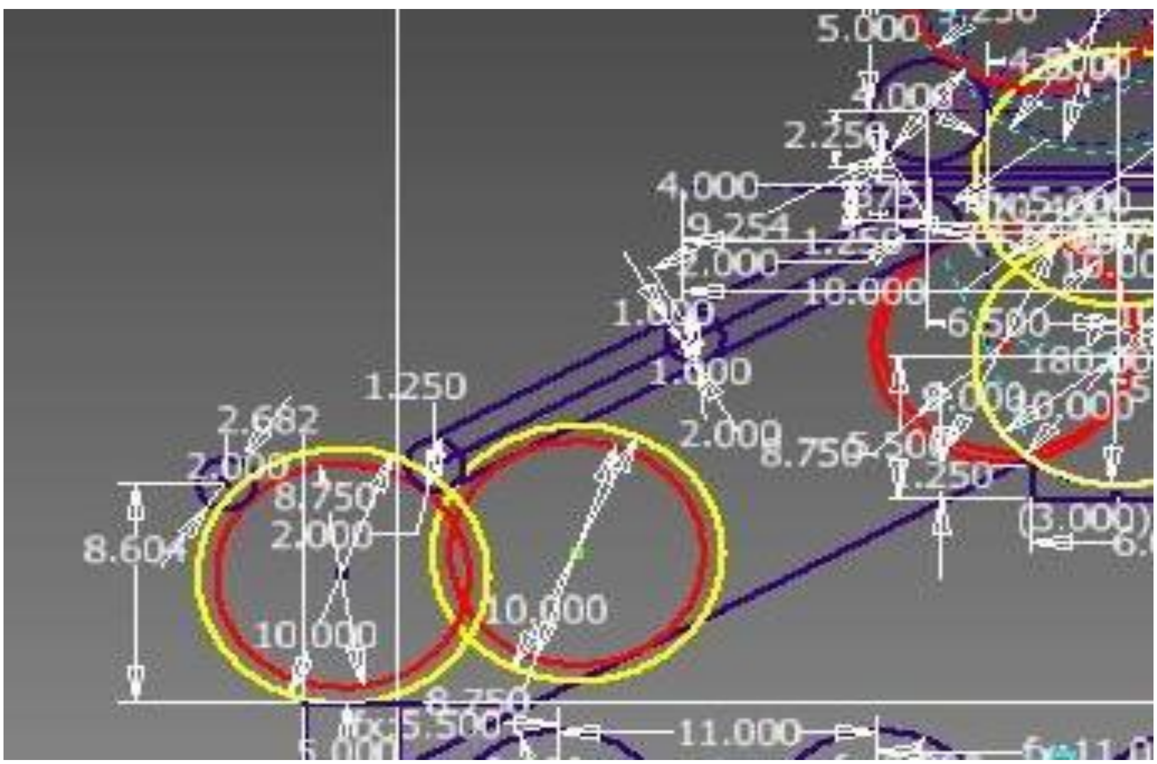
- Geometry can breach Portcullis, Cheval de Frise, Drawbridge, and Sally Port defenses
- Intake rollers allow ball possession over the bumper into conveyor
- Roller speed approximately 18ft/s
- Intake Joint is powered using 2 MiniCIM motors through gearbox and sprocket reduction of 308:1
- 3 Turn Potentiometer used to create set points for the arm for autonomous

Conveyor

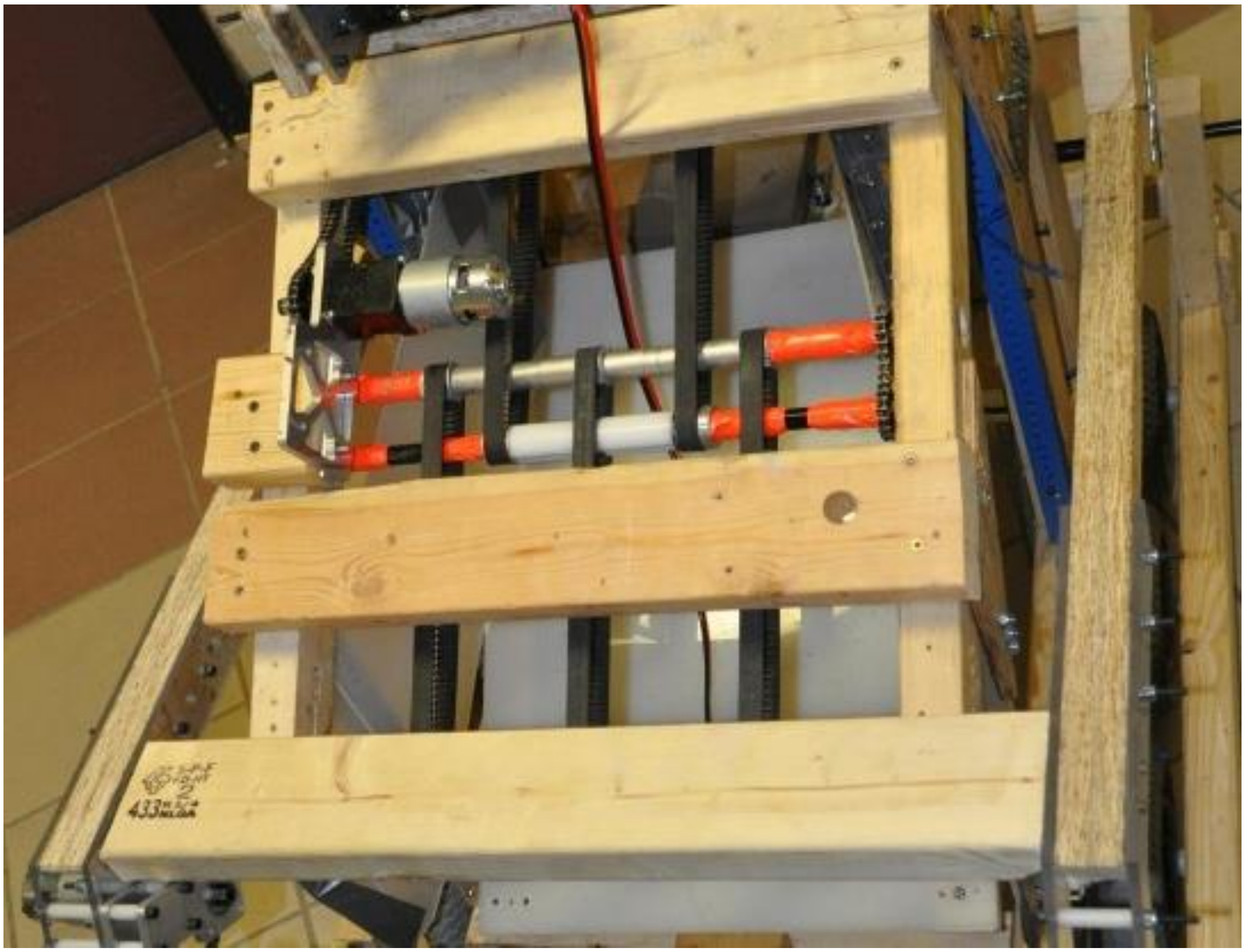
Parameters/ Variables:

- Ensure the front roller is inside frame perimeter
- The front roller must be placed so that the ball will always be in contact between the intake and conveyor
- Create 8.5" of pinch consistently throughout the conveyor
- The back roller must not hit the shooter
- The back roller must not interfere with the ball while shooting
- The back roller still has enough speed to push the ball into the popper
- The conveyor length must be a size that is the same as a easily accessible belt center- center distance

Parametric Studies



Final Prototype



- Utilises vex pulleys and belts
- 3 at the front and 2 at the back
- Polycarbonate flaps on side to assist funneling
- Used 1 Banebot RS775 motor with a vex versaplanetary 7 : 1 gear ratio
- Structure made out of 2x4 lumber

Final Design

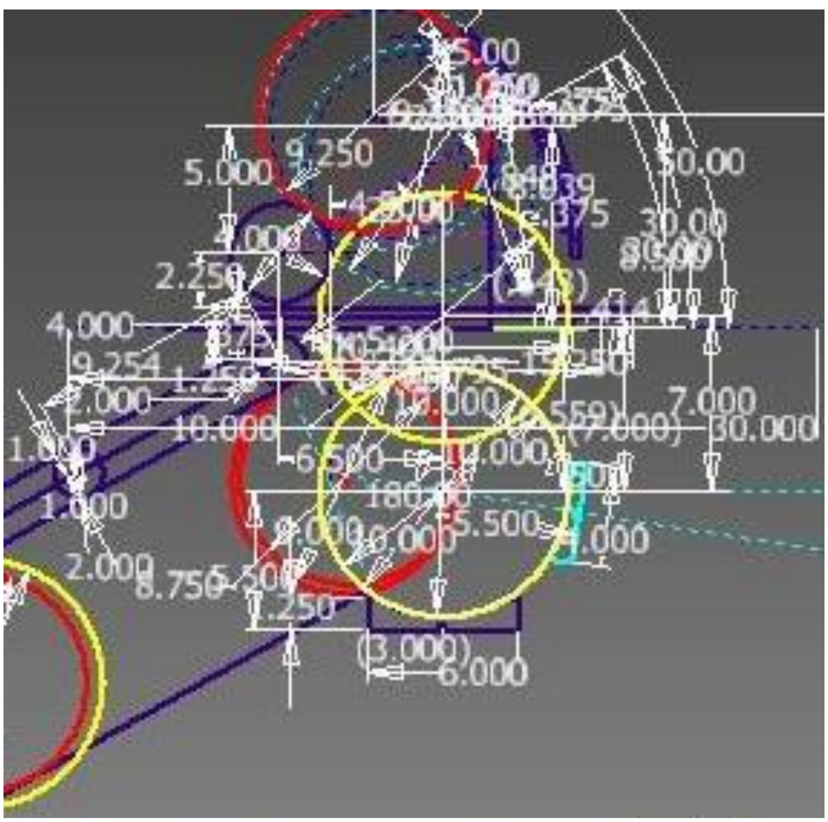
- Transitions ball from intake to popper
- 3 HTD Belts driven at 18 ft/s by a 775pro motor with assisting rollers
- Polycarbonate funnels help guide the ball from a wide entrance area to the popper
- Optical sensor used to automatically close "Halo" holders when ball is detected.

Popper

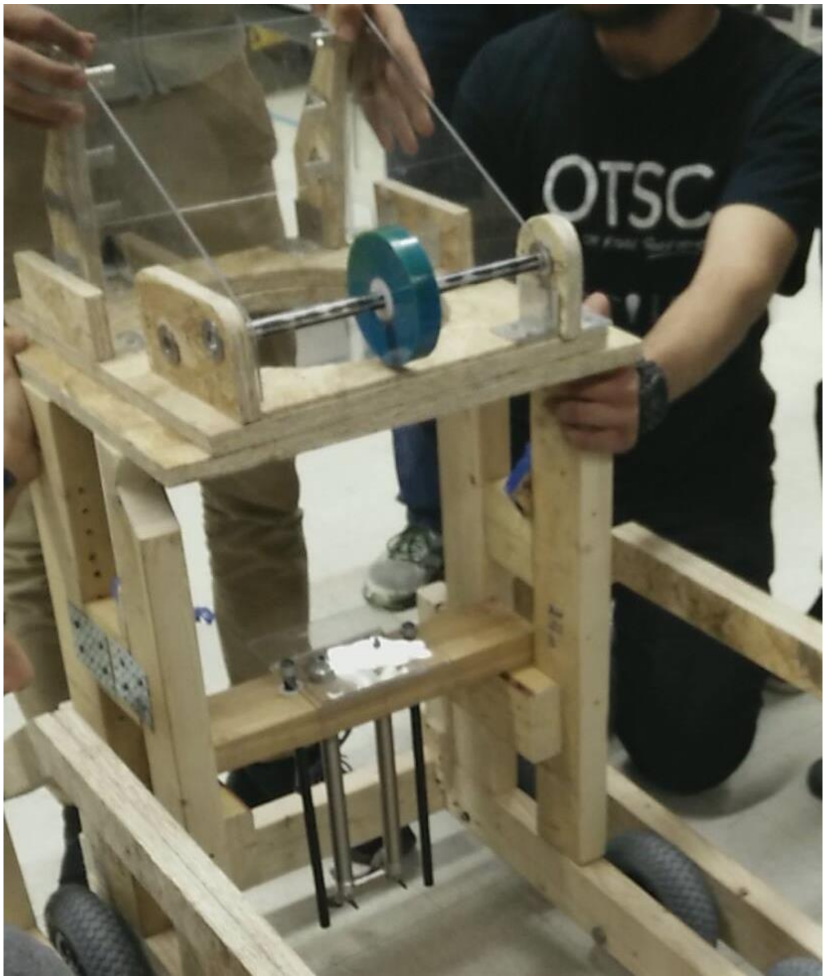
Parameters/ Variables:

- Maintain Height of Shooter so our shot can never be blocked
- Feed ball with a linear movement
- When ball is fed leave overlap so there won't be any dead spots
- Create a pocket where the ball will sit
- Make sure the pneumatic cylinder of desired length fits underneath the ball without interfering with the belly pan
- While fed the ball must be in the exact center between the shooter wheels and the hood

Parametric Studies



Final Prototype



- Dual 8 inch stroke cylinders
- 2 0.5inch round guide rods to stabilize the motion
- CPVC CNC'd cup contoured to match the shape of the boulder
- Frame made from 2x4 lumber
- Vex plates used as gussets
- Outtake bar to push the ball back into the conveyor to outtake
- CNC'd ABS pieces to settle the ball

Final Design

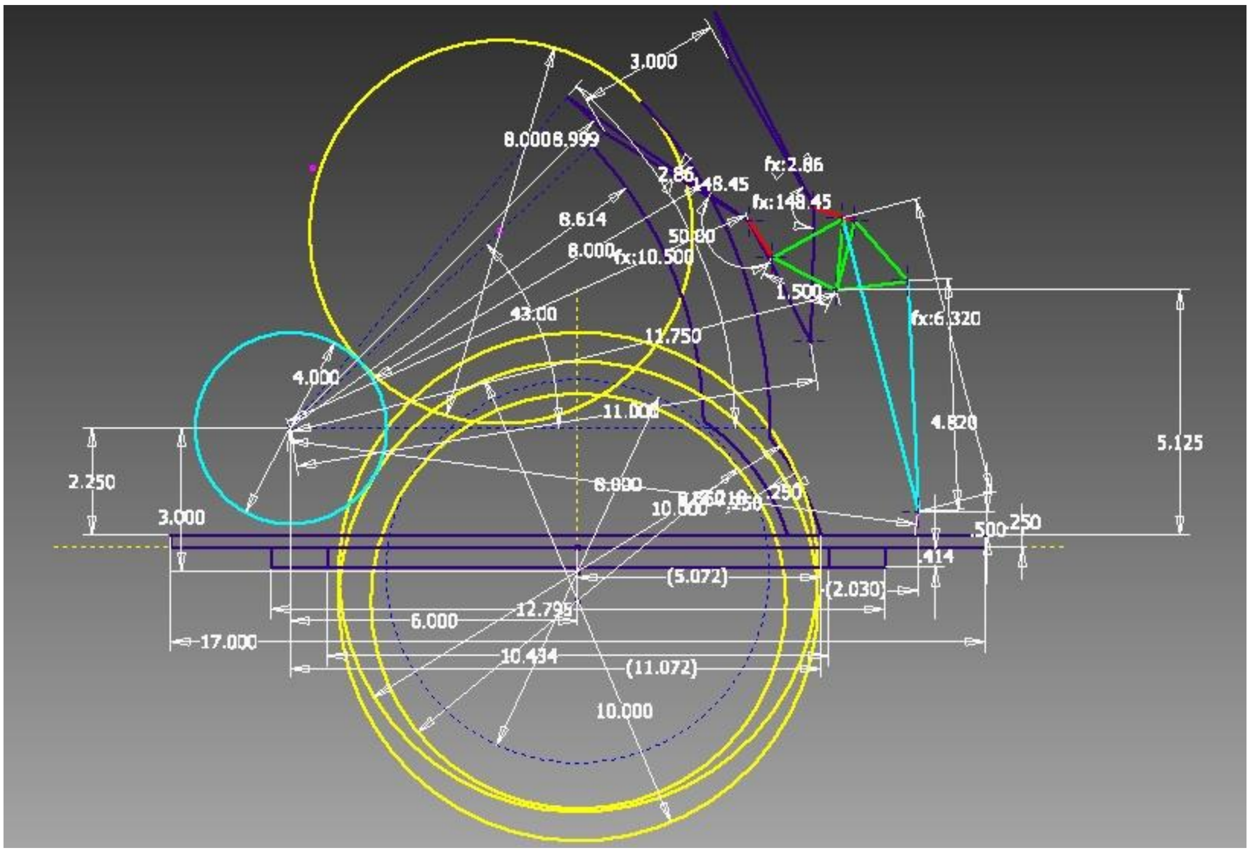
- Popper feeds shooter consistently in any turret orientation
- Powered by one pneumatic cylinder and 2 guide rails for stability
- 4 bars enclose the ball to keep the ball in the desired position while under defense and traversing the field

Shooter

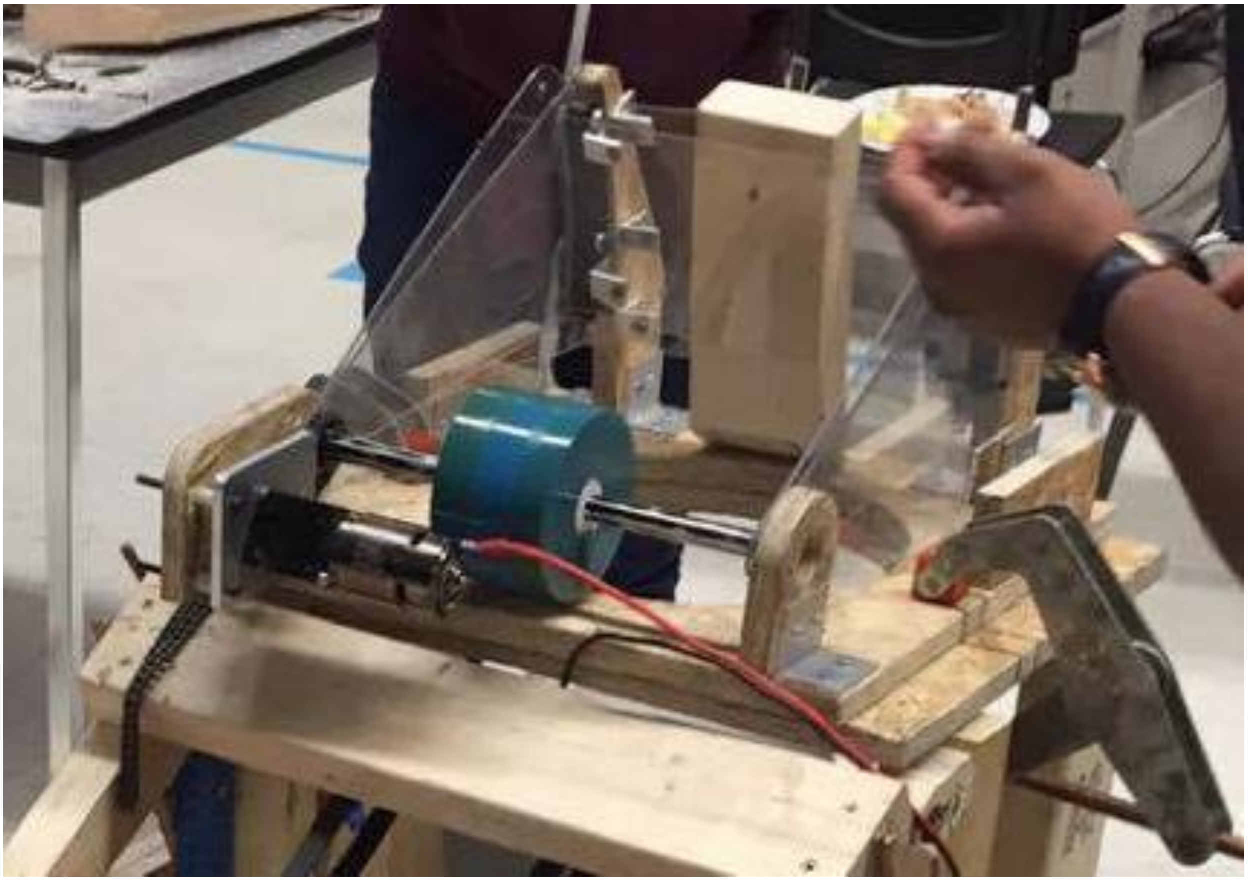
Parameters/ Variables:

- Exit pinch
- Entry pinch
- First contact points
- Wheel position
- Angle
- Ball compression

Parametric Studies

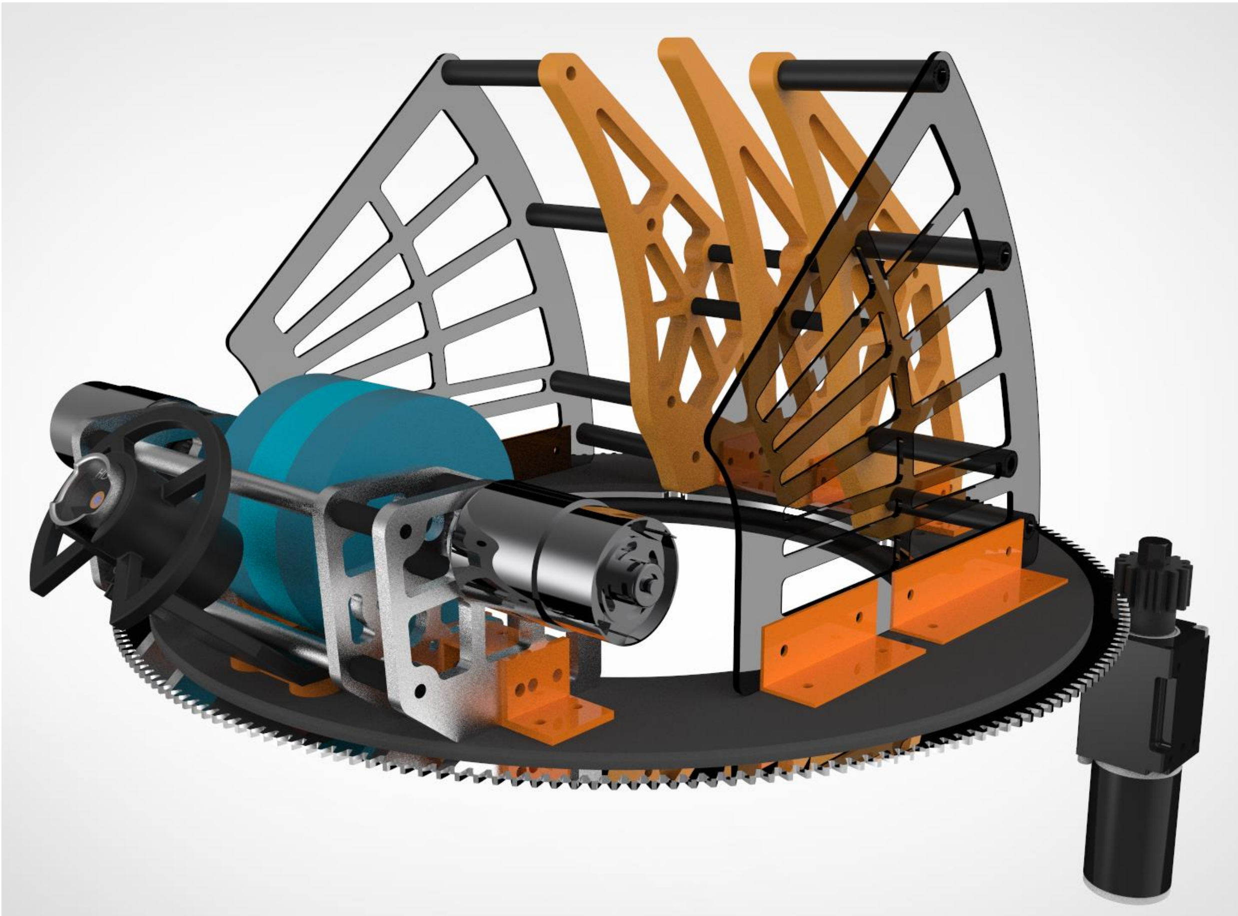


Final Prototype



- 2 position hood made out of polycarbonate
- Adjustable pinch and angle for testing
- 3 4in Diameter Urethane wheels powered by a 775pro motor
- Gear/sprocket reduction ratio of 2.9 yielding max 6300 RPM

Final Design



- Shoots ball into the high goal from various positions in the courtyard
- 3 Urethane wheels Ø4& powered by 2 775pro motors through a 3:1 reduction
- Fixed hood angle of 43 degrees above horizontal for all shots
- Turret uses one Bag motor through a planetary gearbox to a custom sheet metal gear
- Combination of RPM and turret position allows the robot to shoot from many orientations

Controls

Sensors

Optical Sensor

- Used to read the revolutions per minute on the shooter
- Gives more accurate readings than if an encoder was used
- Allows easier use of PIDs for shooter to get consistent final velocity of boulder

- Used to detect the boulder inside the popper
- If the boulder is detected, then the holders actuate to keep the boulder in place, allowing minimal movement before shooting

Encoder

- Placed on the drivetrain, one on each side
- Used for autonomous, reading the distance travelled
- Placed on the turret motor
- Has 1024 ticks per revolution
- Is converted to degrees to give accurate reading for the direction of the turret
- Used to turn the turret to a specific degree with a button that the driver can use

Potentiometer

- An analog input used on the intake arms
- Determines the angle the arm has risen
- Used for autonomous, allows pre-coded control of the arm

Gyro

- Used on the drivetrain to determine the angle of the robot
- Allowing S-curves and turns for autonomous

Future

Ultrasonic sensor

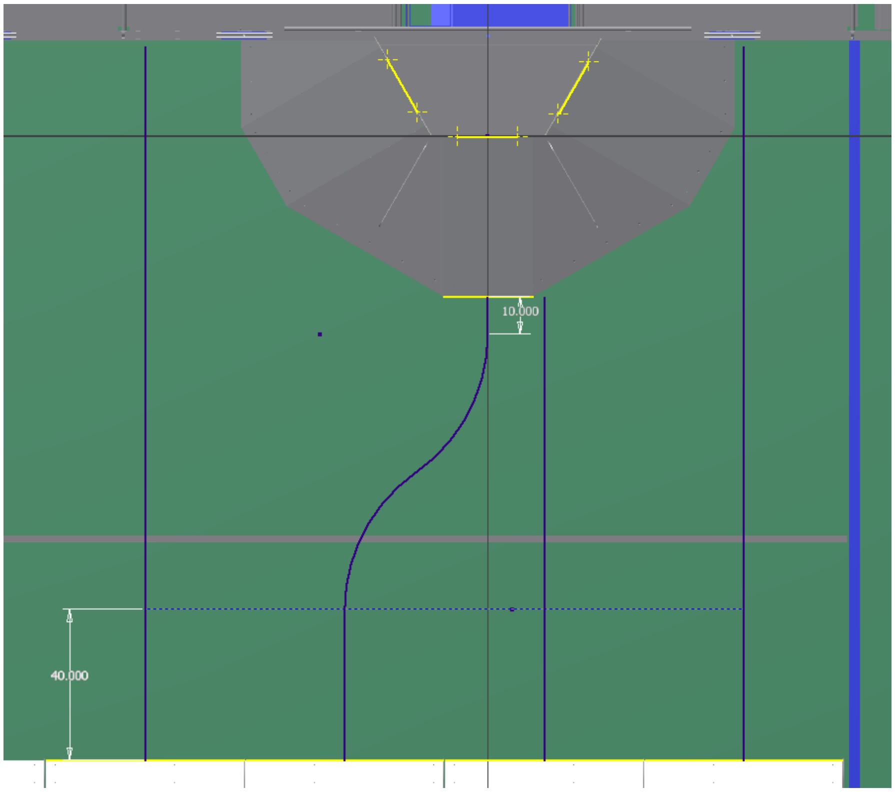
- Mounted on the intake to detect when a ball enters the robot
- Used during autonomous when a second ball is needed
- Makes sure that the robot does not move past the autonomous line and receive a foul

Autonomous

1. Shoots a ball from the spy zone and move the robot to outer works
2. Traverses over a defense, drive towards the tower, then shoots into the target
3. Traverses over a defense, shoot into target, drive back and intake a second ball

- Has the ability to go through defense A,B, and D from any location, with shooting to the high goal
    - Totalling to 20 points

Drive Path on the Courtyard



- After traversing a defense, the robot drives towards the tower depending the starting location
- Once the robot ends its drive path, it turns the turret towards the target through camera tracking and shoots the ball towards the high goal

Other

- Using camera tracking to automatically turn the turret towards the target
- Allows easy use of turret turning, driver does not need manual control over turret

Used during autonomous to move the turret instead of using presets