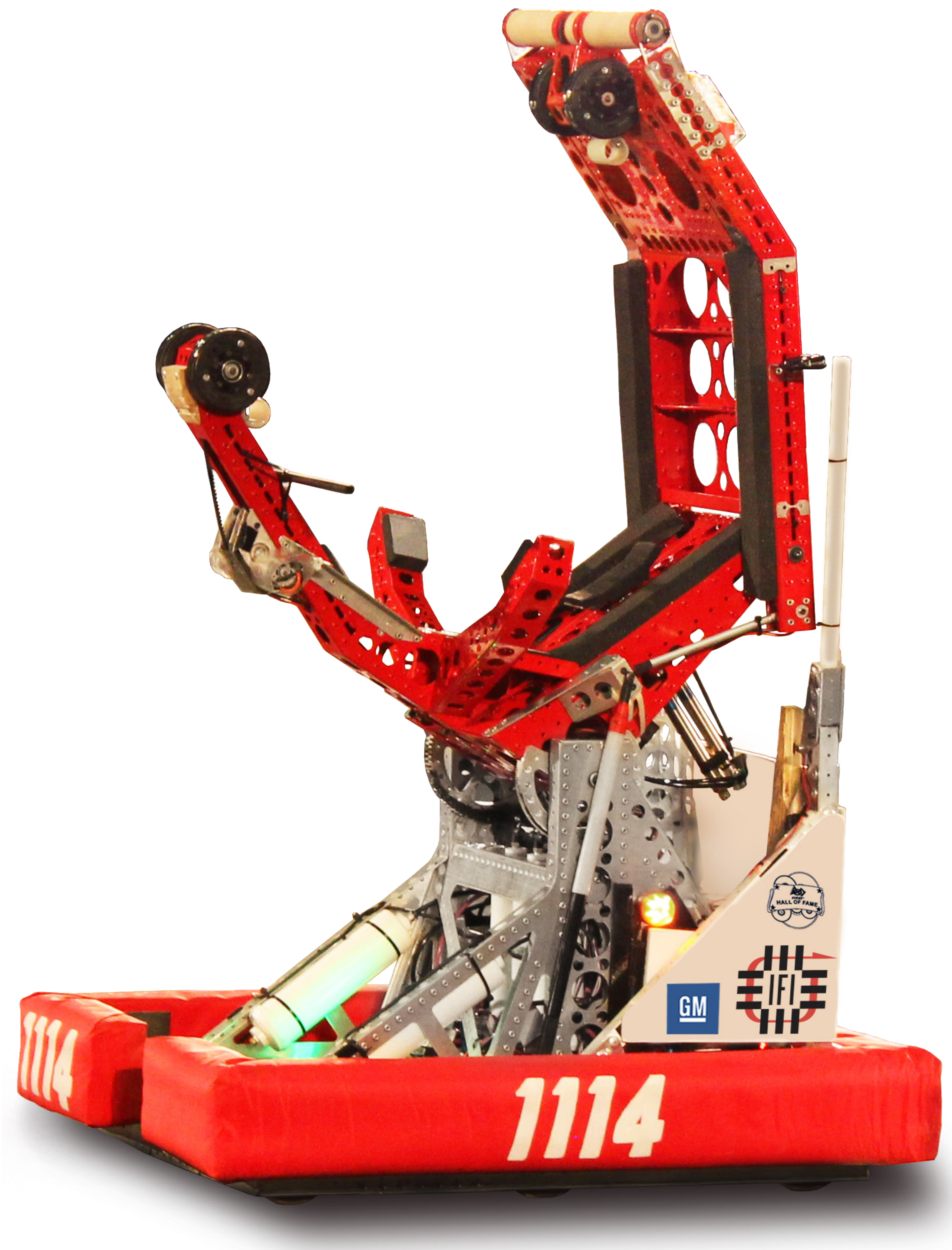
TEAM 1114 PRESENTS:

EVOLUTION

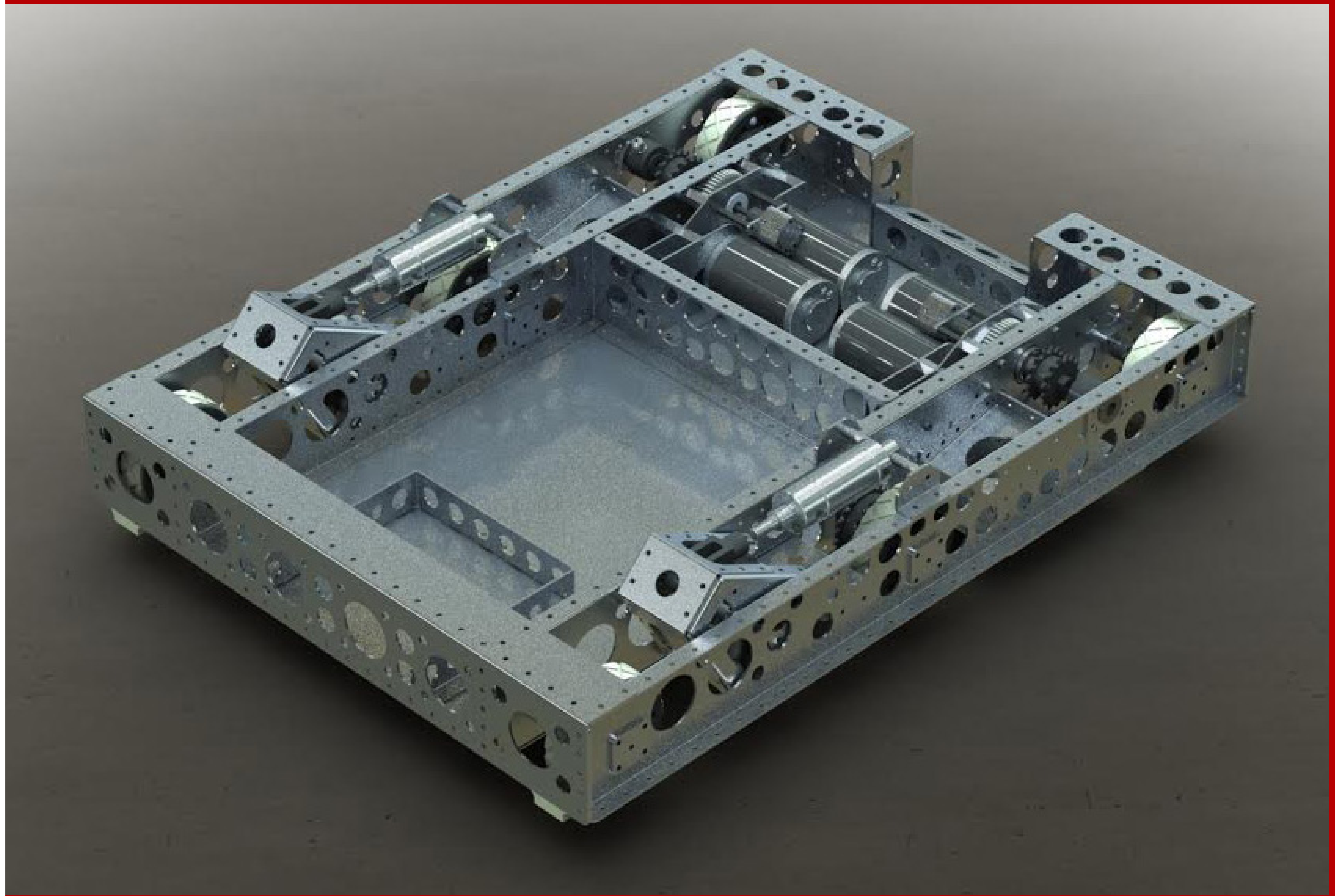
ENGINEERING NOTEBOOK

Drivetrain Claw Shooter



Intake Goalie Stick Controls

DRIVETRAIN



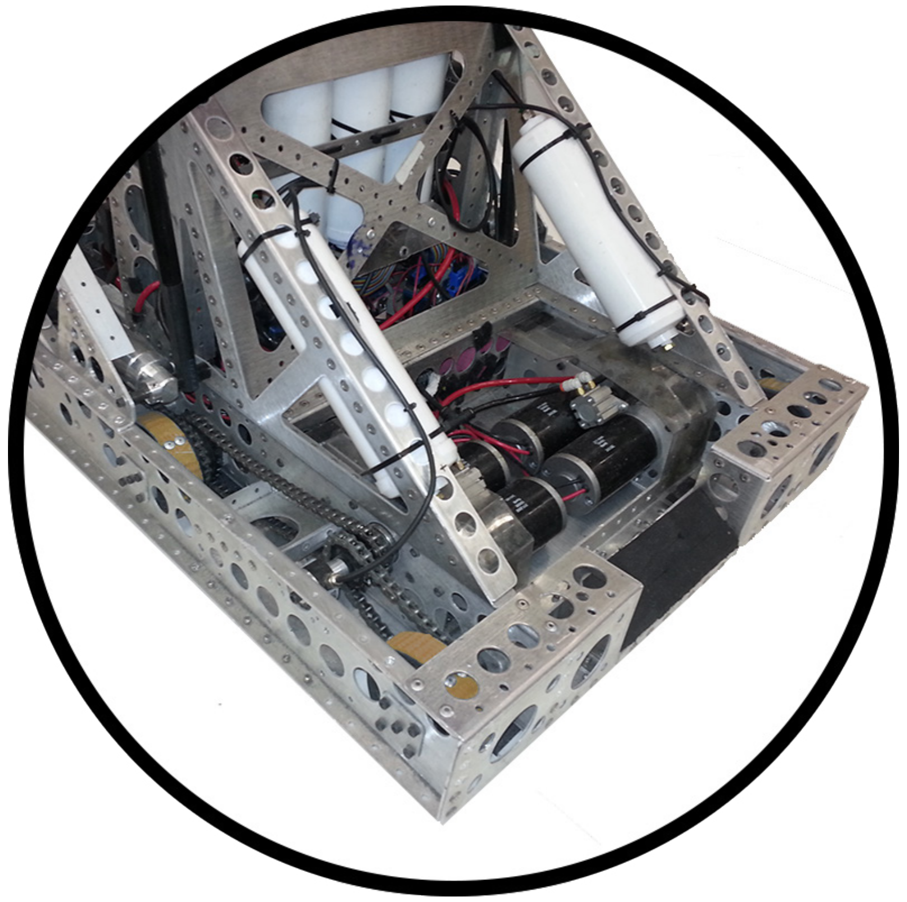
Subsystem Includes:

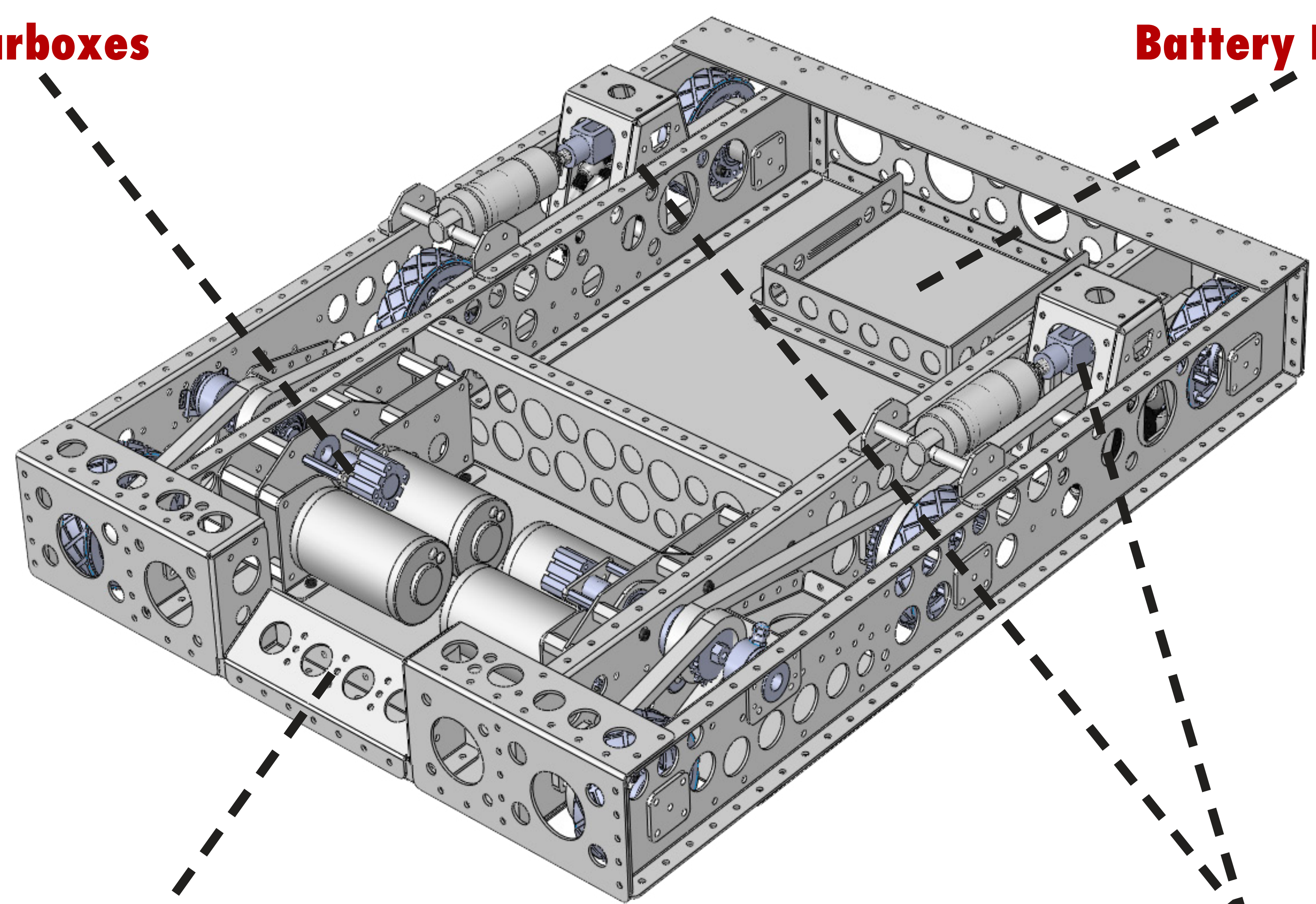
- Information
- Gearbox
- Drop-down Wheels

DRIVETRAIN INFORMATION

Info

- Riveted 0.090″ aluminum sheet metal chassis
- Six wheel drive utilizing 4″ x 1″ VEXpro traction wheels
- Wheelie blocks to move tipping point fulcrum out and closer to the ground, making the robot more difficult to tip
- 0.125″ dropped center wheel for easy turning
- Drivetrain dimensions of 31.8″ x 24″

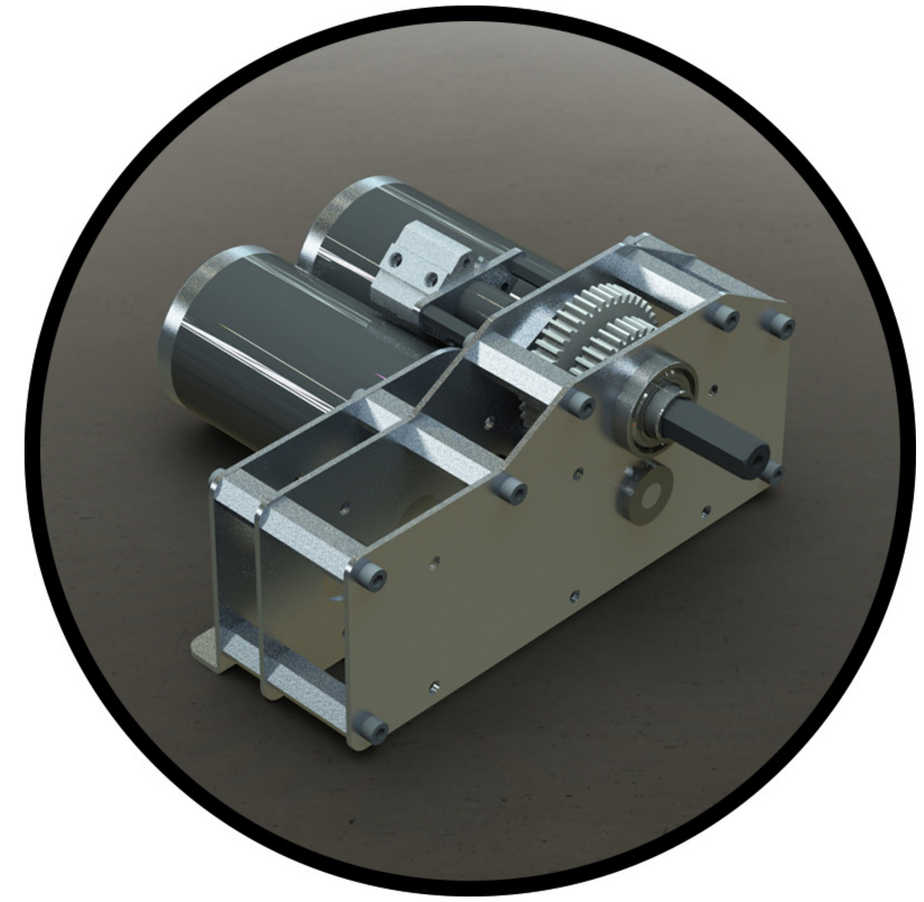


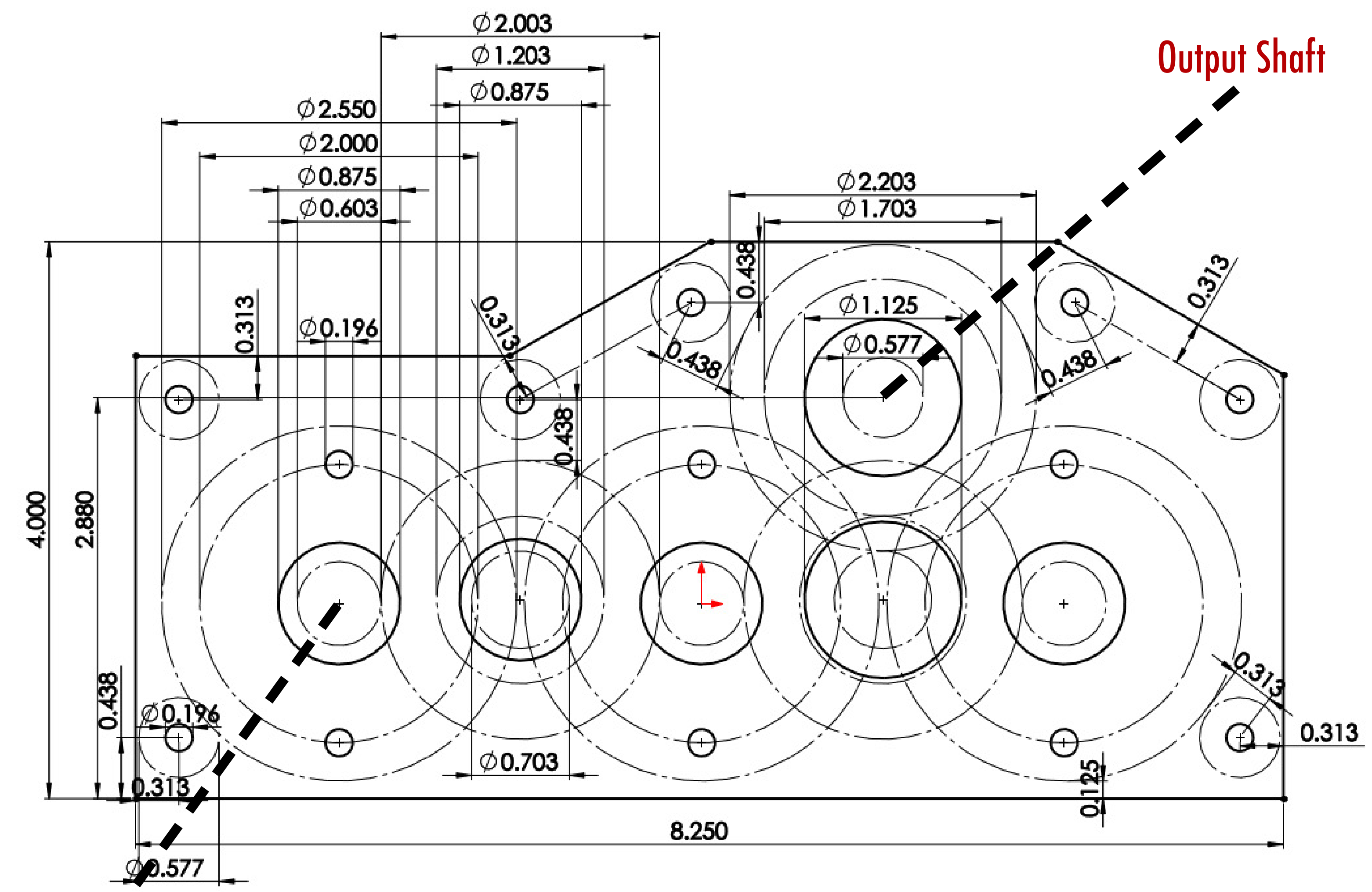


DRIVETRAIN GEARBOX

Info

- Powered by four CIM motors; power transmission via custom two speed transmission, utilizing VEXpro ball shifter components and roller chain drive
- Approximate top speeds of 5.7 ft/s (in low gear) and 13 ft/s (in high gear)
- Mounting option for an additional CIM motor





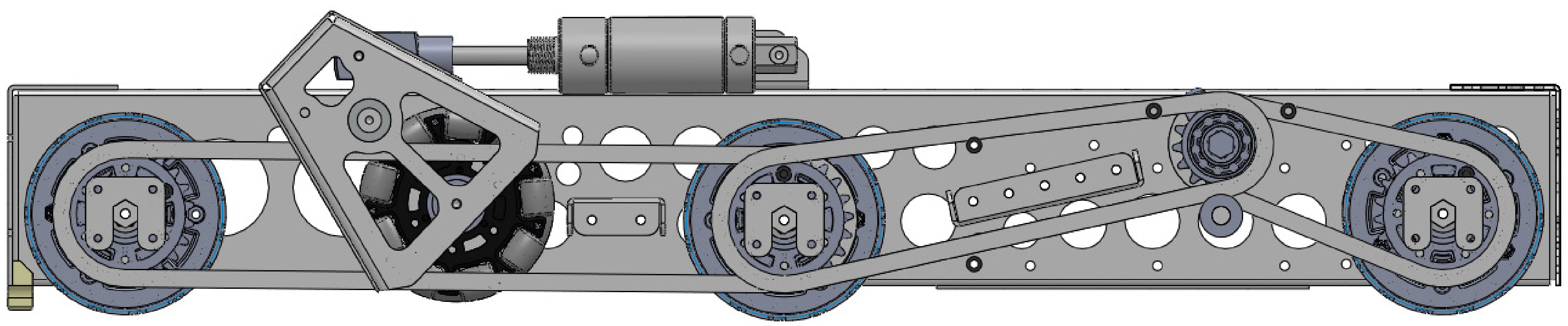
DRIVETRAIN DROP-DOWN WHEELS

Info

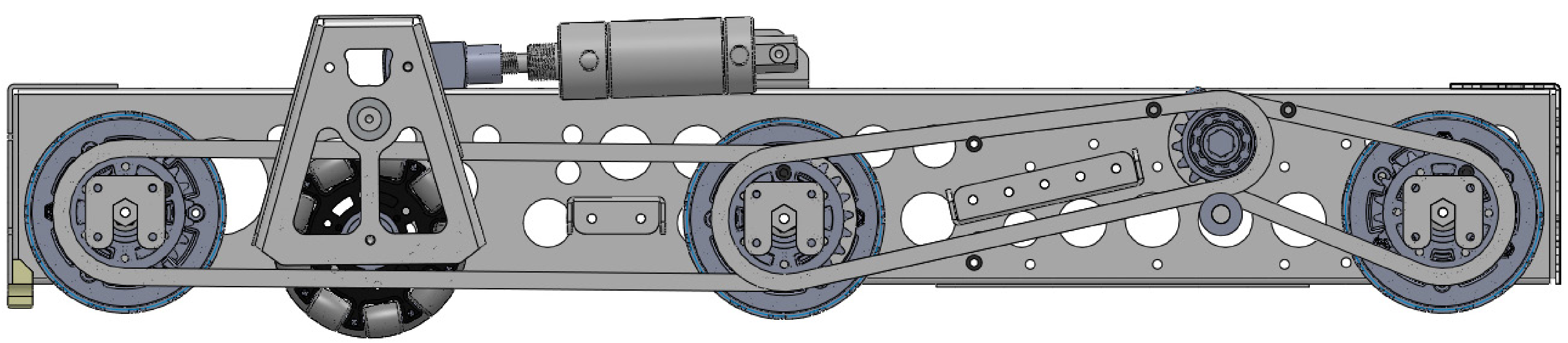
- Drop-down VEXpro 4" omni wheels to assist with getting out of t-bone pins
- In active position, the two drop-down omni wheels push against the ground and lift the back 4 traction wheels off the carpet
- Two 1.5" bore, 1" stroke cylinders actuate the module
- Drop-downs sits within the drivetrain rails between the back and middle wheels. Chain runs thought clearence holes on the module

Clearance holes for chain

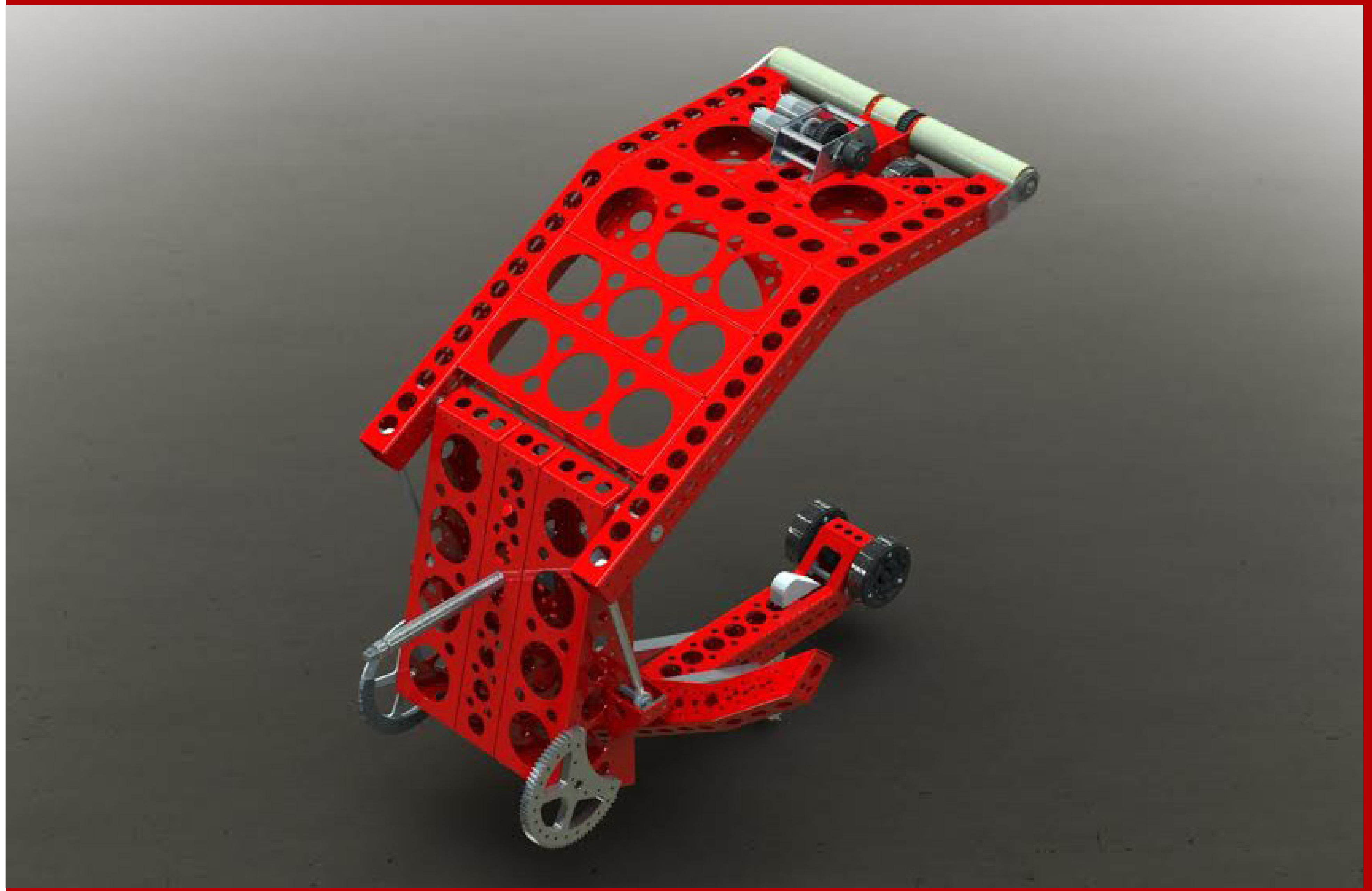
Inactive Position



Active Position



CLAW



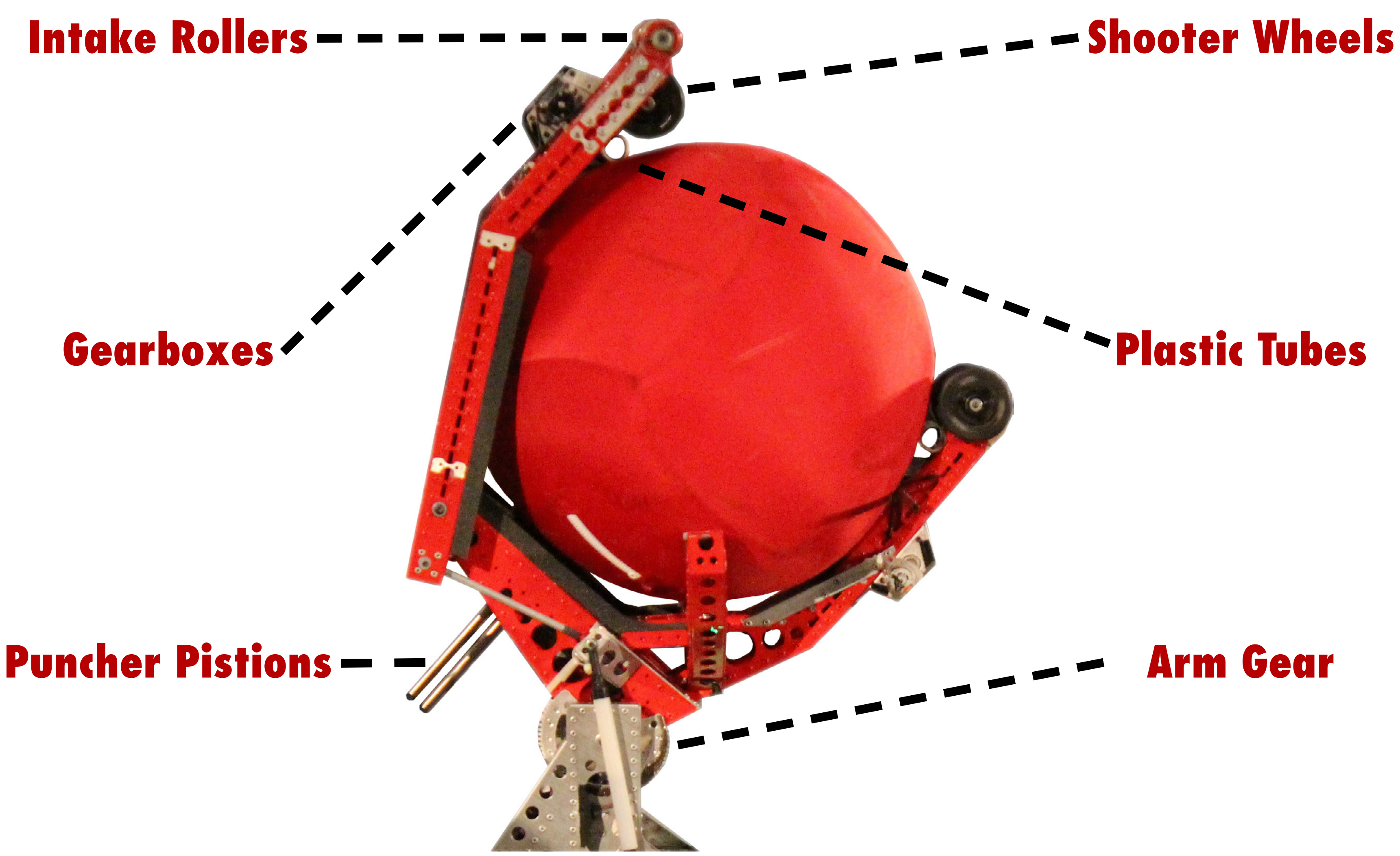
Subsystem Includes:

- Information
- Design Notes
- Concepts

CLAW INFORMATION

Info

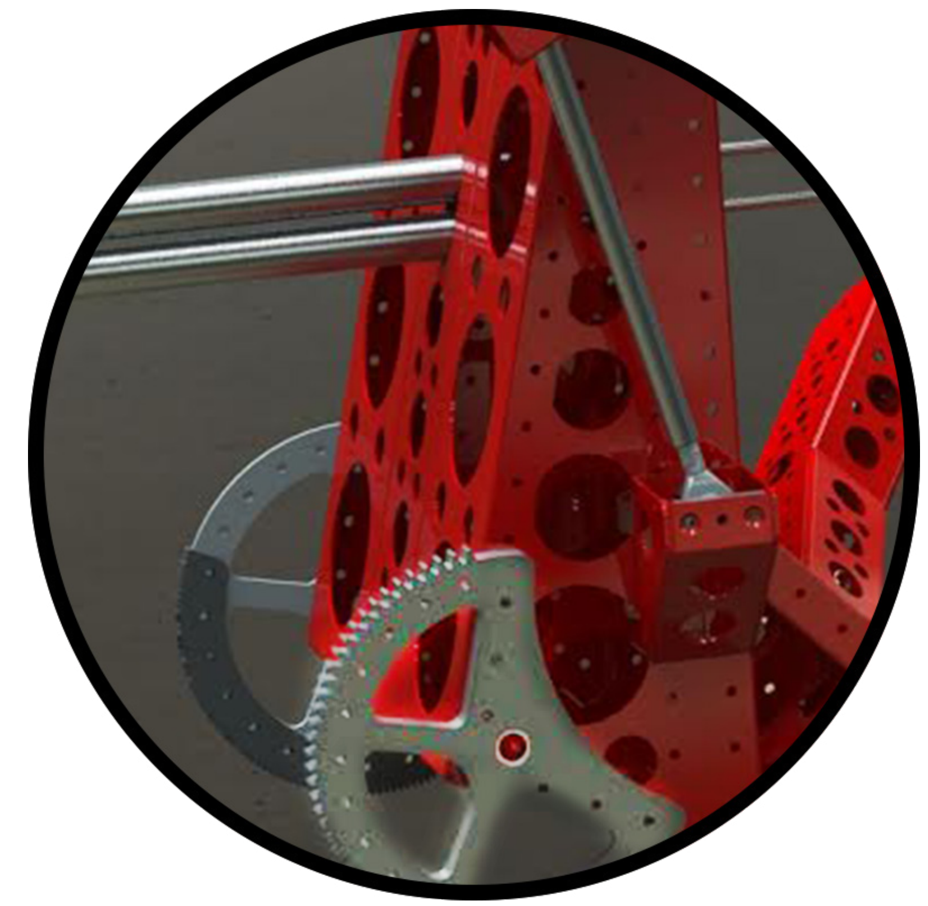
- Robust riveted 0.063" aluminum sheet metal, designed to withstand collisions
- Driven by a VEXpro BAG motor through a 50:1 Versa Planetary gearbox and a 7:1 sheet metal gear for an overall 350:1 reduction ratio
- Two plastic tubes prevent accidental contact between the ball and shooter wheels
- Two gas shocks counterbalance the weight of the arm

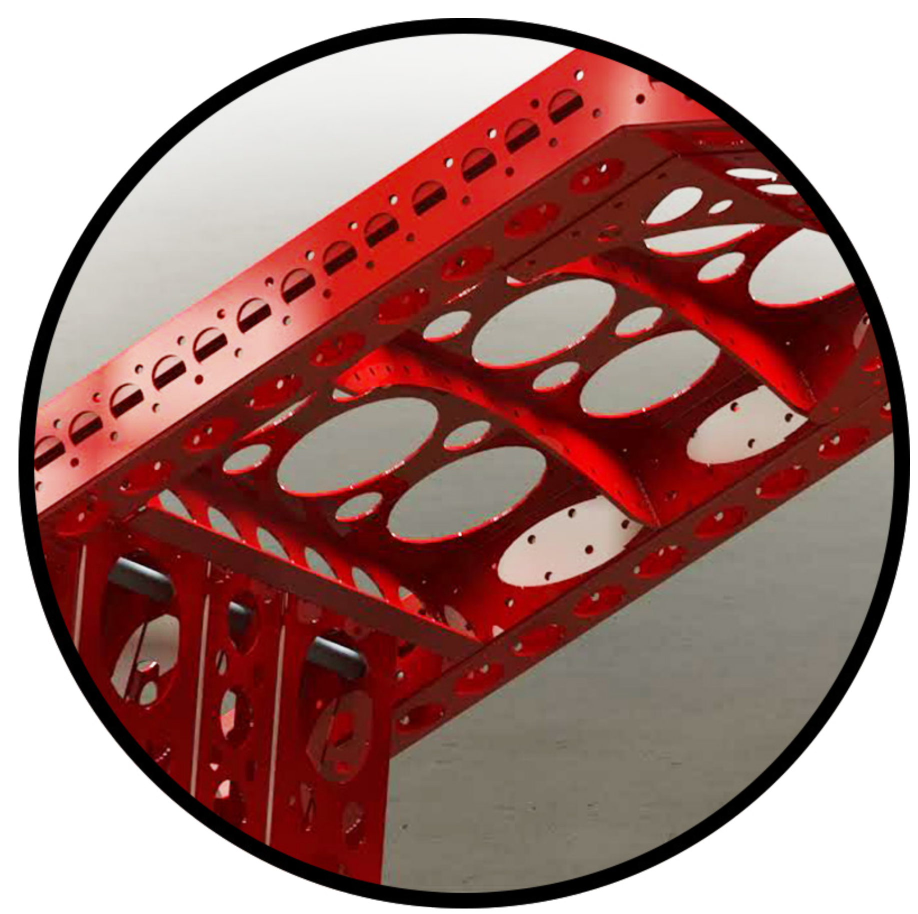


CLAW INFORMATION

Claw Gears

- 12 DP sheet metal gear attached to claw for additional 7:1 speed reduction for an overall 350:1 speed reduction
- 24 DP 3D printed gear is attached to the opposing side of claw frame for potentiometer feedback

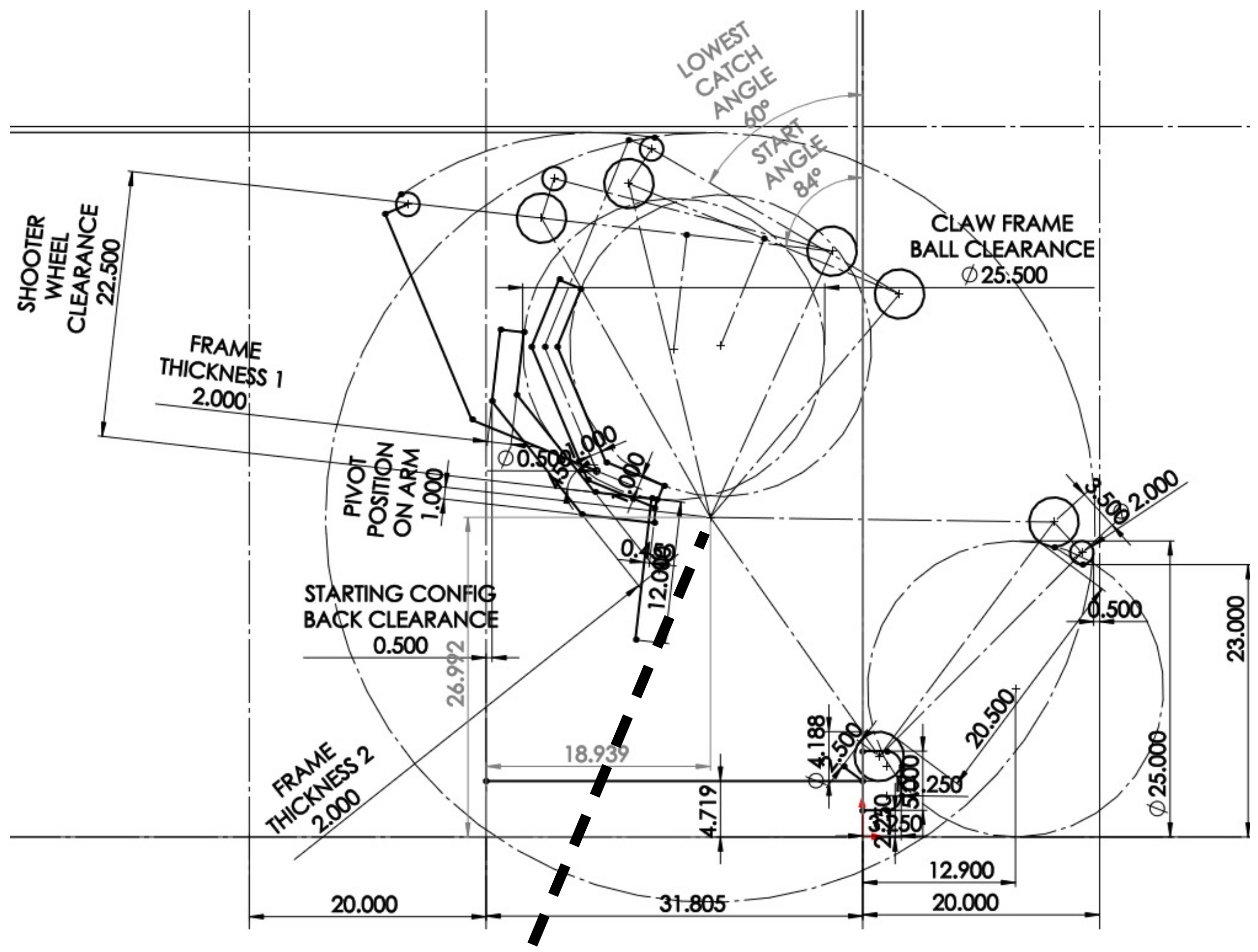




Ball Cutout

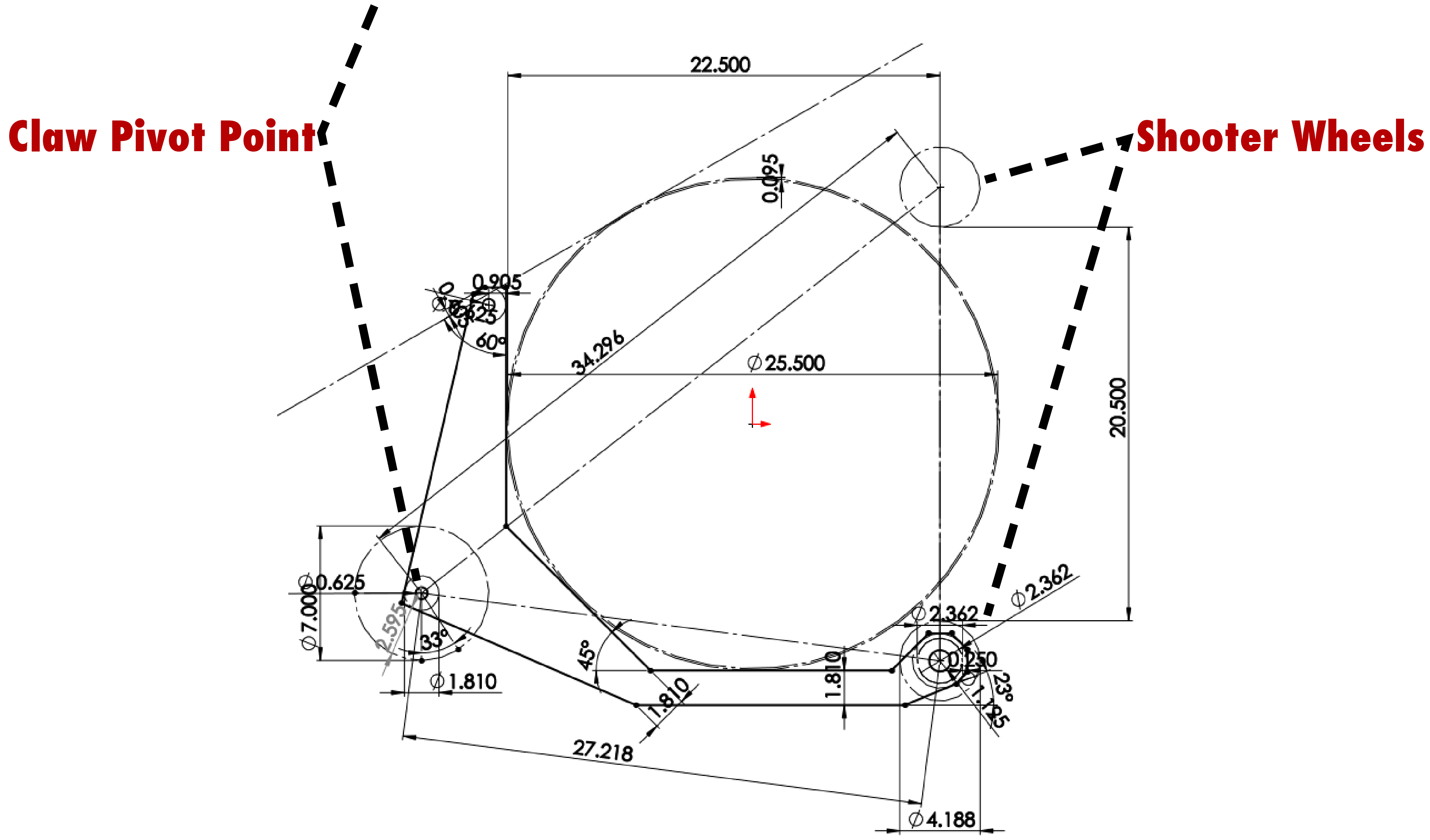
- A pocket is designed into the claw sheet metal to maximize the height in the robot's starting configuration, maximizing the release height of the ball

CLAW DESIGN NOTES

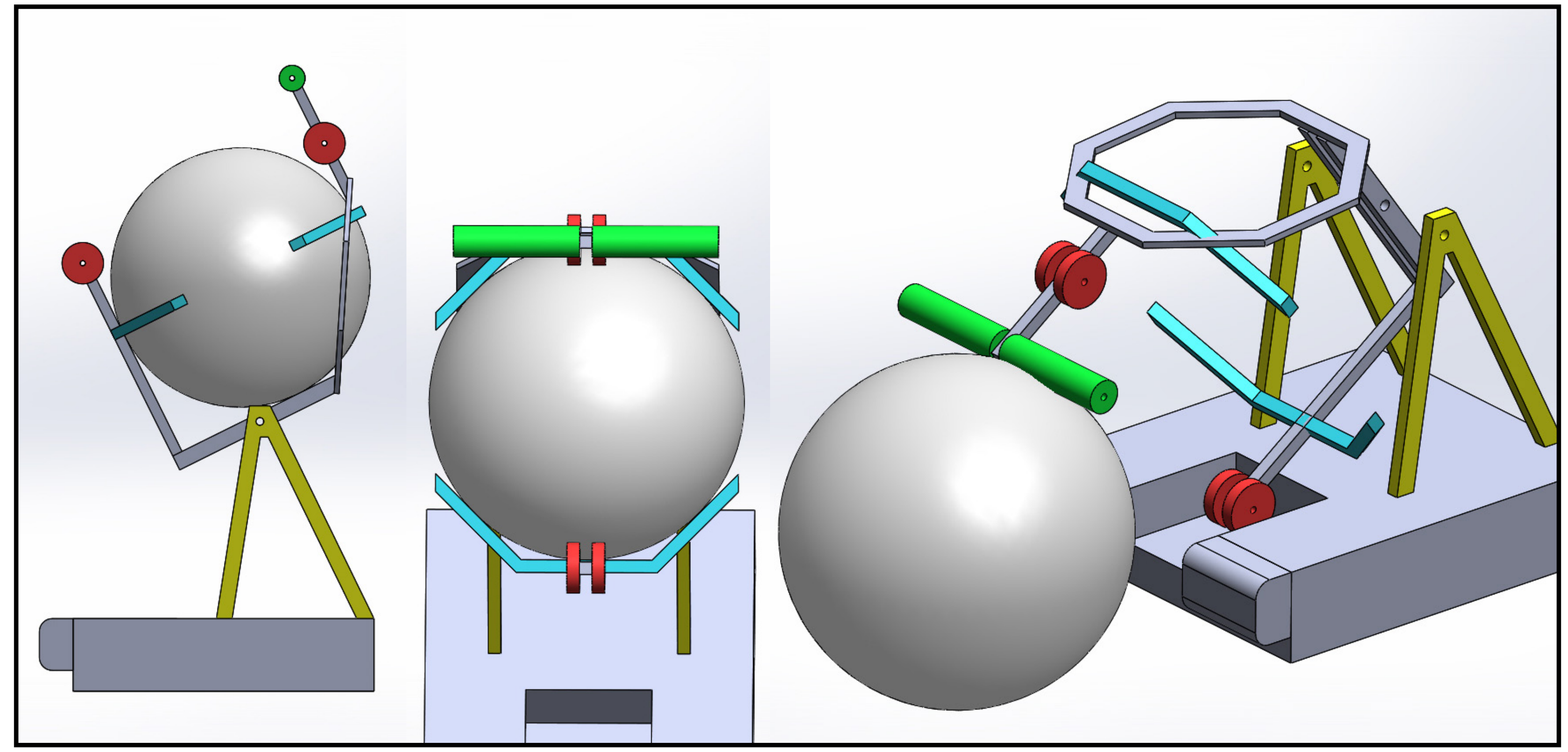


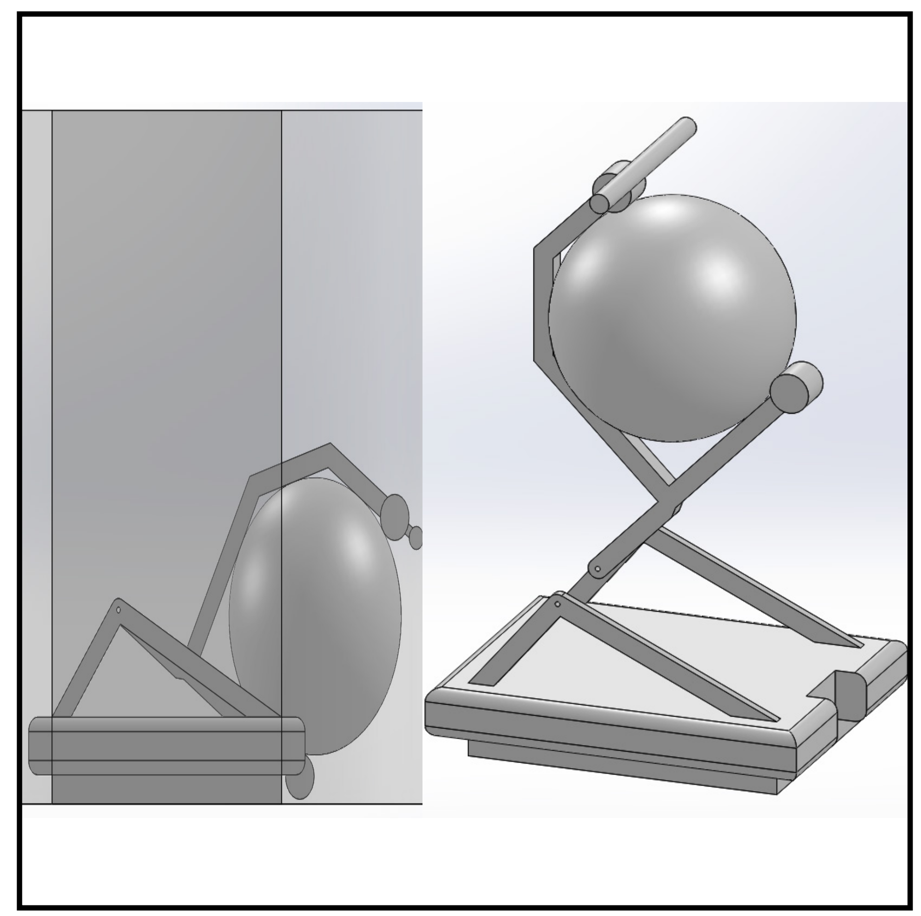
- Claw geometry determining pivot position, maximizing its height, while within starting configuration, 20″ extension and 60″ max height.

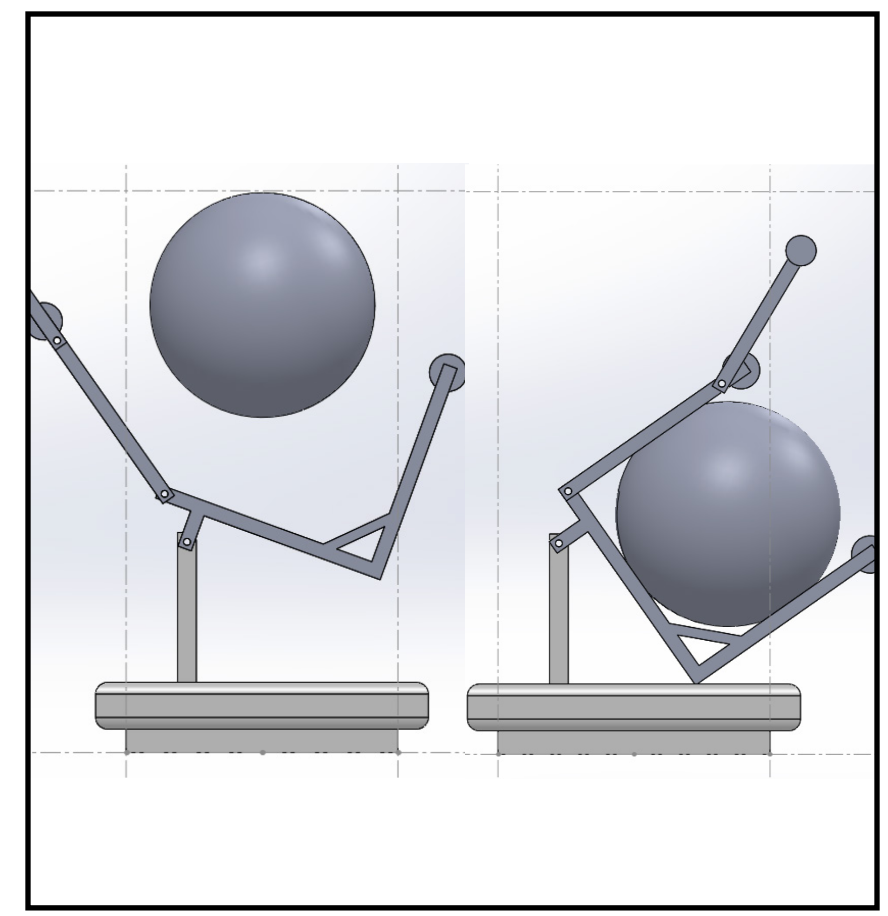
Claw Side Plate



CLAW CONCEPTS







SHOOTER

Subsystem Includes:

- Information

- Puncher

- Prototype V.1

- Prototype V.2

SHOOTER INFORMATION

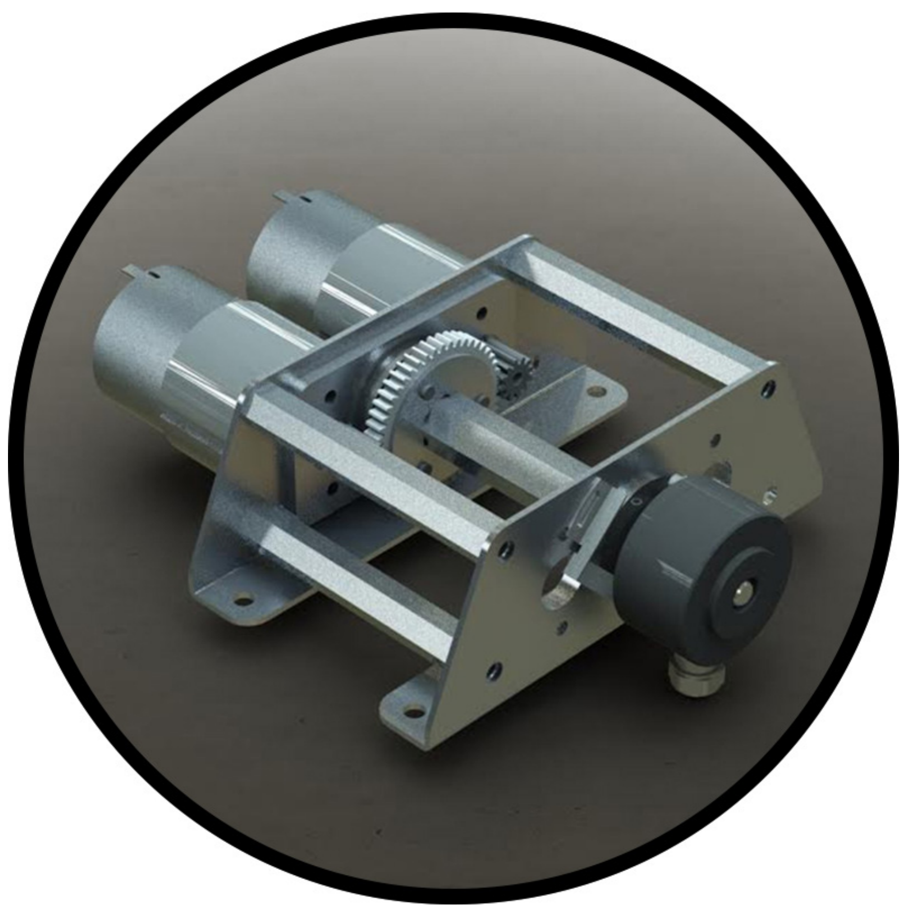
Shooter

- Shooter wheels spin at various speeds determined by the operator to allow for various initial shot velocities and shooting styles (backspin/knuckle ball)
- 2 pairs of 4" x 1" VEXpro traction wheels with 3/16" fabric backed urethane riveted to the circumference
- Theoretical free speed linear velocity of 88 ft/s

SHOOTER PUNCHER

Puncher

- Two 3/4" bore, 8" stroke cylinders accelerate the ball into the shooter wheels
- Each cylinder has a designated high flow solenoid and working pressure accumulator to maximize actuation speed
- Surgical tubing retracts cylinders to reduce air flow restriction



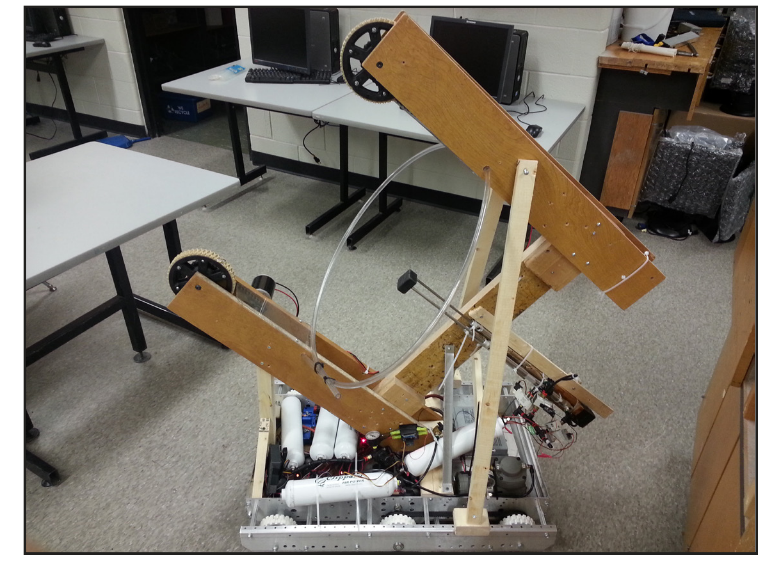
Gearbox

- Each pair driven by two RS-550 motors through a custom gearbox with a 4:1 gear reduction and VEXpro belt/pulley power transfer
- Three mounting options for different pulley ratio configurations that allow for different shooter wheel RPM
- Encoders mounted to top and bottom shooter gearboxes give encoder feedback to allow for various shooter speeds.

SHOOTER PROTOTYPES V.1

We prototyped 3 main shooters:

- Wheeled shooter
- Catapult
- Linear punch

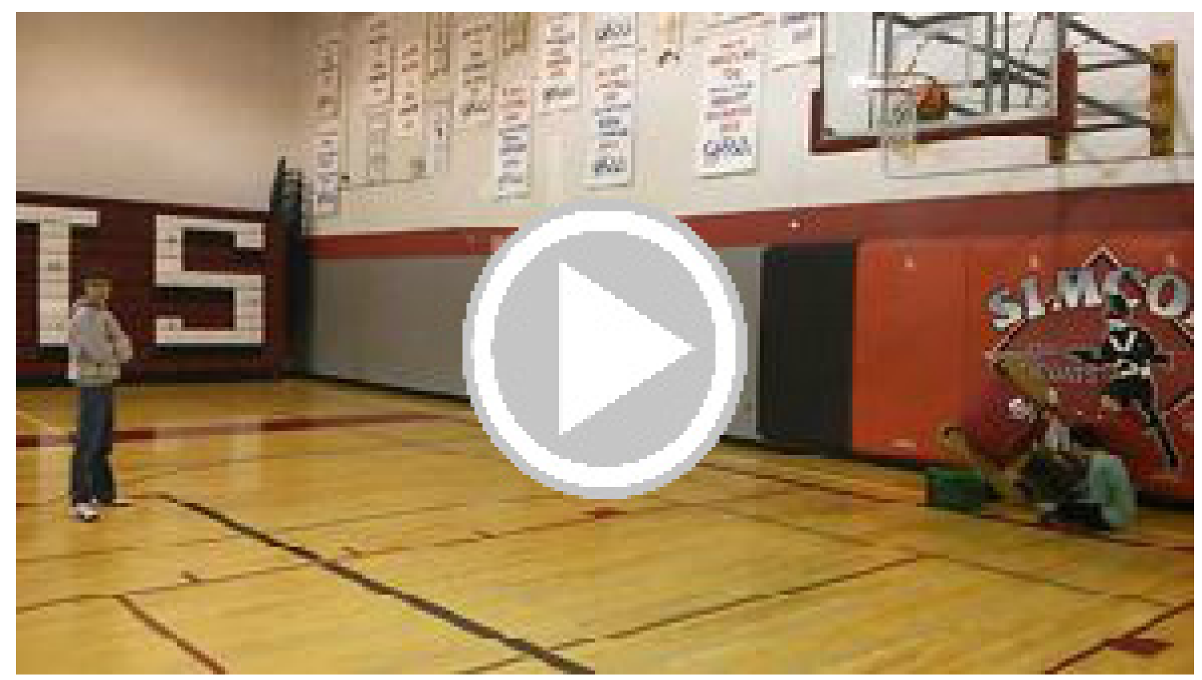


- We had the most success with the wheeled shooter
- The concept offers variable shooter speeds allowing for multiple shooting positions on the field and variable shooting styles (back-spin, knuckle ball)

First shot of the season

- The ball was originally pushed into the shooter wheels by hand
- Sprockets could be changed to test multiple linear velocities of the shooter wheels.

- Later we added pneumatic cylinders to push the ball into the shooter, for more powerful shots and consistent testing



Test of upgraded shooter

- We upgraded the shooter and added three 1/2" bore, 8" cylinders for the puncher
- 2:1 sprocket ratio
- It was mounted on the KOP drivetrain to simulate a running shot

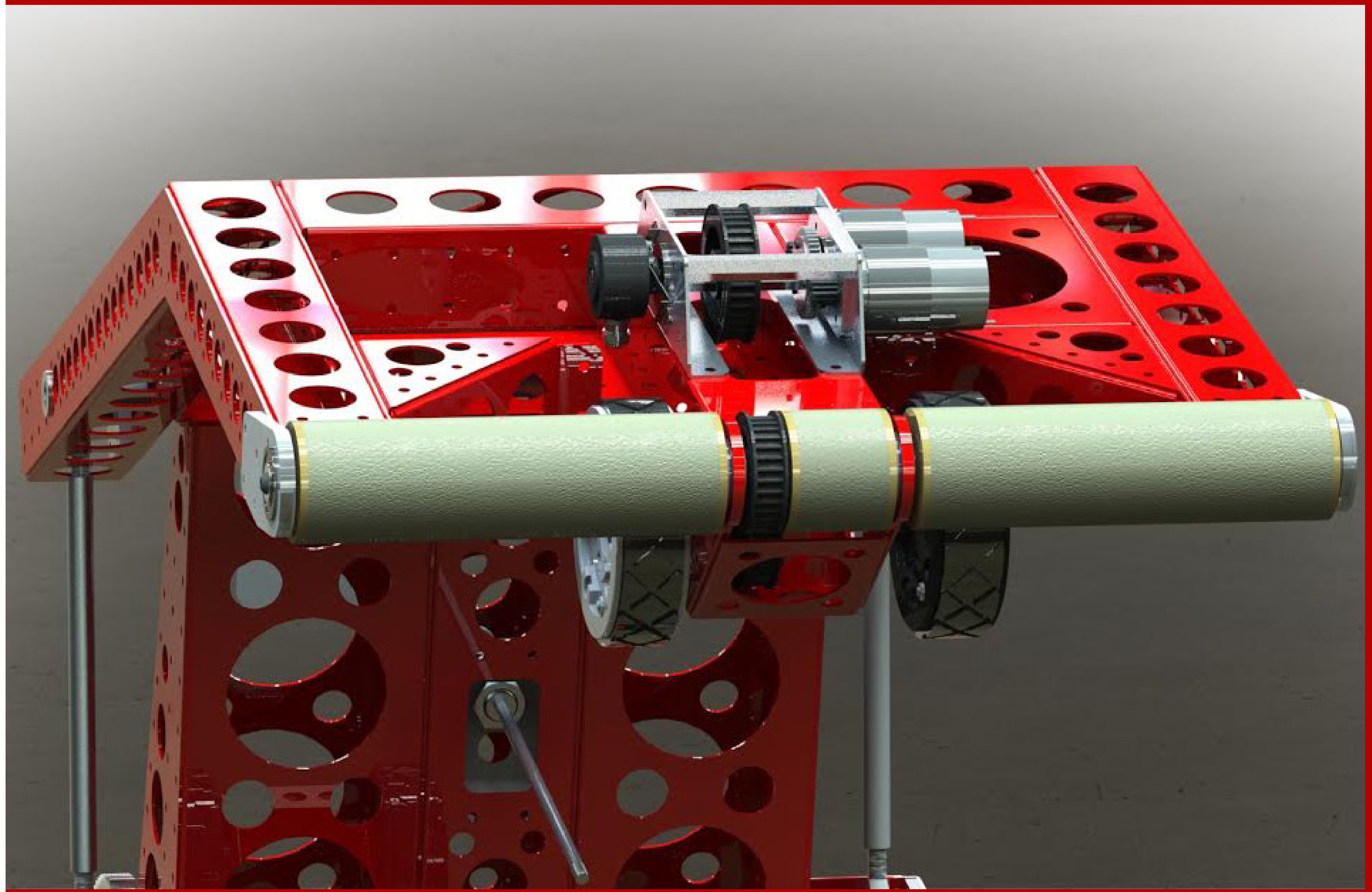
SHOOTER PROTOTYPES V.2

Version 2

- An upgraded design with a control system to adjust shooter wheel RPM based on encoder feedback
- Made from 2" x 3"wood , 3/4 plywood, and 1/8" aluminum plates
- Bottom wheels powered by CIM and mini CIM motors
- Top wheels powered by CIM motor
- 4" wheels instead of 6" for better claw packaging geometry.

- Puncher was powered by two 1/2" bore, 8" cylinders
- 60 psi accumulator was placed close to the shooter solenoid for faster shots
- We tested a variety of shooter wheels and tread material including 3.75" banebot wheels, 4" urethane drive rollers, wedge-top tread, linotex rubber, and fabric backed urethane
- Wheel plates were adjustable to test different compressions of the ball.
- 1.5" bore, 2" cylinders articulated the top of the claw to test catching

INTAKE



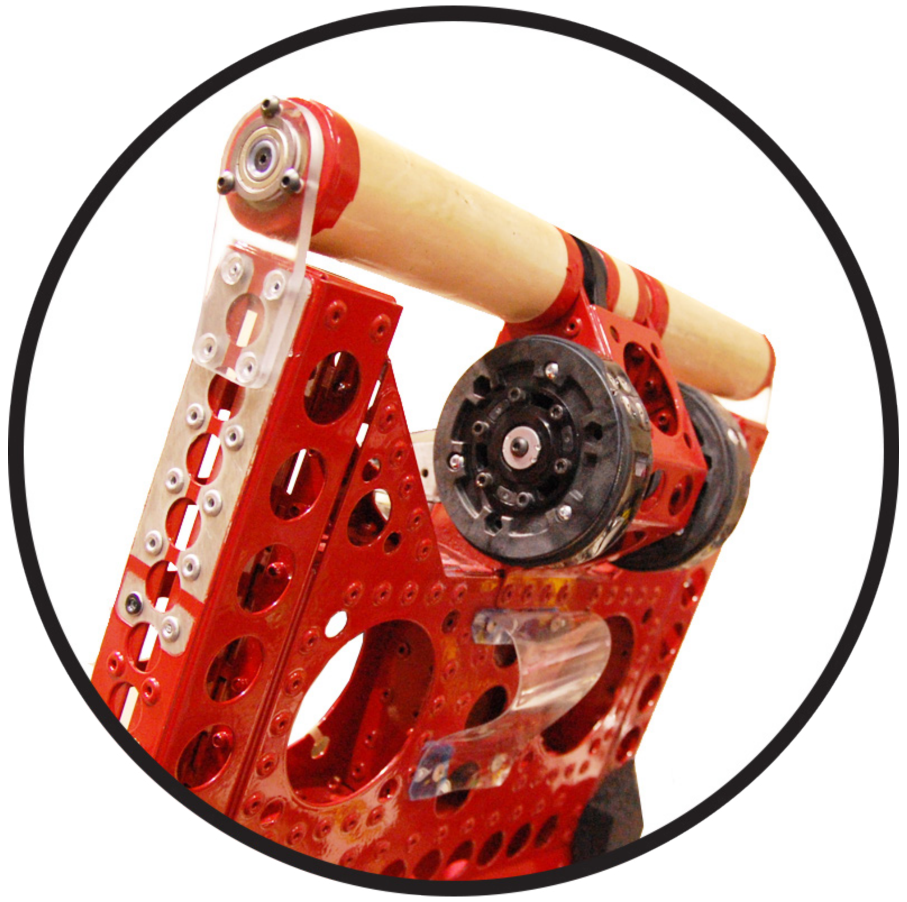
Subsystem Includes:

- Rollers
- Prototypes

INTAKE ROLLERS

Info

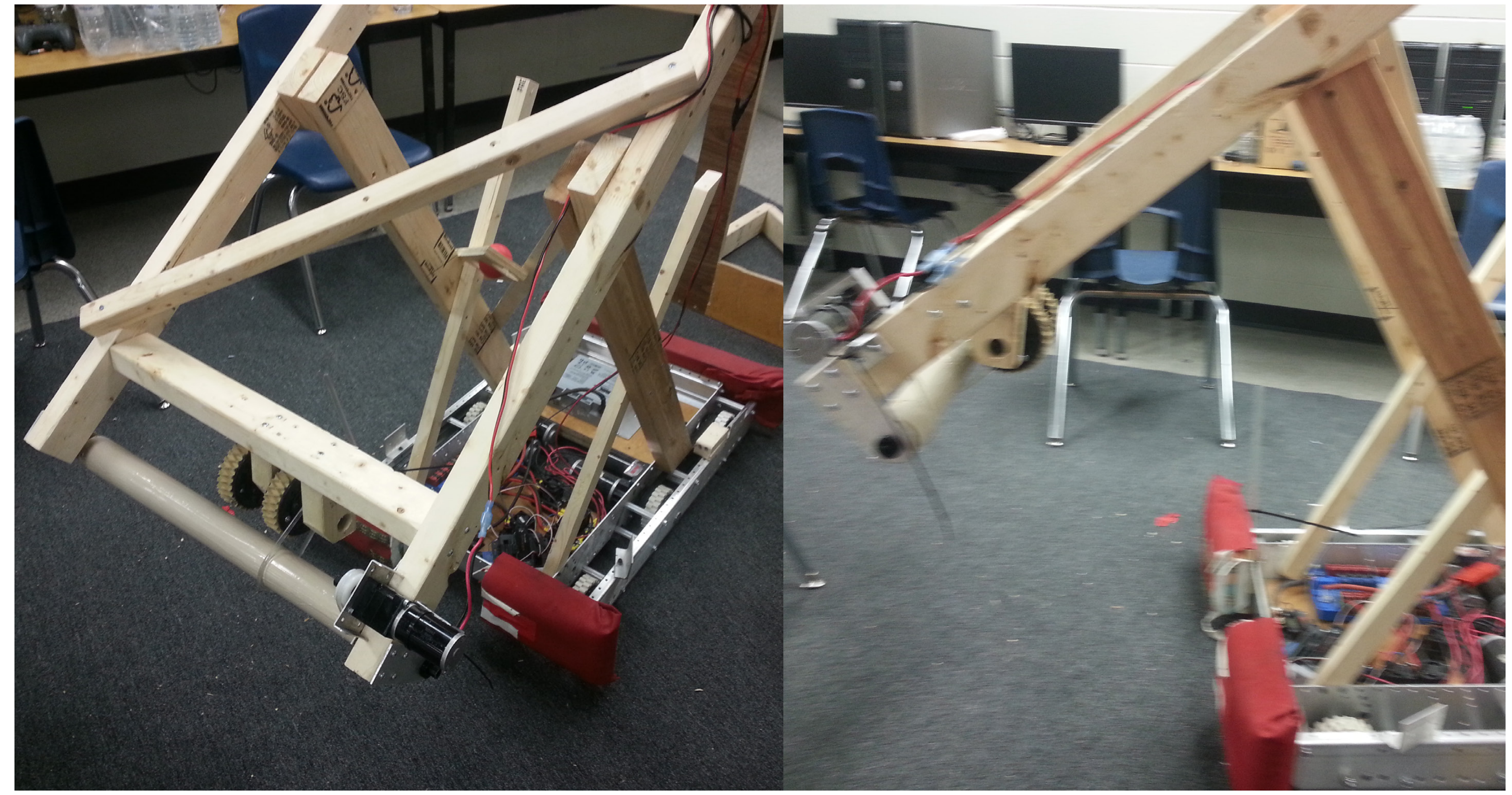
- 2" diameter PVC tube covered in paint-on urethane with wooden plugs, driven by nylon hex shaft
- Powered by shooter gearbox with a 30:18 VEXpro belt/pulley reduction
- Theoretical free speed linear velocity of 25 ft/s



Tusks

- Two sheet metal tusks are used to help center the ball, along with adhesive backed foam and teflon

INTAKE PROTOTYPES



- We tested different intake roller material including brush-on urethane and hockey tape
- Tested how effective rollers were at intaking the ball over bumpers

GOALIE STICK

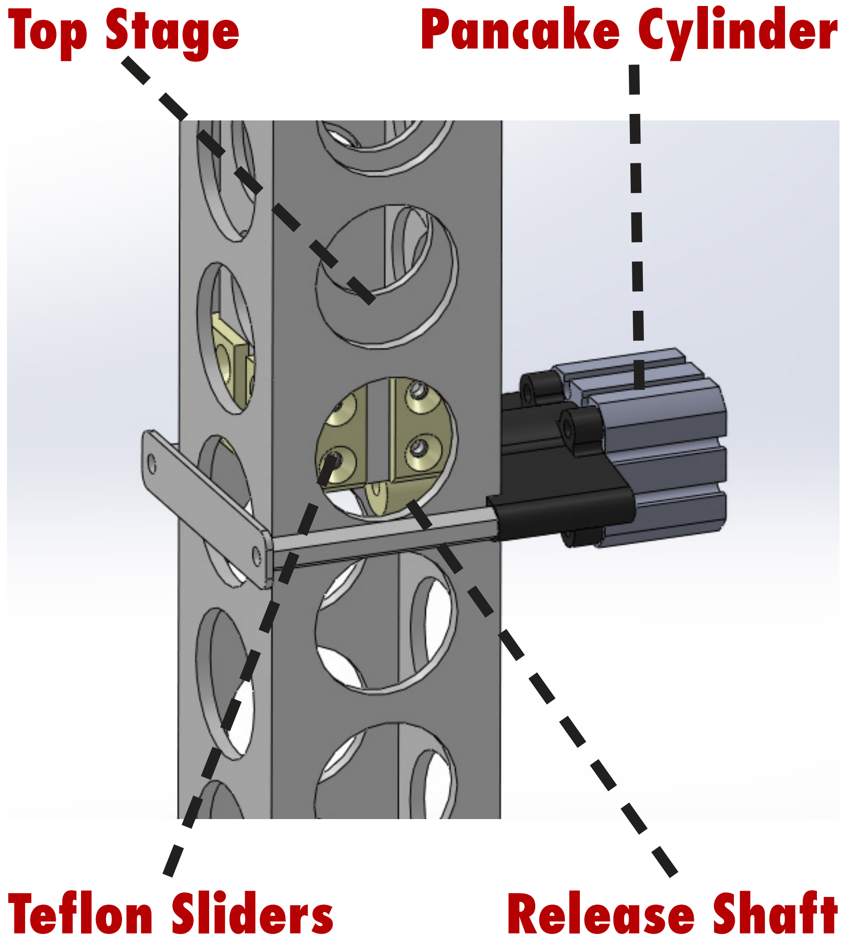
Subsystem Includes:

- Information
- Design Process

GOALIE STICK *INFORMATION*

Info

- Single stage goalie stick constructed from 2″ x 2″, 1/8″ thick aluminum box tube base and a 1.5″ x 1.5″, 0.095″ thick aluminum boxtube top stage
- The top stage rests on a retractable shaft at the start of the match
- Before the robot leaves the goalie zone, a pancake cylinder retracts the release shaft, allowing the top stage to fall into the bottom box tube with gravity so that the robot is within the 60″ height limitation
- The top stage slides on 1/8″ teflon spacers which reduce friction when the top stage drops



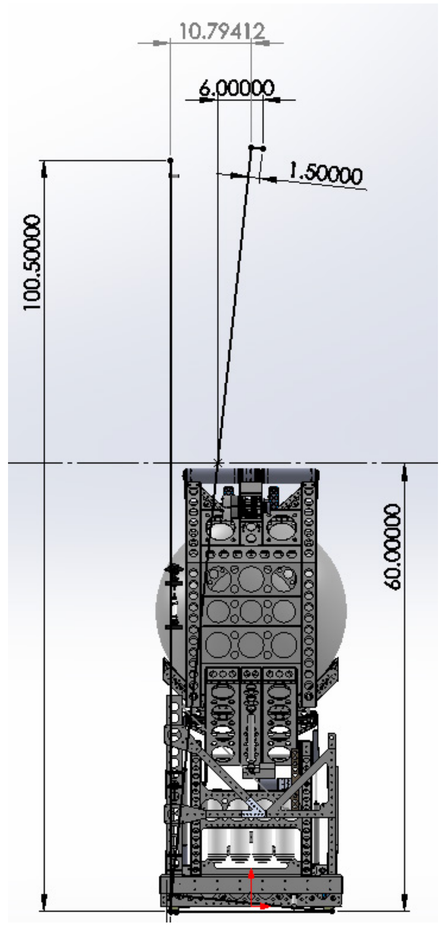
GOALIE STICK *DESIGN PROCESS*

Deflection Testing

- The original material that we intended to use for the goalie stick was 2" vacuum tube
- We set up a deflection test where the vacuum tube is place vertically and is supported 4' from the top. A ball is thrown directly at the tube and the we check if it is within the 6" cylinder

Vacuum Tube Deflection Test

- After we realized that vacuum tube wouldn't work our second material of choice was aluminum
- We determined the strength to weight ratio of round tube vs square tube, and found that square tube was lighter than round tube
- We set up Solid Works strength simulations to determine how light we could make the goalie stick with lightening holes



- To solve for the load to be applied, the sketch above was used to see how far the robot could tip before going outside the 6" space we are allowed to occupy above 60" which was 10.8". Also the max shot speed used in the calculation was 40 ft/s and the weight of the ball was 2.5 lbs
- We determined that the force of the ball would be 69lbs
- To setup the simulation, we assumed the worst case scenario where the ball traveling at 40 ft/s hit the goalie stick at the top 6"
- We determined that lightening hole failures were on the front and back faces of the stick
- The final goalie stick design has lightening holes only on the sides of the top stage

Calculation for Force

$V_f^2 = V_i^2 + 2ad$, $V_f = 0$

$a = (V_i^2)/(2d)$

$a = (12.2^2)/(2*0.274) = 271\ m/s^2$

$F = ma = 1.14*271 = 308\ N = 31.4\ kg = 69\ lbs$

CONTROL

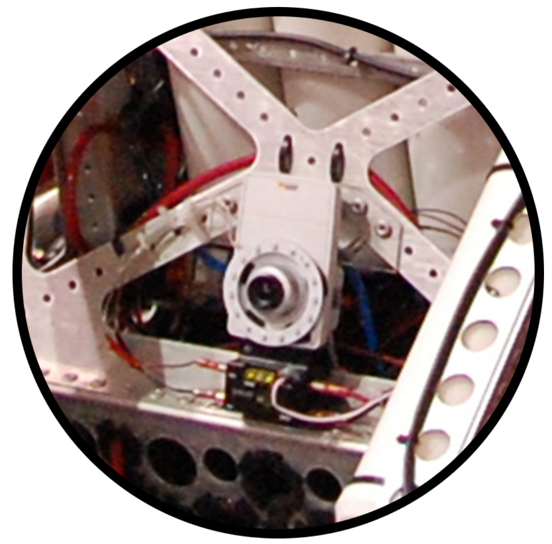
Subsystem Includes:

- Autonomous
- Kinect
- Auto Prototypes
- Teleop

CONTROL AUTONOMOUS

Hot Goal Detection

Method 1: Camera - AXIS M1013



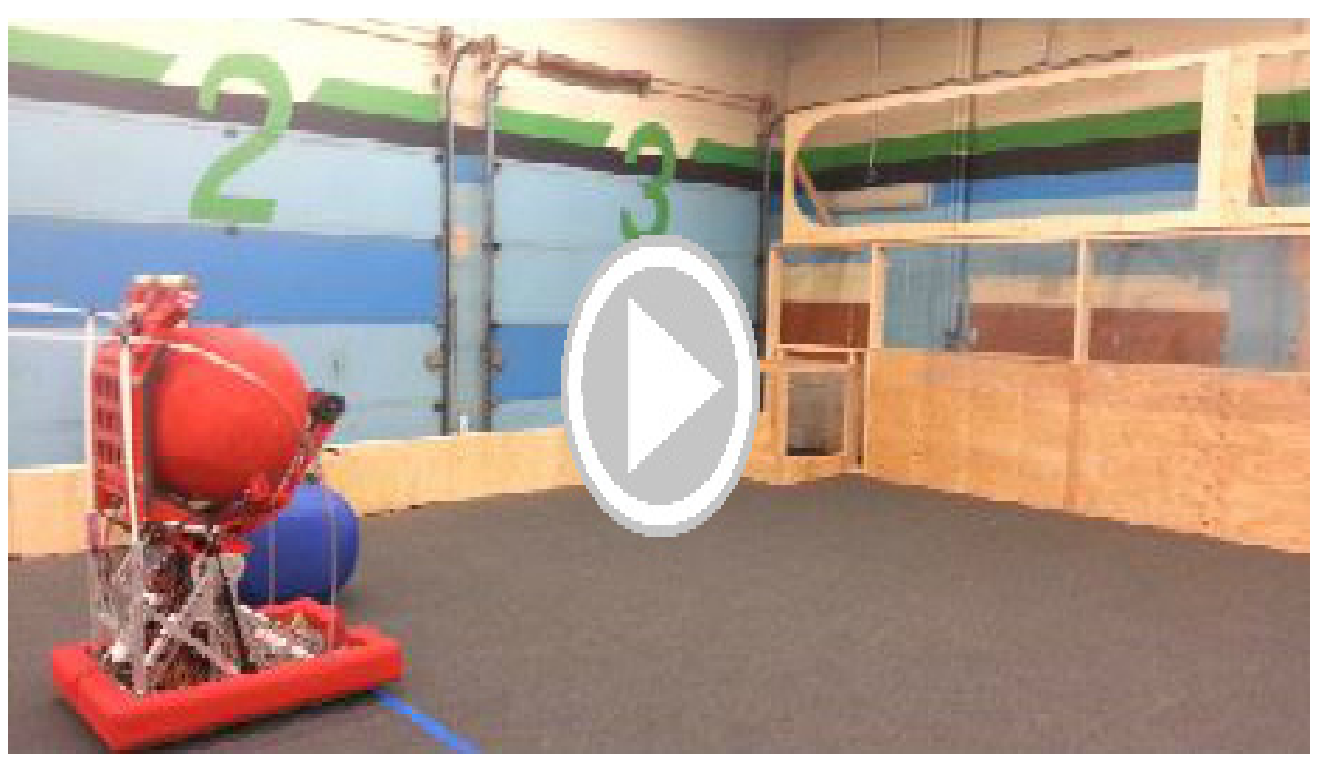
- Brightness and exposure are minimized to avoid unexpected particles from being detected
- Captures an image at the beginning of autonomous, converts it into a binary image to perform particle analysis
- Each particle of the image is calculated and assigned a score by using a scoring method comparing height, width, size and aspect ratio specifically tuned for each venue

Method 2: Kinect

- Uses arm height to determine hot goal

Autonomous Control

- Pre-match controlled autonomous selection to allow last minute change
- Variety of auto modes ranging from Two Ball Hot to Goalie Mode
- Angle correction using gyro to maintain a conastant orientation
- PID control for accurate driving, turning and claw movement
- Bang-bang control to maintain accurate shooter speeds
- Baselock capbility to hold position when firing shots



CONTROL KINECT

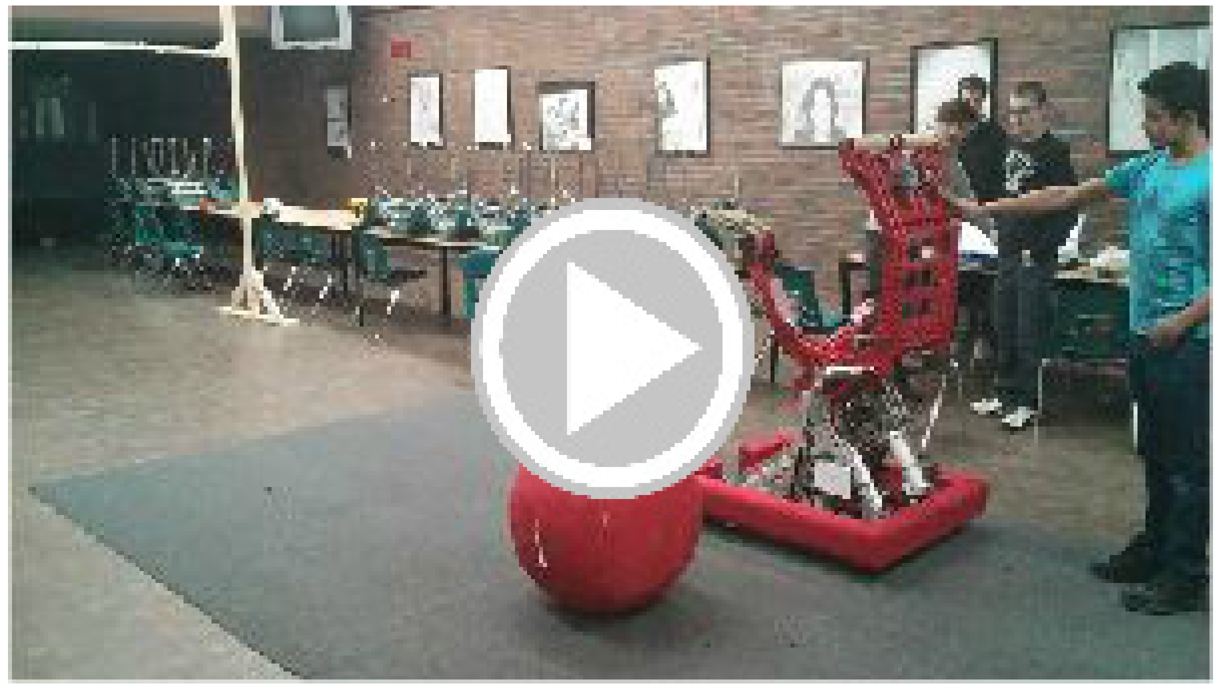
Kinect Control - Goalie Auto

- The detected arm position is mapped to a specific location in the goalie zone
- Range of the arm height is modified from between -1 and 1 to between 0 and 100 for more accurate control on drive movement, which is corrected using gyroPID and encoderPID
- Balance control using gyro and voltage to avoid unintended turning or tipping and to stay within the 6" cylinder
- Returns to original position if no arms are detected

CONTROL PROTOTYPES

One Ball Auto

Two Ball Auto



CONTROL TELEOP

Info

- Arcade game pad control
- Operator controls the claw movement and the shooter by using different presets
- Potentiometer is used to control different presets
- Different presets have different shooter speeds controlled by Bang-bang, which maintains accurate shooter speeds by controlling maximum and miminum voltage on the shooter wheels
- Drive movement, intake and firing is controlled by the driver
- EncoderPID and gyroPID controlled baselock to hold position

SIMBOTICS