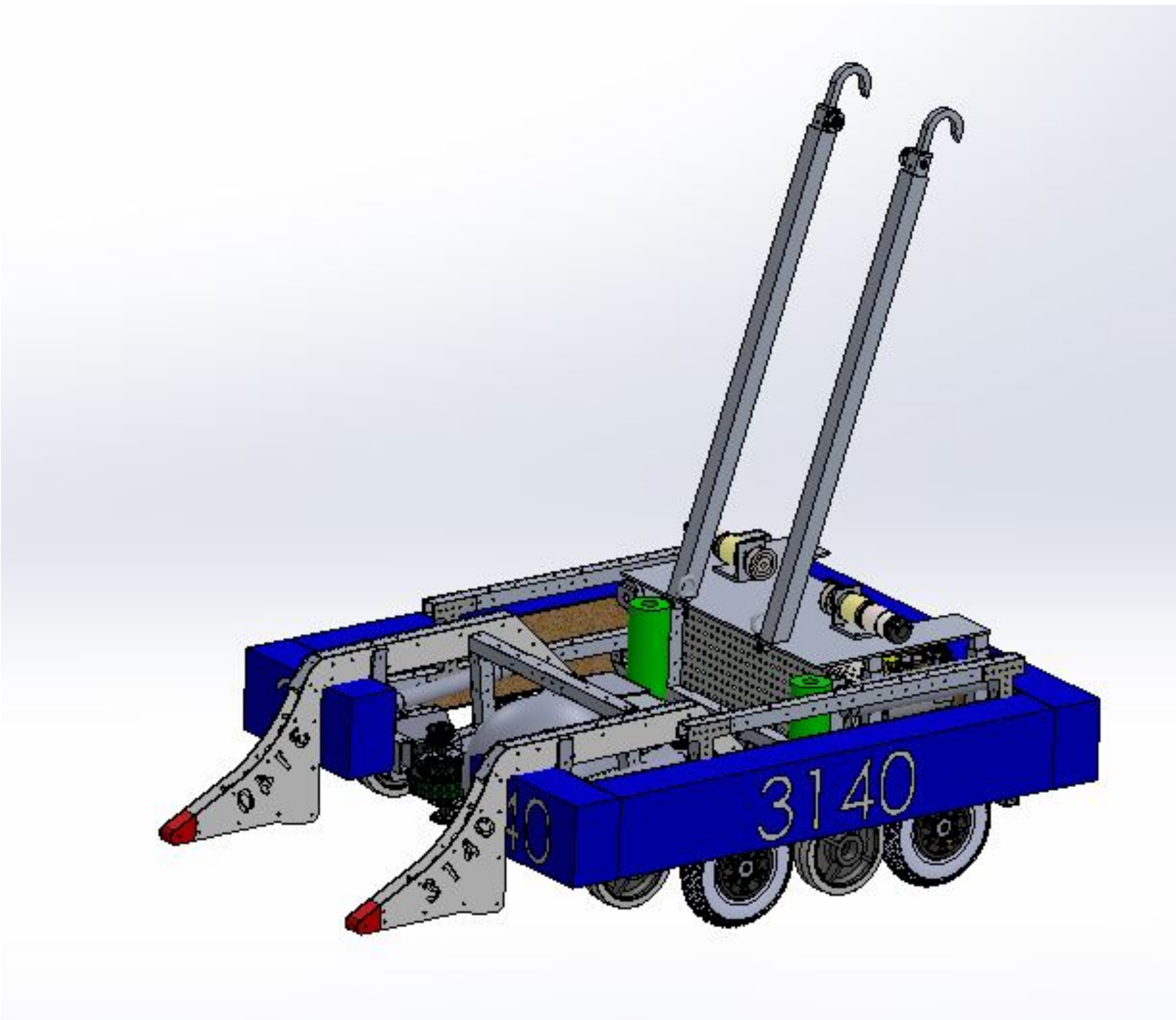
FIRST STRONGHOLD

FLAGSHIP 3140 FIRST ROBOTICS TEAM



2016 Technical Binder

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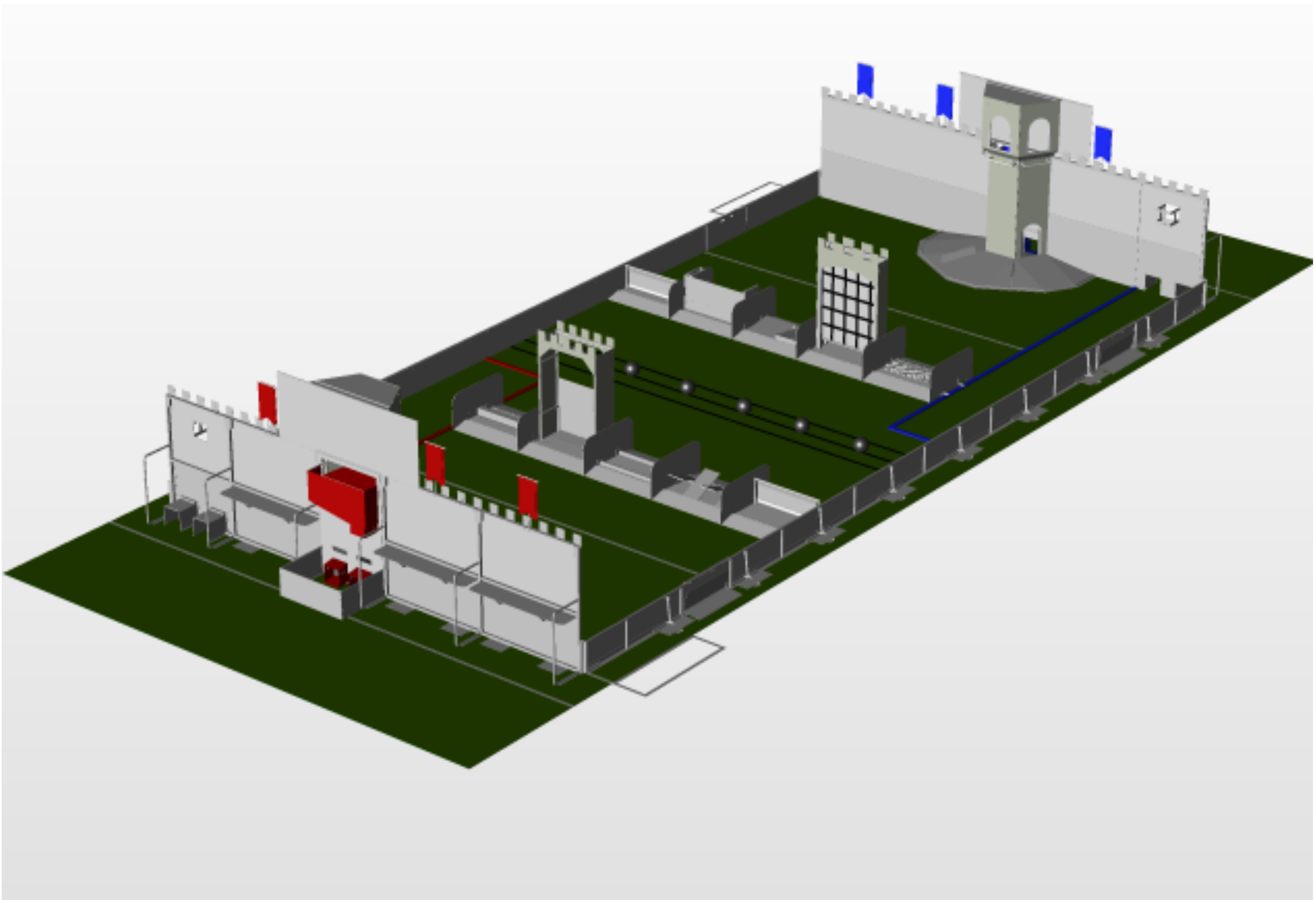
FRC TEAM 3140



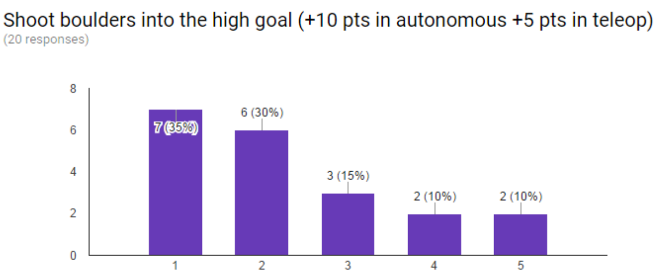
GAME ANALYSIS

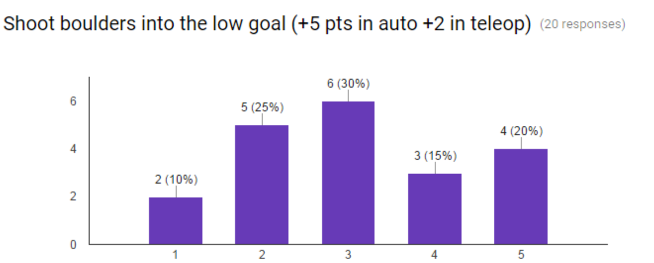
STRATEGIES

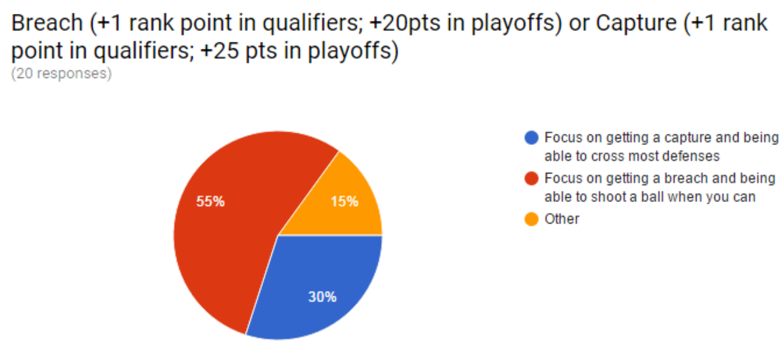
- **Robot "Types" –** Through extensive research, we determined four distinct types of robots in this year's game.

  -Shooter: Focuses on shooting boulders into the High Goal
  -Ferry: Focuses on pushing boulders into the Low Goal
  -Breacher: Focuses on breach points (Crossing 4 to 5 opposing defenses twice each)
  -Defender: Focuses on preventing opposing alliance from scoring

  After much debate and a team vote, using Google Forms (*see below*), we determined that our primary focus would be breaching defenses, but that we would also have the capability to shoot.







- **High vs. Low –** One of the largest debates was about the height of the robot; should the robot be a Low Bot or High Bot. The Low Bot could traverse through defenses more easily, but would be hard to construct, due to space constraints. The High Bot would be easier to build, but was limited as to the defenses it could cross. We finally decided to build a Low-Profile robot in order to maximize our ability to breach, in accordance with our strategy.

- **Wheels –** Since we would be crossing all defenses at some point in the match, ability to get over defenses became the main design parameter for the robot. We realized that traction wheels would not be able to go over some of the obstacles well or at all, so we instead decided on pneumatic wheels.

PLANS FOR SCORING

- **Autonomous –** The Autonomous period is the first 15 seconds of the match, during which robots operate using pre-programmed instructions and without driver control. During Autonomous period, we planned to cross at least one defense and shoot a ball (into the low or high goal)

- **Teleop -** The Teleop Phase is the remaining 2 minutes and 15 seconds of a match, in which drivers directly control their robots. During Teleop, we planned to damage a minimum of four defenses (ideally five), and to shoot boulders in the High-Goals.

- **Final 20 Seconds –** In the final 20 seconds of a match, teams are allowed to either “challenge” the tower by parking on the Batter (ramp), or to “scale” it by lifting the bumpers above the low goal. We determined the we would at least challenge the tower, but ideally scale it.

DESIGN PARAMETERS

- **Drivetrain Size**

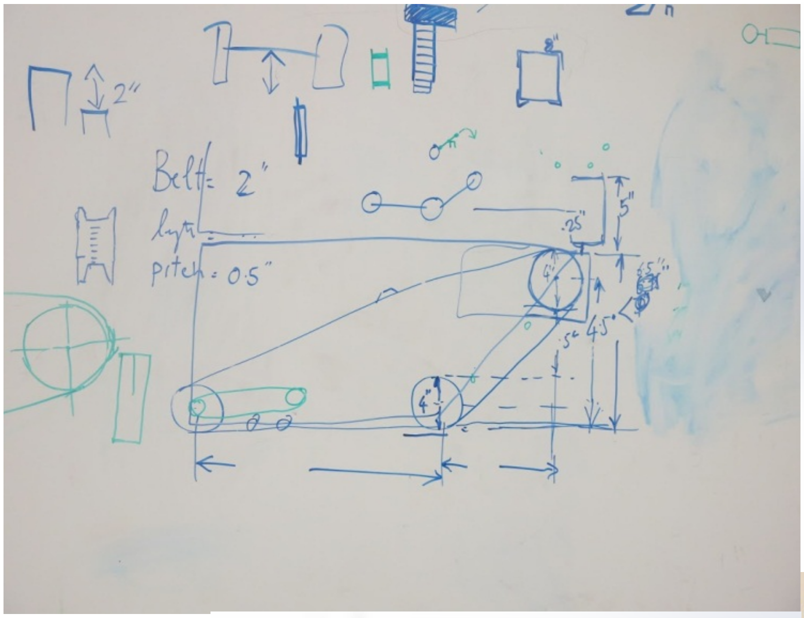
  -Frame Perimeter: no more than 120”
  -Extensions Beyond Perimeter: no more than 15” on any side
  -Height: no more than 54”
  -Weight: no more than 120 lbs.

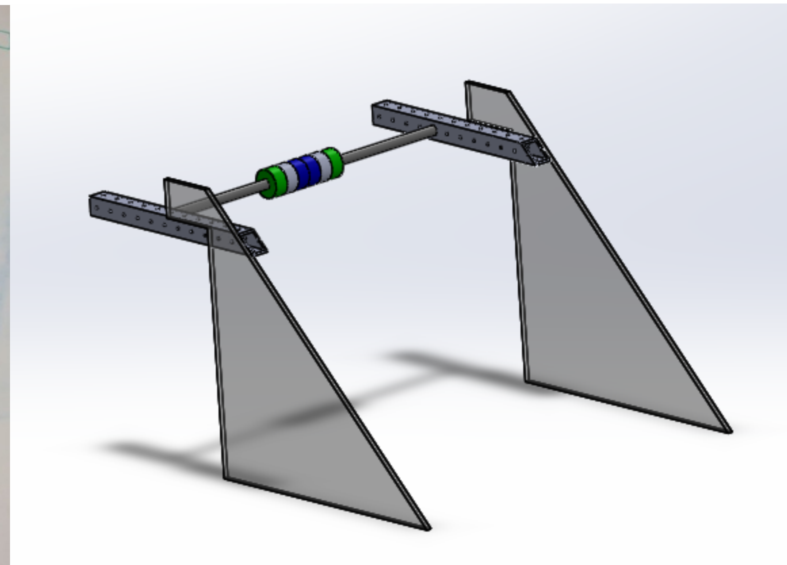
- **Shooting & Intake**

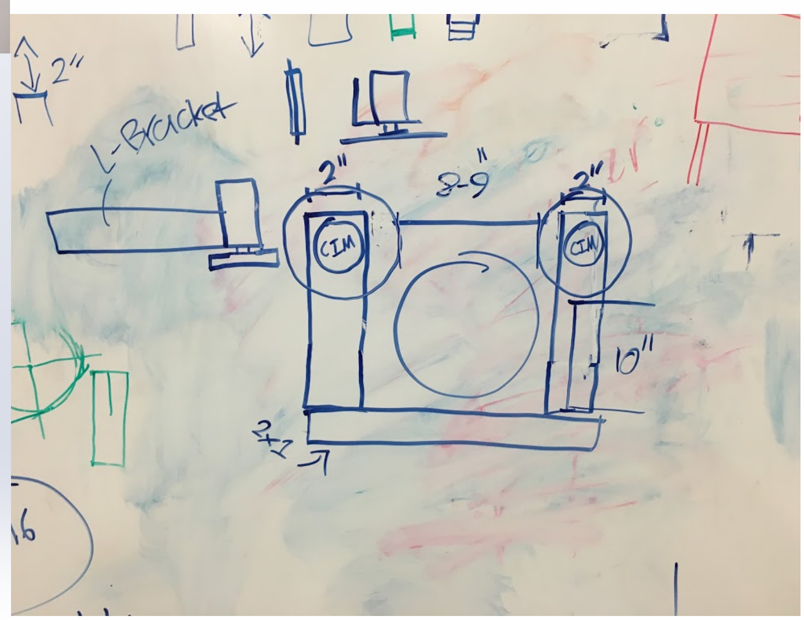
  -Size: Wide enough to take in a boulder that is 10” in diameter. Small enough to fit under the Low Bar. Narrow enough to fit inside the drivetrain.
  -Weight: Not too heavy to lift.
  -Pneumatics: Must be powerful enough to launch the boulder

- **Scaling System**

  -Size: Does not extend more than 15” beyond the frame perimeter. Less than 54” when in down position.
  -Length: Long enough to reach the 6’ 4” rung from the ground



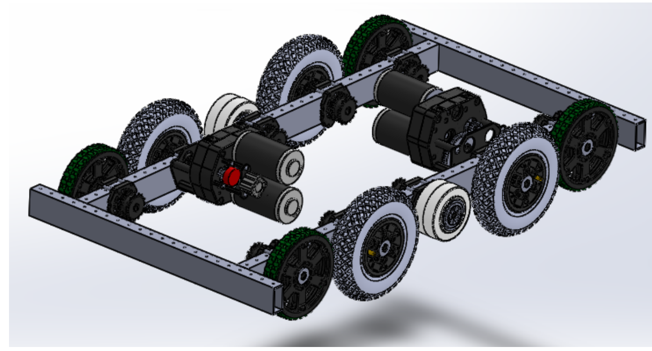




BRAINSTORMING & PROTOTYPING

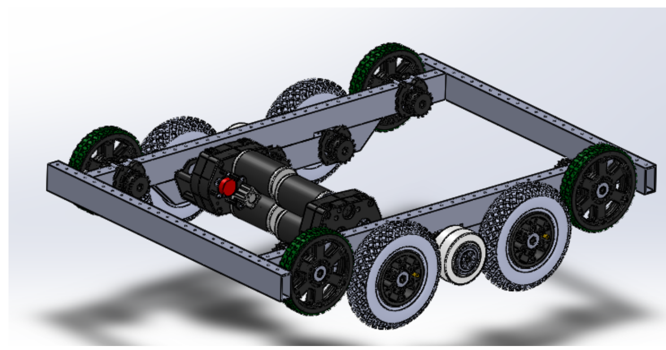
DRIVETRAIN PROPOSALS

- **INLINE**



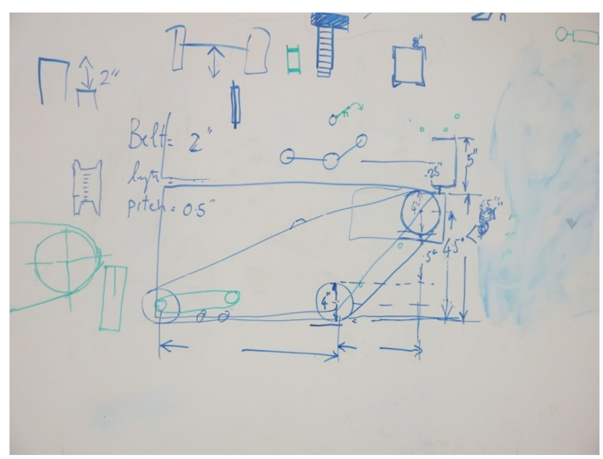
The first proposal for a drivetrain was a 10-wheel Inline design. It would have been 38” long by 22” wide. It would have been built out of 2” x 1” VersaFrame; using four 6” Traction Wheels, four 8” Pneumatic Wheels, and two 4” x 2” Colson Wheels; and powered with two 3-CIM Ball Shifters. This design was eliminated, due to its over-complexity and inability to climb over numerous obstacles.

- **RAISED**



After the Inline Drive, we had created a similar design, but instead raising the Traction Wheels on either side. Dimensions came out to be 34.5” long and 25” wide. It would have also been built of 2” x 1” VersaFrame and powered by two 3-CIM Ball Shifters. This design was improved to become our final robot.

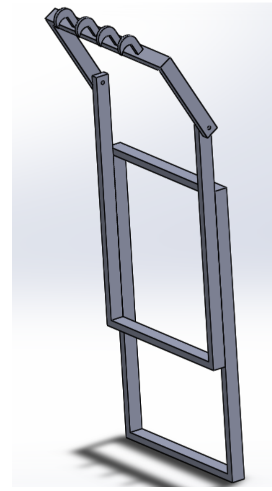
- **TREADS**



The last proposal was to build a frame similar to the raised design, but to use treads. The treads were timing belts ordered from McMaster-Carr and measured 1.875” wide and 78” in length. The design was eliminated due to the difficulty of constructing a frame that would work with the design.

ELEVATOR SYSTEM PROPOSALS

- **PROTOTYPE ELEVATOR**



The first proposal for a scaling system had no official name, but can be understood fairly easily. It was only a rough design, so it was not designed with a way to mount to the frame. The idea was to extend upward using a U-shape structure—constructed from VEX—that measured 24" across and 36" high, which was mounted to a rectangular frame of the same dimensions. The upper section of the moving frame could pivot to clamp onto the rung, with a set of four hooks on the top bar, each with a radius of 1.25". This prototype was replaced by other designs.

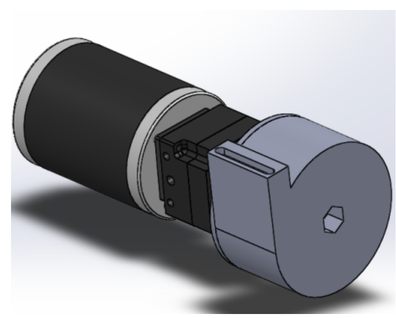
- **FRAME TELESCOPING**

One of our initial designs was a telescoping frame like the prototype. It mounted to the drivetrain with a shaft and pivoted around the attachment point. The pivoting was powered by a Mini-CIM motor. The lower pieces were 49" long and 15.25" apart. The Upper VEX, which would reach upwards to hook onto the rung, measured 40.5" long and 11.793" apart from one another. Like the first design, this too was supplanted by others.

- **PNEUMATICS**

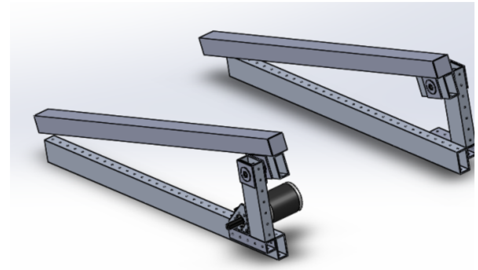
Another design for the Elevator System used pneumatic cylinders. The base of this elevator was made of 1" x 1" VersaFrame, stretching 18.5" wide and 30" long. Two Double Acting Round Body Air Cylinders hinged onto the base from the back, able to extend from 32.62" to 60.62" and onto a 90° angle. A single 1" x 1" VersaFrame bar was attached to the base by a hinge and to the Drivetrain frame.

- **TAPE MEASURE**



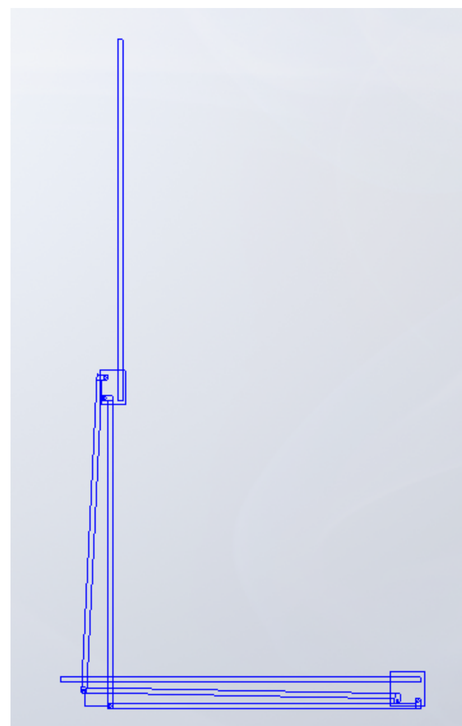
The simplest design for a scaling system was the using of powered measuring tape. According to research, a tape measure is strong enough tolift a whole robot. The roll's housing was 3-D Printed with its face having an area of 7.55 in.^{2}, and mounted onto a CIMple Gearbox. Problems that arose with this design were the constant need to reprint new housings due to damage caused by the tape scraping the housing, as well as the difficulty of fitting the tape measure properly into the housing without damaging either of the pieces. The design finally proved inadequate and was discarded.

- **TUBE TELESCOPING**



The final design used telescoping tubes again, but had the mounted in a different manner. Two pieces of 2” x 1” VersaFrame, both at 31” Long and 18” apart, were mounted to the frame of the drivetrain. The outer casing was 1.25” x 1.25” aluminum, lined with 1” x 1” polycarbonate tubing. The inner section was 0.75” x 0.75” aluminum tubing. The tubes were raised upwards with a single CIM motor.

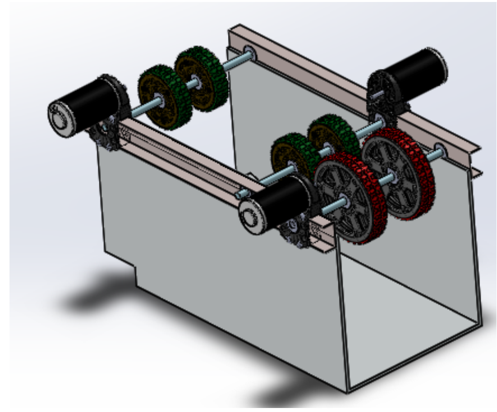
- **HOOK LADDER**



The premise of the “hook ladder” was the idea of pivoting. Two fixed poles --their lengths 30.33” and 29.83”—would pivot upwards to a 90°. In doing this, the attached plate would rotate another 35” long pole upwards, to reach over 5 ft. in the air. The main complication that arose was the difficulty in understanding and constructing this scaling system.

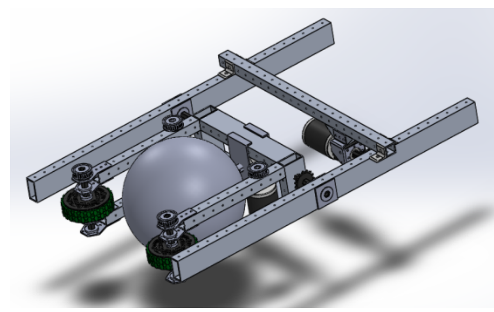
INTAKE & SHOOTING MECHANISM PROPOSALS

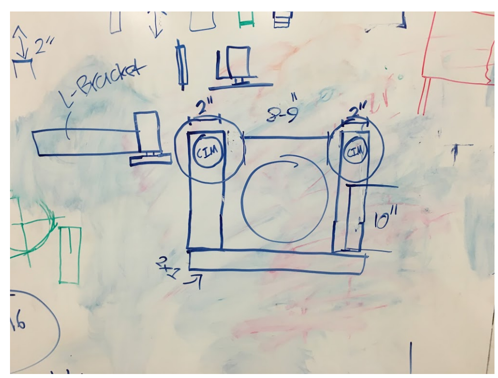
- **ELBOW DESIGN**



The first design for intake & shooting we had was called the "Elbow" shooter. To operate, a boulder (10" in diameter), would be collected by two 6" Traction wheels, and shot by another set of two 6" wheels and two 4" wheels. The wheels were mounted onto a 12" wheel axle, with a CIM motor on either end. The Intake C-Channel was 12" wide, 24" long, and 0.25" thick. The inner ramp was angled at a 160° angle and measured 22.665" from its edge to the edge of the Channel's base.

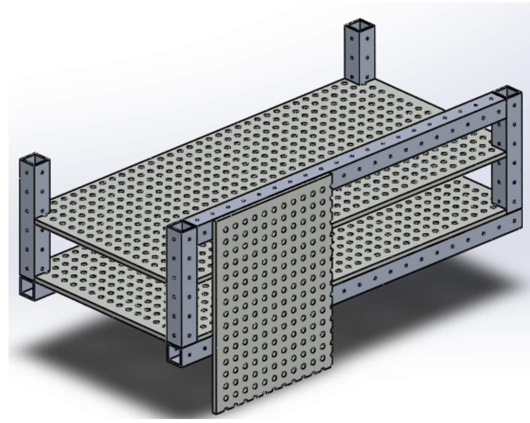
- **RIVVET DESIGN**





The second design to intake & shoot was dubbed the "Rivvet" design (after Robot in 3 Days team, The Greenhorn's 2016 robot).It mounted upper drivetrain frame rails. A single 22" long VEX piece prevents the mechanism from pivoting too far. To intake, two 4" Traction Wheels rotate in opposite directions, pulling the boulder inward and holding it in the pivoting assembly. From there, a 1.0625" x 1" pneumatic cylinder attached to a 3-D printed pusher plate would push the ball out, sending it flying. The primary problem of its design was that its center of mass was too far from the pivot. It was refined into the final design.

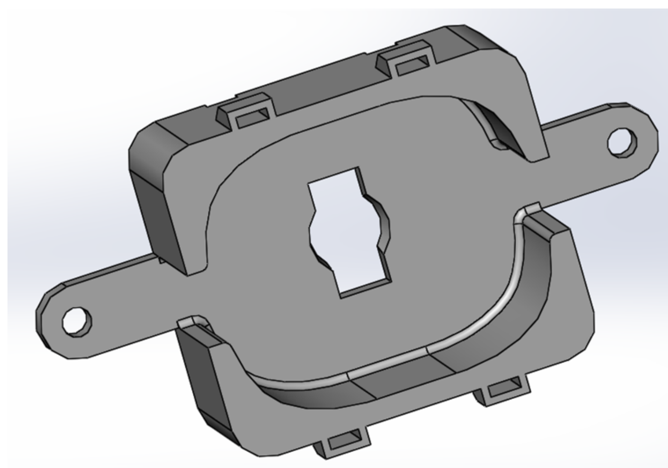
ELECTRONICS BOARD PROPOSALS



- **ELECTRONIC BOARD DESIGN**

One of our numerous models for the electronics board had two horizontal boards (22” x 11”) and one vertical board (5” x 7”). The board mounted to the rest of the frame using 1” x 1” VersaFrame. In the final design, the vertical board was flipped around and moved forwards 2”.

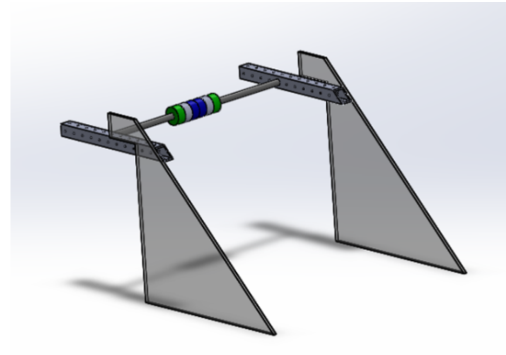
CAMERA MOUNT PROPOSALS



- **HD CAMERA MOUNT DESIGN**

A late entry into our build season designs was the mounting for one of two cameras. The extrusion through the center of the mount measures about 2” across, with plenty of room to encase the Microsoft LifeCam HD camera. The holes on either side were to be riveted onto VersaFrame, measuring 0.16” in diameter each. From the centers of the holes, the mount was 3” long. Rectangular extrusions on the top and bottom of the mount were placed for zip-tie management. This design was eliminated in favor of placing the camera directly inside the VersaFrame.

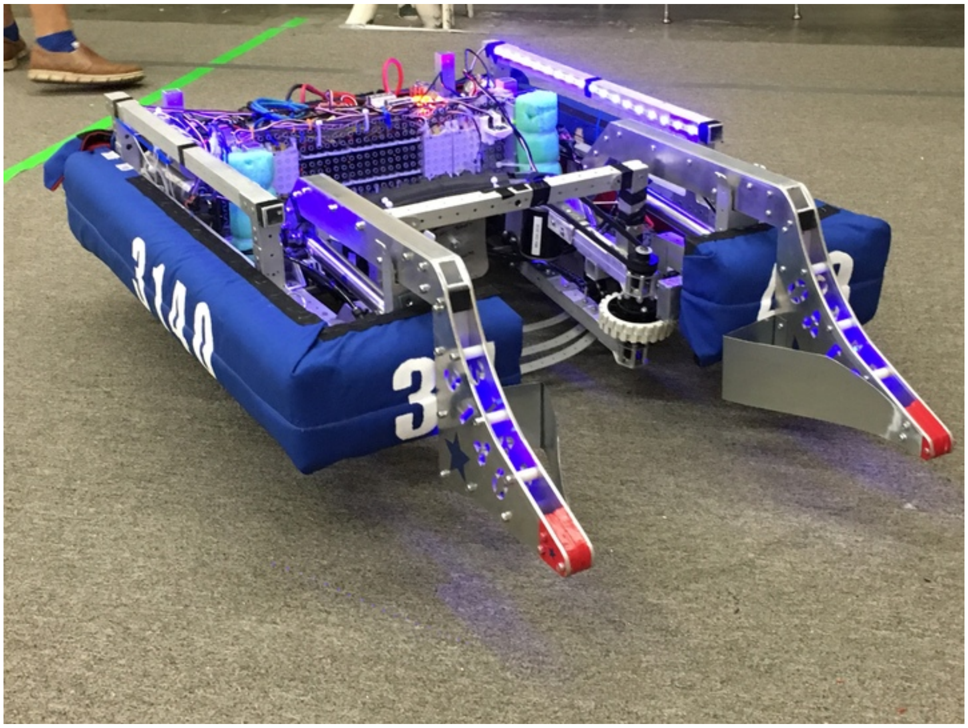
BATTLE AXE SYSTEM PROPOSALS



- **PLEXIGLAS BATTLE AXES**

Another Robot in 3 Days-derived idea the Tomahawks/Battle Axes Were plexiglas triangles (*see picture),* 0.25" thick and with a perimeter of 57.213". They were mounted to the frame with two 12" long pieces of 1" x 1" VersaFrame and pivoted using a 0.5" long rotational actuator. They were used to open the Portcullis and Sally Port. The final Battle Axes were to be waterjetted out of plexiglas or metal to display our team's number (3140).

FRC TEAM 3140



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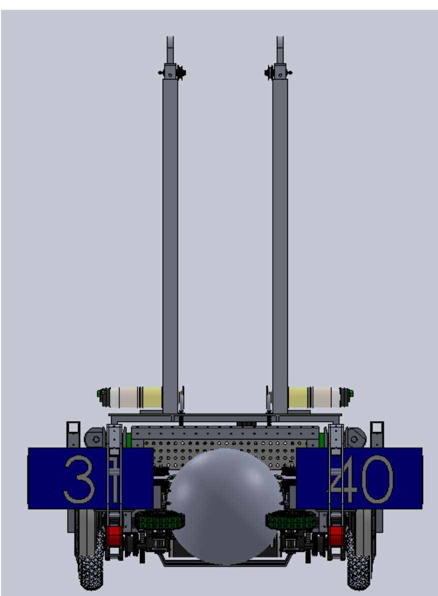
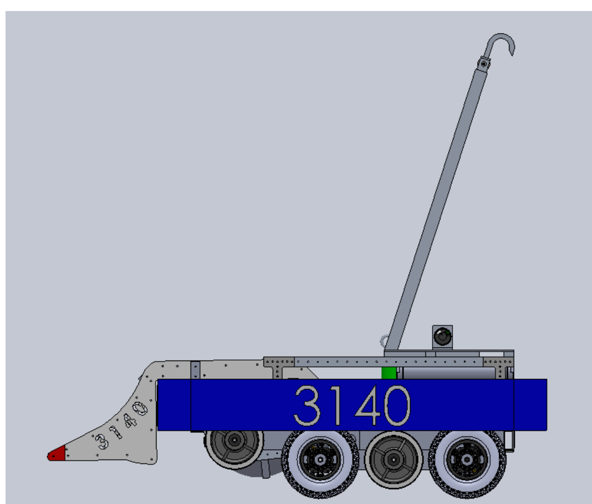
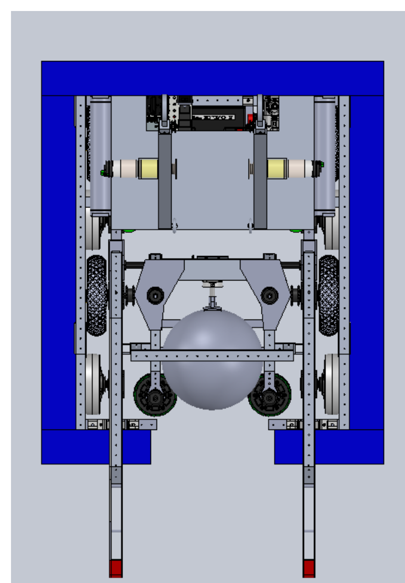
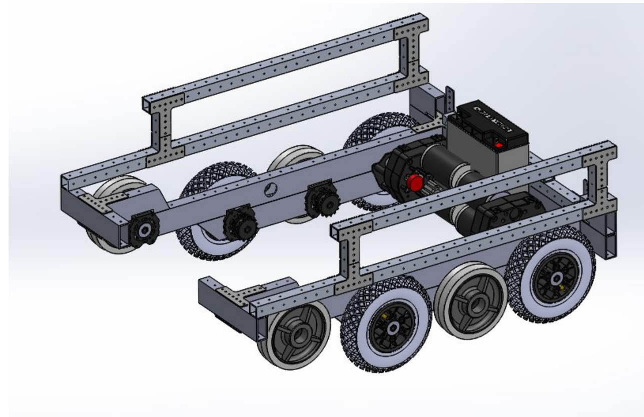






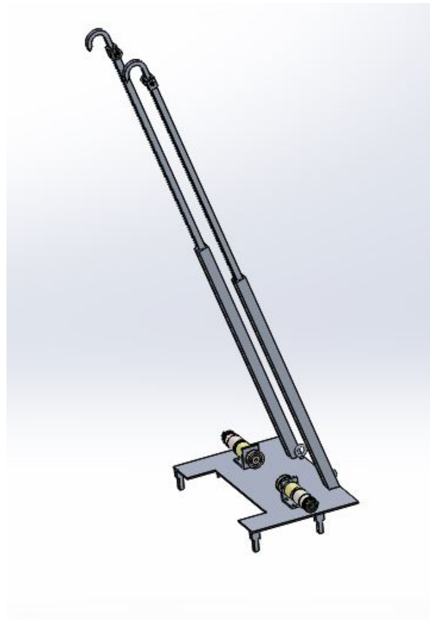
FINAL DESIGN

DRIVETRAIN



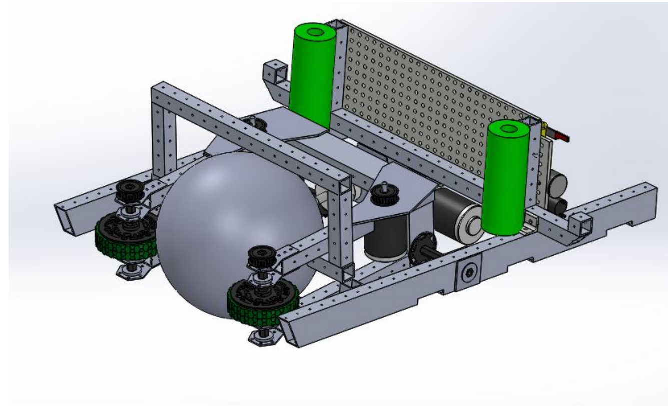
The final model of the drivetrain was a modified version of the "Raised" design. The drivetrain features a total of 8 wheels, which include 2 pairs of Pneumatic Wheels and 2 pairs of Colson Wheels (originally Traction Wheels, changed for aesthetic). Dimensions for width are 27", and 33" for length. The largest addition to this design was the inclusion of guardrails. The rails are entirely constructed from 1" x 1" VersaFrame, measuring 25.5" long, 4.5" high (from the mounting on the drivetrain), and 25" apart. Vertical pieces of 1" x 1" VersaFrame mount the rails onto the drivetrain, measuring 3.5" high, and placed 8.375" from the front, and 0.875" from the back. Two CIM Motors power the backmost Pneumatics wheels, while chains run through sprockets (front-most wheels are not operated by chains). Finally, the battery housing is placed at the drive's rear, sitting on a metal sheet 4.25" wide and 8.5" long within the cut on the Electronics Board. Bumpers are placed onto the drivetrain directly, covering 134.75" (outer) in perimeter, and 5.25" high. Blue LED lights were placed along the inner-facing side of the top rails.

ELEVATOR SYSTEM



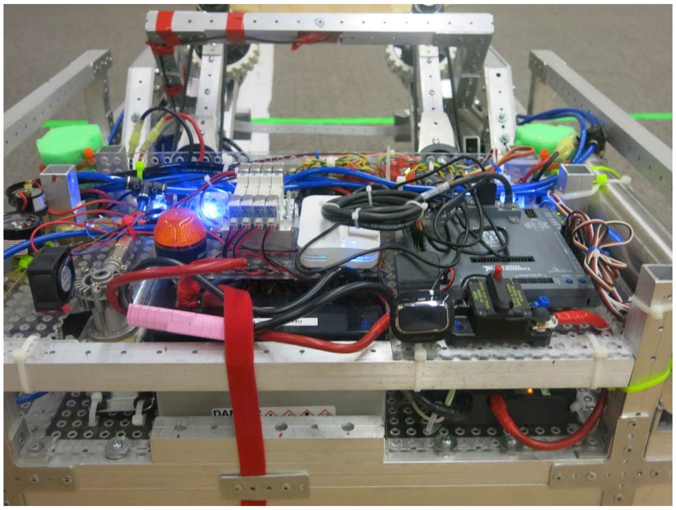
This final model of our scaling system is a complete version of the Tube Telescoping (*SEE ABOVE*). Dual winches rotate the rectangular tubing upwards, as well as extending inner tubing with attached hooks from 30.156" up to 57.656" in order to reach the rung. A cut metal plate, covering 73.5" in perimeter, mounts tubing. A 0.75" x 0.75" piece of extending Aluminum rectangular tubing is placed within a 1" x 1" PVC Rigid insert, then to the outer 1.25" x 1.25" Aluminum tubing. 4 individual base mounts slide into the vertical VersaFrame pieces mounting the Electronics Board. The top hooks have an inner radius of 0.875" and an outer radius of 1.375".

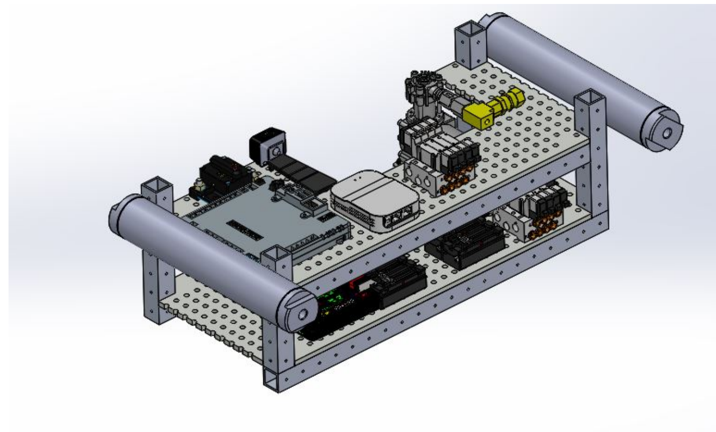
INTAKE & SHOOTING MECHANISM



Our method to intake a boulder & shoot into a high goal came down as the “Rivvet” design (*SEE PAGE 11*). The shooter is mounted onto the drivetrain using two horizontal pieces of 2” x 1” VersaFrame, with the front cut at a 63.43° measuring 39.75” on the top. Two rectangular cuts are made in the bottom of the mounts, 4.5” long and 0.38” high. A single 0.5” Hex Shaft axle pivots the shooter, with a length of 20.38”. As for the wheel assembly, dimensions are 12.25” wide, and 12.5” long. Two Mini-CIM motors rotate the 4” Tractions Wheels in opposite directions to feed the ball inwards and shoot outwards, with the aid of plastic chains. The shooter’s arms are 10.25” apart, long enough to hold a boulder 10” in diameter. To prevent the boulder from off the ground, two additional housing were added: an upper ball retention assembly, constructed out of 1” x 1” VersaFrame at 6” high and 16” high; the other being 2 holder straps, each 10.41” long, angling up 116.19° and mounted to the arms. Two pool-noodles 6.5” high were added to prevent the shooter from hitting the vertical Electronics Board (Limit Switches were later inserted to set maximum & minimum pivot points). Finally, a camera placed within the center of the retention assembly’s top bar, to allow frontal vision for our drivers.

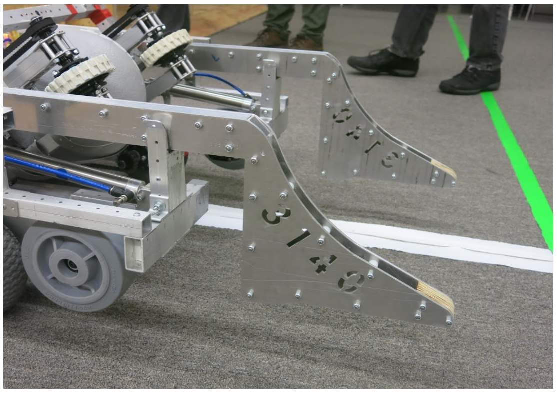
ELECTRONICS BOARD

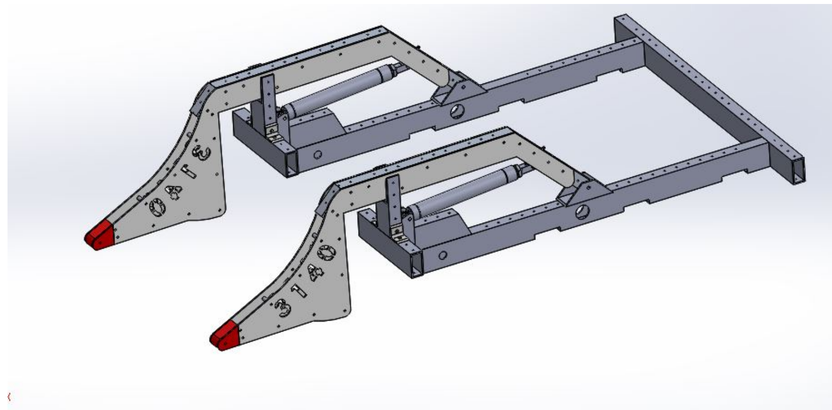




The electronics board, as opposed to our previous robot, was sectioned off to the back of the robot. It is in a double-decked fashion, holding two 18” x 7” boards, each with a 7” x 4.75” cut to encase the battery (top board’s cut is larger, but the compressor takes up space within it). Mounted with 1” VersaFrame, mounting is 20” across and 7” high. The upper board’s components include: roboRIO, 120-Amp Circuit Breaker, Microsoft HD-5000 Camera, OpenMesh 2-way Radio, & four Double Solenoids. The lower board holds: Power Distribution Panel, five Talon SRXs, four Double Solenoids, Pneumatics Control Module, and the Voltage Regulator Module. Two Clippard AirPower Accumulators are placed on either side of the vertical VEX pieces. Finally, on the vertical board placed against the shooter (*SEE PAGE 17*), is 19” long and 6.5” in height, with a 1.05” x 1.05” square cut at each top corner. Components include: Dum Valve, four REV Robotics SPARKs, and four Talon SRXs.

BATTLE AXE SYSTEM





The last major parts of this year's robot are the Battle Axes. The Battle Axes pivot using two 1.0625" x 6" Pneumatic Cylinders. Mounting consists entirely of 2" x 1" VEX, including the raised bar of the drivetrain, two 8" pieces to hold the Battle Axe rests, and a 27" back-bar. The Battle Axes themselves are constructed from VEX and metal plating. The front-most backing angles 135° downward, flat for 14.6", then come back 135° to be placed into the mounting brackets. Each plating covers a perimeter of 77.939", and water-jetted with the team's number (**3140**) by MilleniTek. End spaces are placed at the tip between plating. Each Battle Axe assembly is 17.75" apart. Blue LED lights were placed in between the Battle Axe plates.

```java
private DrivePid(String name, double heading, double speed, double distance, double output, double tolerance)
    // TODO: tune this pid
    super(name, PID_P, PID_I, PID_D);

    requires(Robot.dt);
    this.dt = Robot.dt;
    this.heading = heading;
    this.speed = speed;
    this.distance = distance;
    this.output = output;
    this.PID_TOLERANCE = tolerance;

    // since this is a closed loop command, and may be running without operator intervention, set a timeout
    this.setTimeout(10);

    LiveWindow.addActuator("DriveSystem", "DriveHeadingPid", this.getPIDController());
}

@Override
protected void initialize() {
    hasDrivenFarEnough = false;

    if (driveCurrentHeading) {
        // use current heading
        this.setSetpoint(dt.getNormalizedAngle());
    } else {
        // use the specified heading
        this.setSetpoint(heading);
    }

    this.desiredSpeed = speed;

    this.getPIDController().setInputRange(0, 360);
```

SOFTWARE & CONTROLS

- **JAVA**

In continuation of the 2015 season, the team again chose to use Java as the primary programming language. This year, however, the team has used more advanced programming and electronics to allow for tighter control on the various functions of the robot.

In addition this year marks the first year the team is using close-looped control methods to control the robot accurately through interfacing with various sensors, allowing for precise control on robot behavior such as driving, aiming, and shooting.

Also this year, many strides were made to get vision code on an external chip-set to communicate with the RoboRIO and the end result is very encouraging, with the ability to do vision processing a real possibility.

- **LABVIEW**

As a contrast to most teams which only employ one programming language. Our team made great efforts to maintain the knowledge base of those who knew LabVIEW even after the switch to Java. This allows for rapid development of specific subsystems and enables us to use powerful debugging tools. Allowing the team to test code and the logic behind it before its final and much more powerful deploy as Java code on the competition robot. It also allows our team to help more teams in our continued efforts to maintain gracious professionalism while in the pits. Having members knowledgeable in a variety of different programming languages allows us to help more of the teams, which develop sudden and unexpected technical difficulties.

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