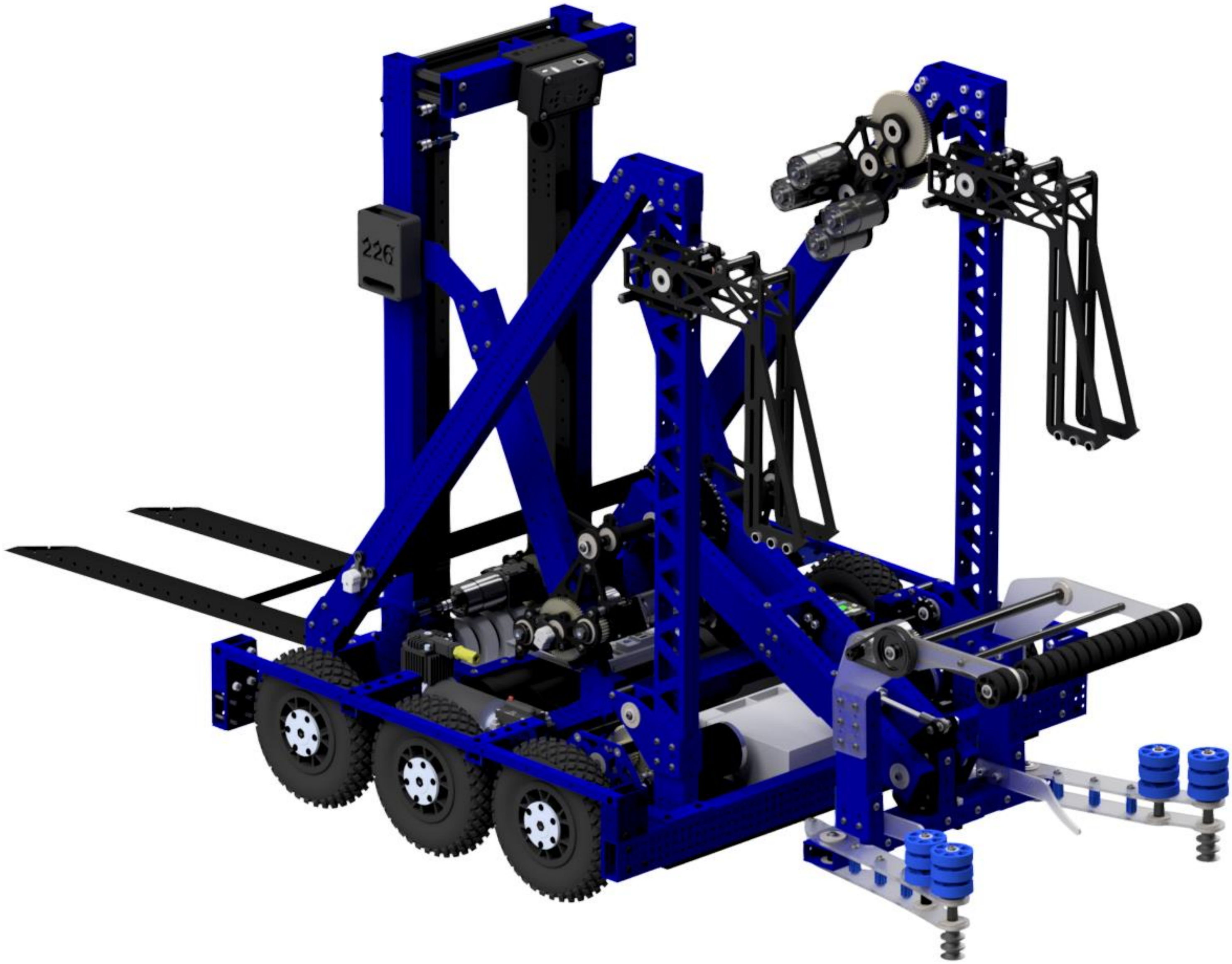

WAVERIDER

2019
Technical Binder

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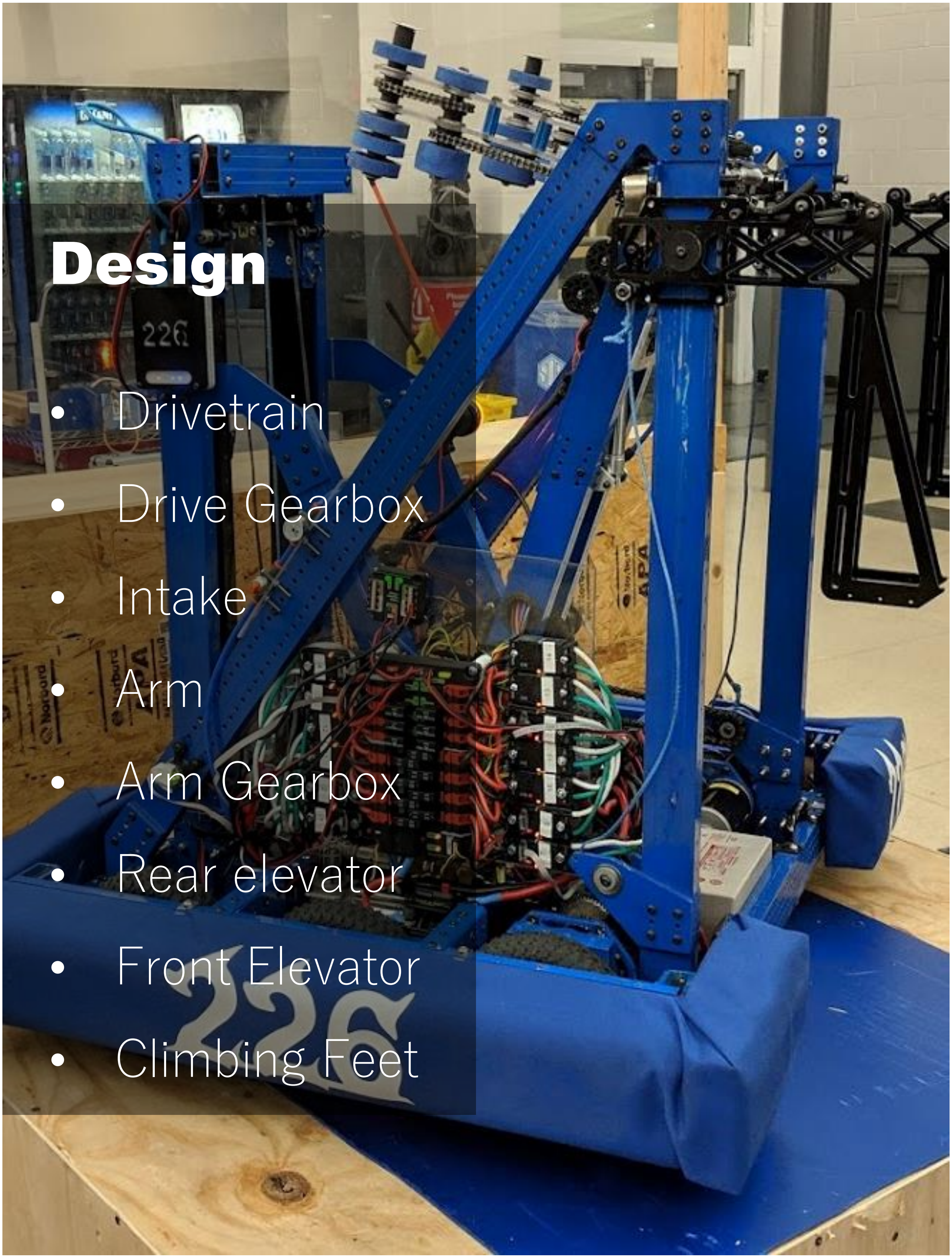
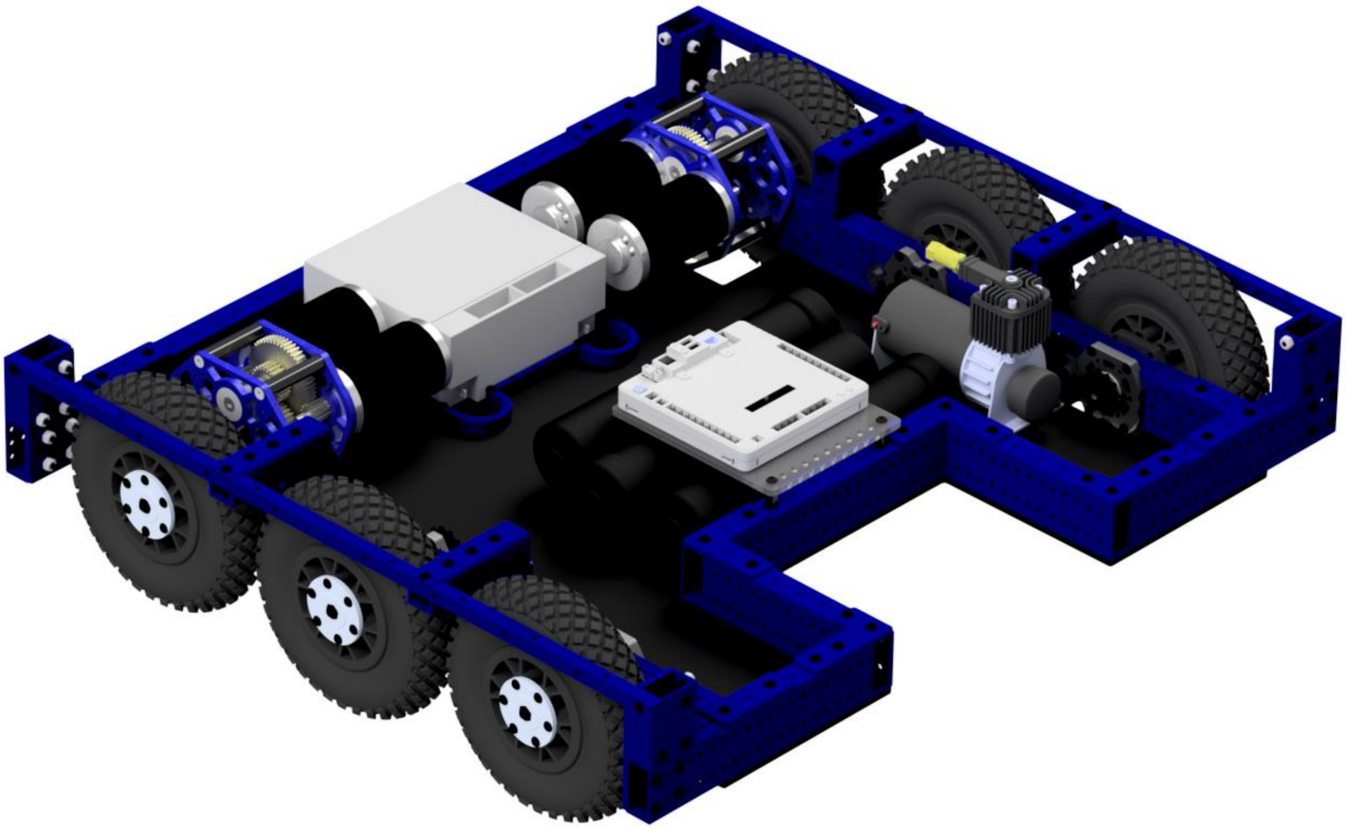


Design

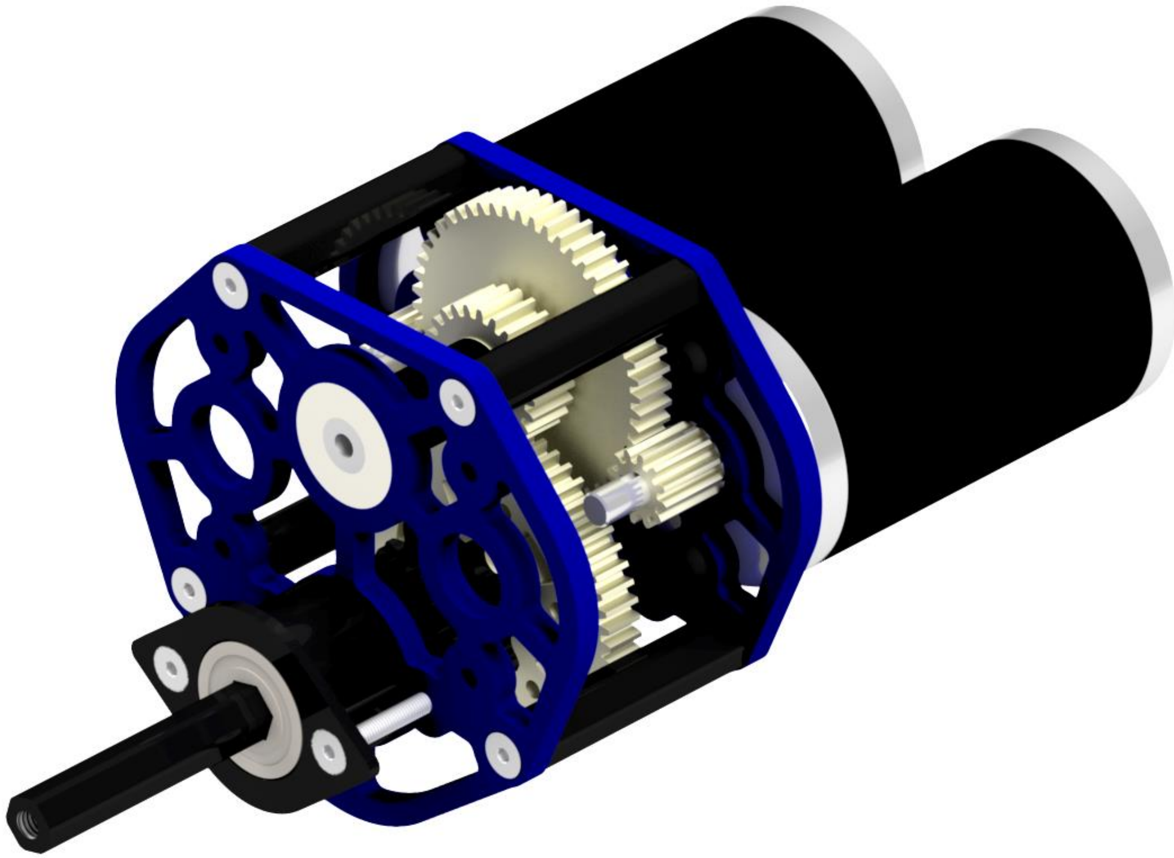
- Drivetrain
- Drive Gearbox
- Intake
- Arm
- Arm Gearbox
- Rear elevator
- Front Elevator
- Climbing Feet

Drivetrain



- Design Constraints
  - Wide wheel base to make space for climbing elevator
  - Drive off of HAB Zone 2 without damaging the robot
  - Must be fast to reduce cycle times
  - Cutout for rear climbing elevator
- Chassis
  - West coast drive with pneumatic tires
  - 8” wheels allow for “passive” HAB Zone 2 climb
  - 9.0” wheel spacing with adjustable bearing block tensioning
  - 1/8” center drop for smooth turning
  - Driven with #35 chain for robustness

Drive Gearbox

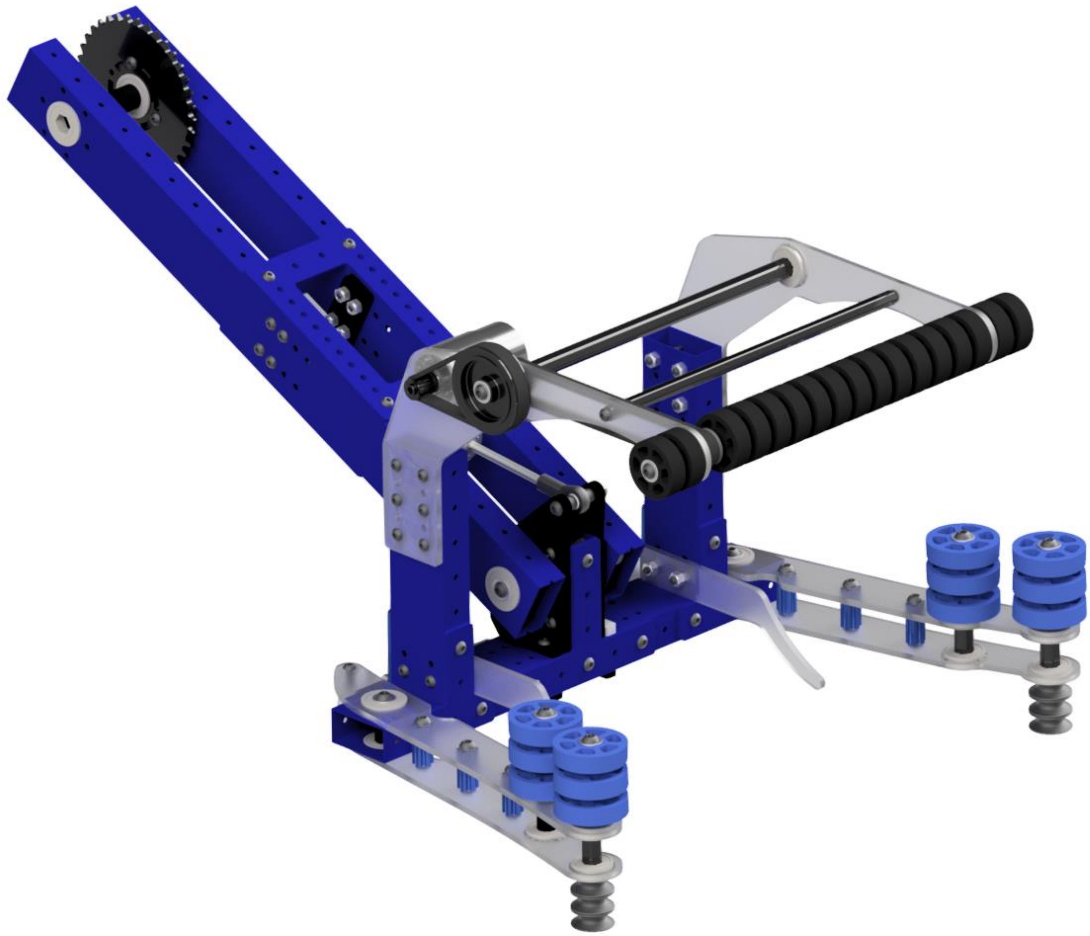


- Design Constraints
    - Low profile to allow arm to come down as far as possible
    - High speed for low cycle times
    - Enough torque to still be viable for defense
- Gearbox
    - Single speed dual motor gearbox
    - Overall 10.83:1 gear ratio
    - 17.17 ft/second free speed
    - First time making a custom drive gearbox

Intake

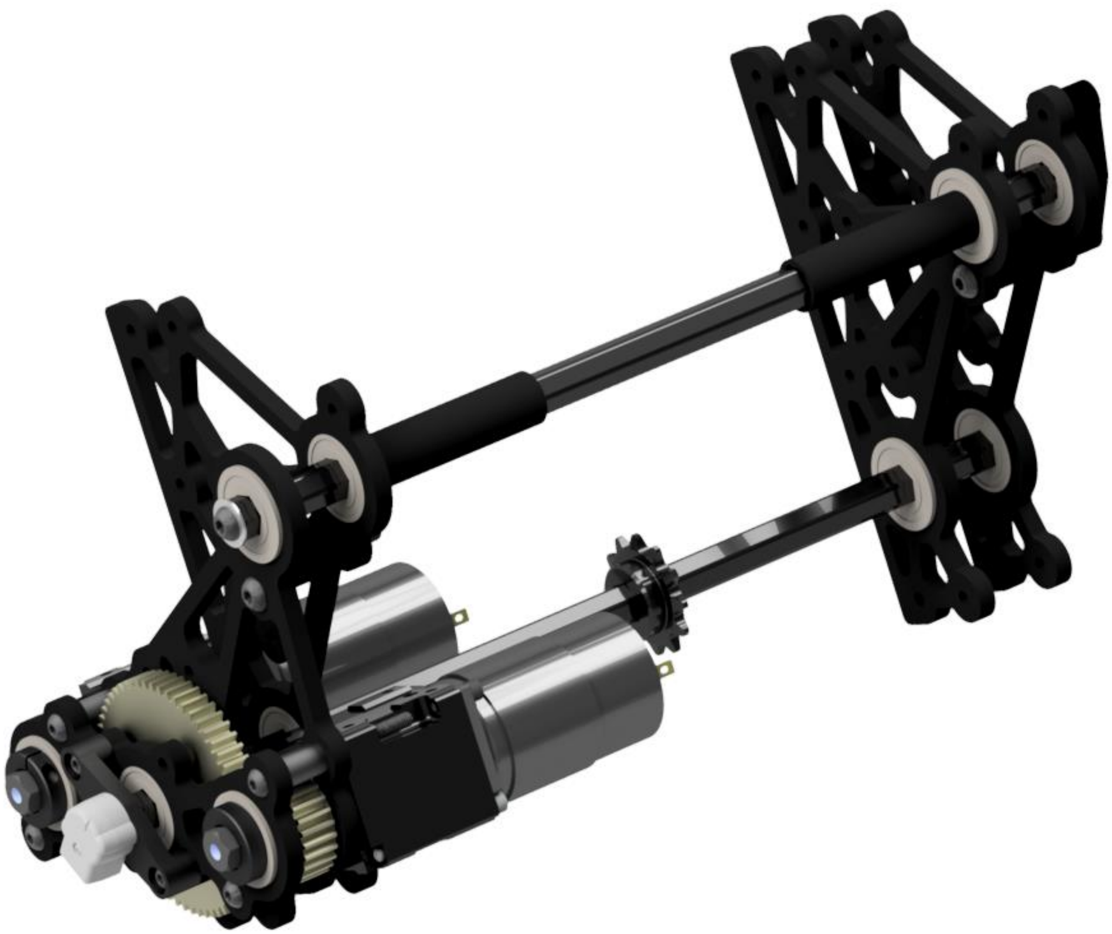
- Design Constraints
    - Must have hatch and cargo intake in one mechanism
    - Cargo intake must have a top roller for “touch and go” intaking
    - Hatch intake must be able to pick hatches up from the ground
- Intake
    - Top roller conforming wheels can intake cargo from 12”-13” in diameter
    - Side rollers funnel cargo in with a 15” intake range
    - Powered by 1 775 Pro motor with a 5:1 reduction
    - Parabolic shaped 3D printed pieces intake hatch
    - Pistons open and close to grip inner circle of hatch and outside of cargo
    - Made mainly of polycarbonate to deflect side impacts

Arm



- Design Constraints
    - Intake and score hatches on the low level
    - Must be able to intake cargo from the ground and score them in the low level
    - Must be able to pick up hatches from the ground
- Arm
    - 22” Long arm with 120 degrees of motion
    - Two 0.05” thick box tubing
    - Driven by #35 chain on 36 tooth sprocket
    - Intake interfaces with arm through a wrist and ABS plates
    - Wrist actuated by pneumatic piston
    - Wrist actuation allows for smooth transition between ground pickup and scoring position

Arm Gearbox

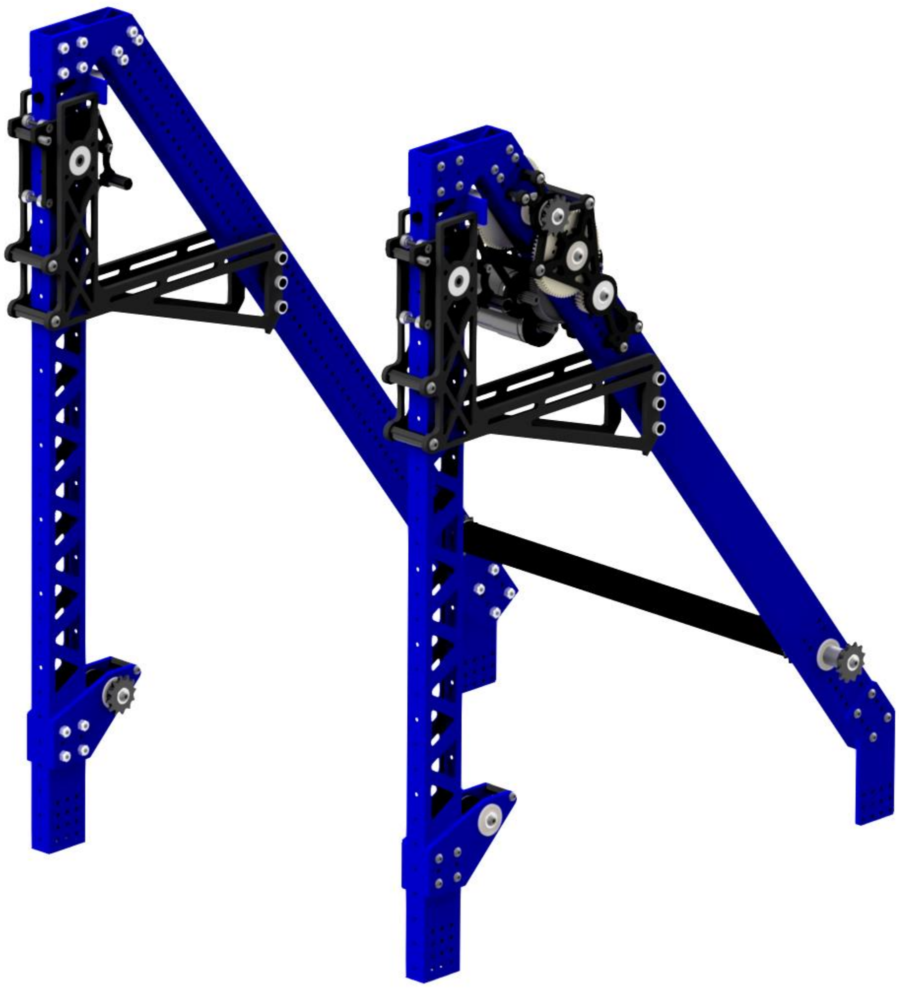


- Design Constraints
    - Arm should be able to move 90 degrees in 1 second or less
    - Should not draw a lot of current
- Arm Gearbox
    - Powered by 2 775 Pro motors
    - Travel time to 90 degrees is 0.62 seconds
    - 100:1 Versa Planetary reduction to a gear stage followed by chain stage
    - Overall ratio of 643:1
    - Final stage on a dead axle to prevent twisting of hex shaft
    - Tracked with an absolute magnetic encoder
    - Mounts directly to rear elevator support

Rear Elevator

- Design Constraints
  - Needs to be able to lift the robot to the level 3 HAB Zone
  - Needs to have powered wheels to push the robot forward
  - Should be able to lift an alliance partner
- Rear Elevator
  - 21” of travel pushes us up to level 3 HAB Zone
  - Rear Colson wheels are extremely durable and impact resistant
  - Rear wheels powered by 1 775 Pro
  - Overall gear ratio of 140:1
  - Buddy bars made out of box tubing
  - Dyneema cord securely pulls elevator up and hold buddy bars parallel to the ground

Front Elevator



- Design Constraints
  - Wide enough to go around arm and intake
  - Will not bend under load
  - Must be able to smoothly slide on level 3 HAB Zone
  - Have gearbox that also powers rear elevator
- Front Elevator
  - 21” of travel pushes down on level 3 HAB Zone
  - Actuates 0.25” thick “feet” that lift the robot up
  - Gearbox is mounted on the front side to shift CoG to the front
  - 4 775 Pros power the front and rear elevator
  - Overall 47:1 reduction in gearbox which is then chained off to rear and front elevator
  - Magnetic encoder on rear spindle tracks the distance traveled

Climbing Feet

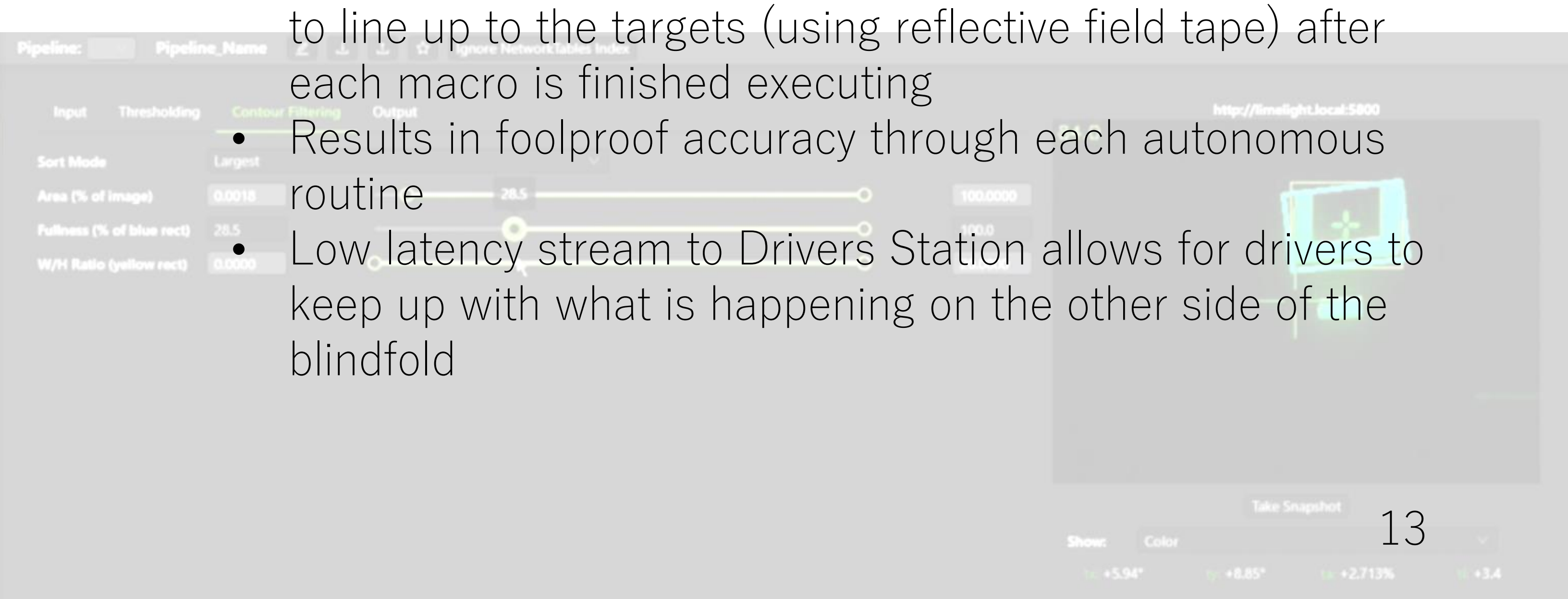
- Climbing Feet
  - Slides on front elevator post with 0.5” bearings
  - Held up during the match with a constant force spring
  - Passively flips out with surgical tubing
  - Hard stops on the top and back prevent feet from over-extending
  - Bearings on the bottom allow for frictionless gliding on the HDPE platform
  - Wedge shape on front pushes foot up in case of surgical tubing failure
  - Pulled down with Dyneema cord

Programming

- Sandstorm
- Teleoperated
- End Game Climbing

Sandstorm

- SharkMacro
    - Lightweight software that is able to record periods (called macros) of drivetrain and manipulator movement in real time, and accurately play the macro back
    - Macros are recorded by drivers in real-time, resulting in each macro playback essentially being an emulation of driver control
    - Encoder position and velocity are recorded into a commas separated values (CSV) file every 10ms while recording, which is then stored in the RoboRio directory
    - Prior to executing each macro, paths are generated by loading each point onto the specified motor controller from the CSV file, allowing for smooth playback
    - Runs through an optimized PID loop for accurate path following
- Limelight
    - FRC smart camera that allows for effortless detection of targets
    - Used in conjunction with SharkMacro during Sandstorm to line up to the targets (using reflective field tape) after each macro is finished executing
    - Results in foolproof accuracy through each autonomous routine
    - Low latency stream to Drivers Station allows for drivers to keep up with what is happening on the other side of the blindfold



Teleoperated

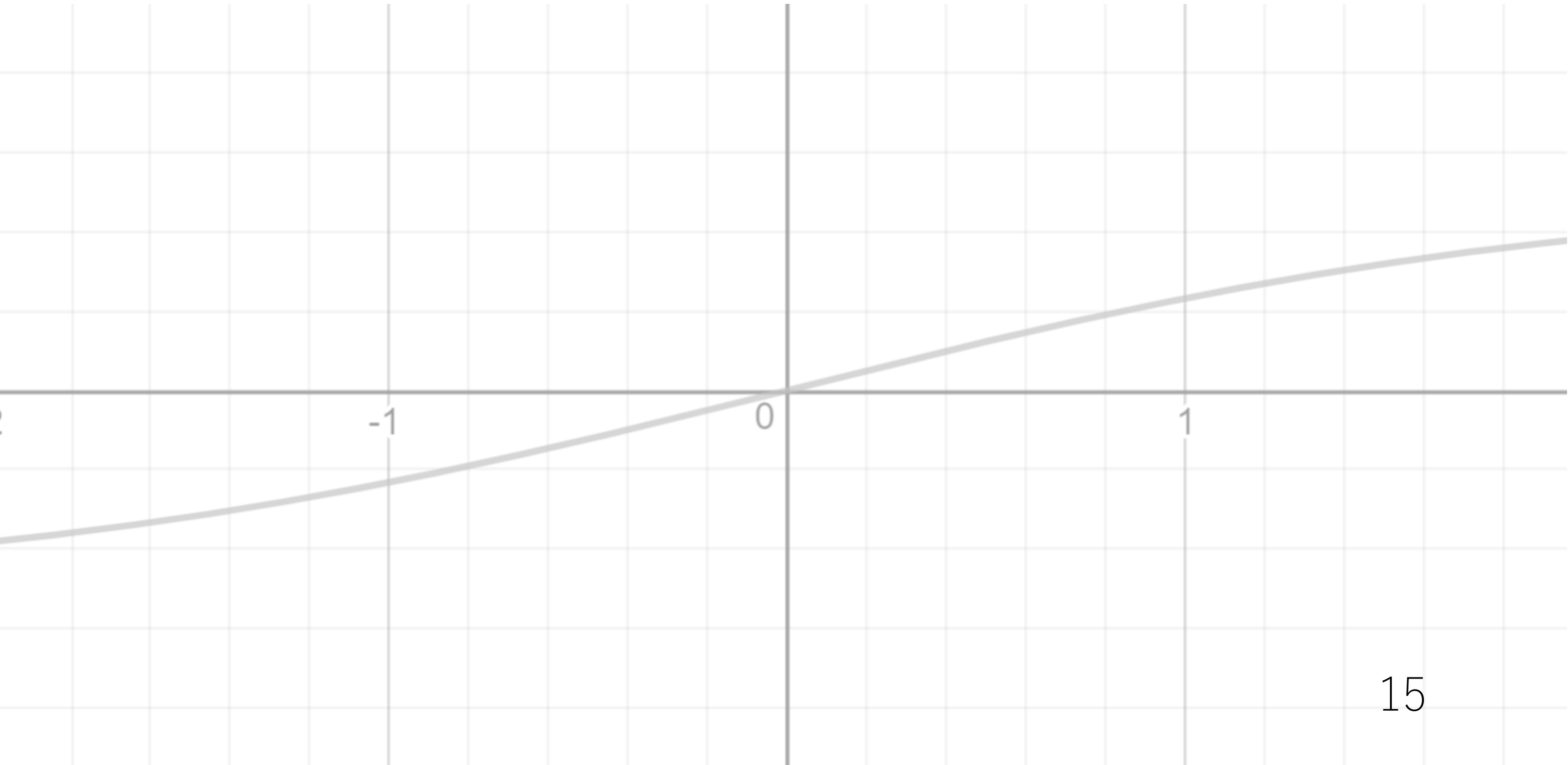
```java
        // Remove differential in list size
        int minSize = Integer.MAX_VALUE;
        for (int i = 0; i < recordings.size(); i++) {
            if (recordings.get(i).size() < minSize) {
                minSize = recordings.get(i).size();
            }
        }
        for (int i = 0; i < recordings.size(); i++) {
            recordings.get(i).subList(minSize, recordings.get(i).size()).clear();
        }

        // Remove leading zero rows
        for (int i = 0; i < minSize; i++) {
            if (!areEqual(i, 0)) {
                for (int j = 0; j < recordings.size(); j++) {
                    recordings.get(j).subList(0, i).clear();
                }
```

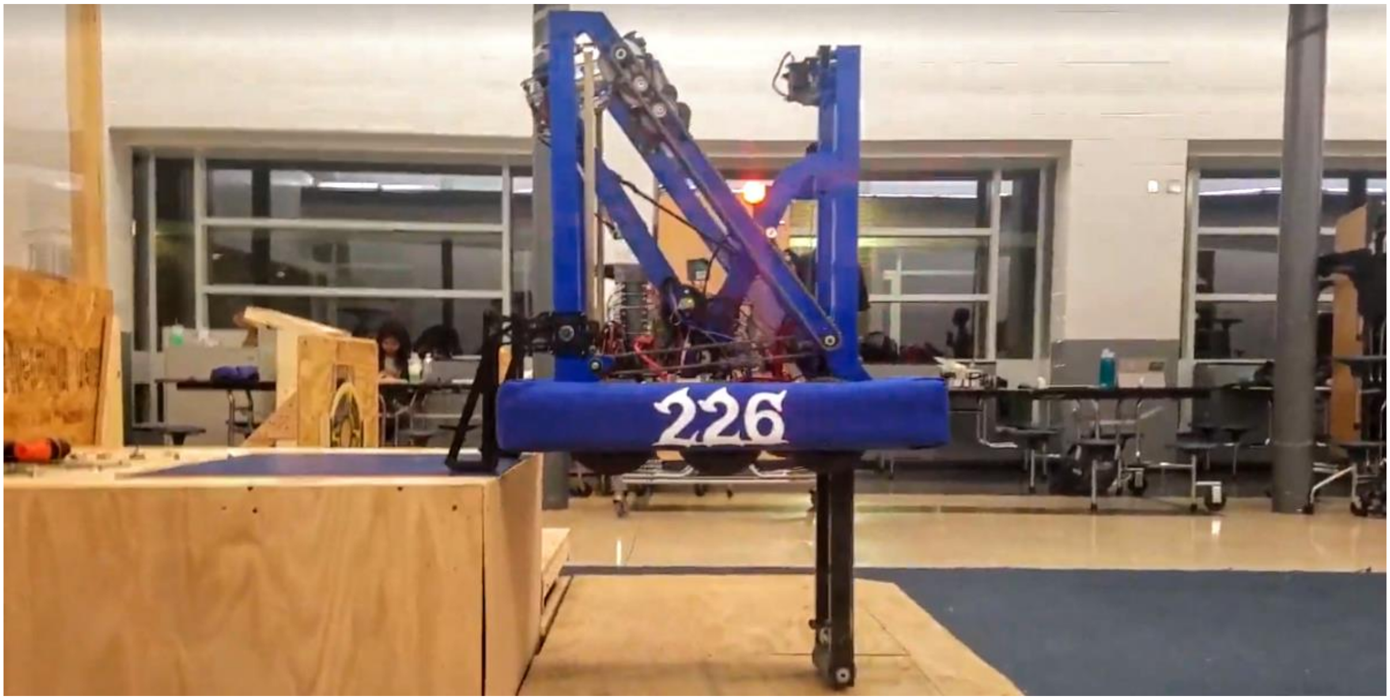
- Arm Setpoints
    - Automated setpoints mapped to manipulator controller allow for effortless movement of arm to ground position, intake position, hatch scoring position, and cargo scoring position
    - Arm position is sampled through pulse width encoder feedback prior to initial movement of the system, which is then set to the quadrature encoder position
    - This results in the subsystem effectively being able to utilize the position accuracy of an absolute encoder, with the quick feedback response of a relative encoder
- Driving and Manipulator Controllers
    - Both the driver and manipulator controllers are defined through a student written Controller wrapper class
    - Unlike the Joystick class, this class allows controller factors such as the deadband and rumble to easily be manipulated in the code
    - All Controllers have methods implemented that allow for easy referral to specific joysticks and buttons, eliminating any need to recall the axis numbers for controllers as well as instantiating Buttons to execute non-default commands

Teleoperated

- Sigmoid Function
  - Implemented as part of our vision routine
  - Used to turn drivetrain toward a target with a speed relative to how far the robot is from the detected target
  - Function takes the target angle as an input, with the output speed consistently remaining between -0.5 and 0.5 which is optimal for routines requiring precise turning
  - One side of the drivetrain is set to the calculated output speed while the other side is set to the opposite, resulting in smooth pivotal rotations



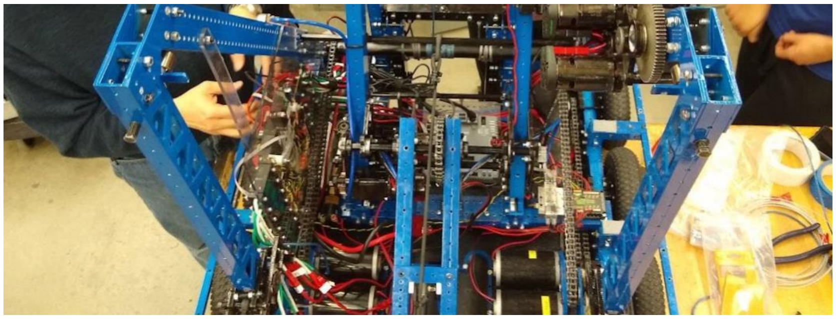
Endgame Climbing

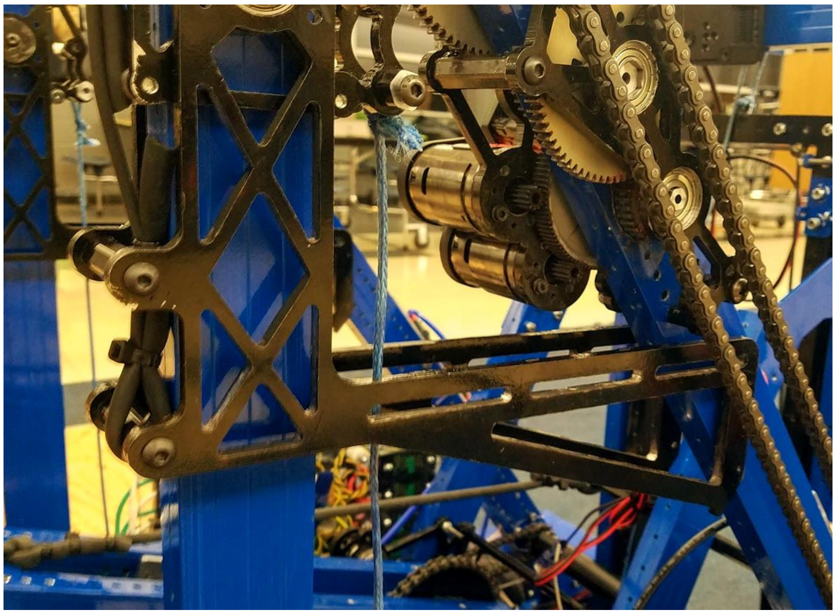


- Endgame Climbing
  - Level 3 HAB zone climb sequence is able to run completely autonomously
  - Used SharkMacro to record the accurate line up with the base of the Level 3 HAB zone, then the expeditious elevator movement down and forward movement
  - Useful during end game when drivers have a very limited view of the robot while it is climbing, which risks breaking or significantly deforming the elevator
  - Macro can be overridden by a simple push of a button on the driver controller on the occasion that an unexpected event occurs, optimizing as many safety measures as possible

Sponsors

This robot would have not been possible without the support of our gracious sponsors



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