2056

UPPERCUT

Orchard Park Robotics
2023 Charged Up Technical Binder

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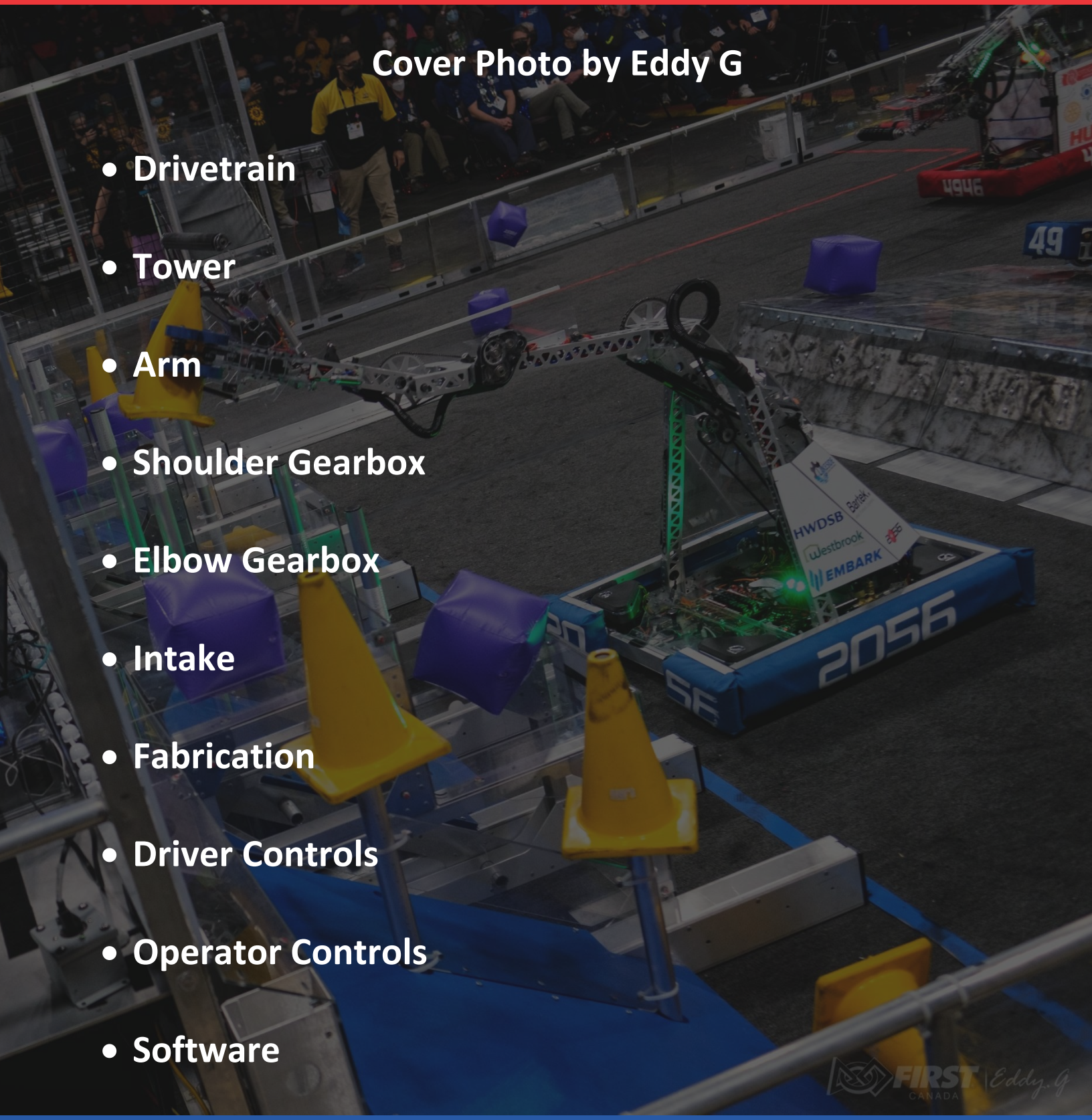

Cover Photo by Eddy G

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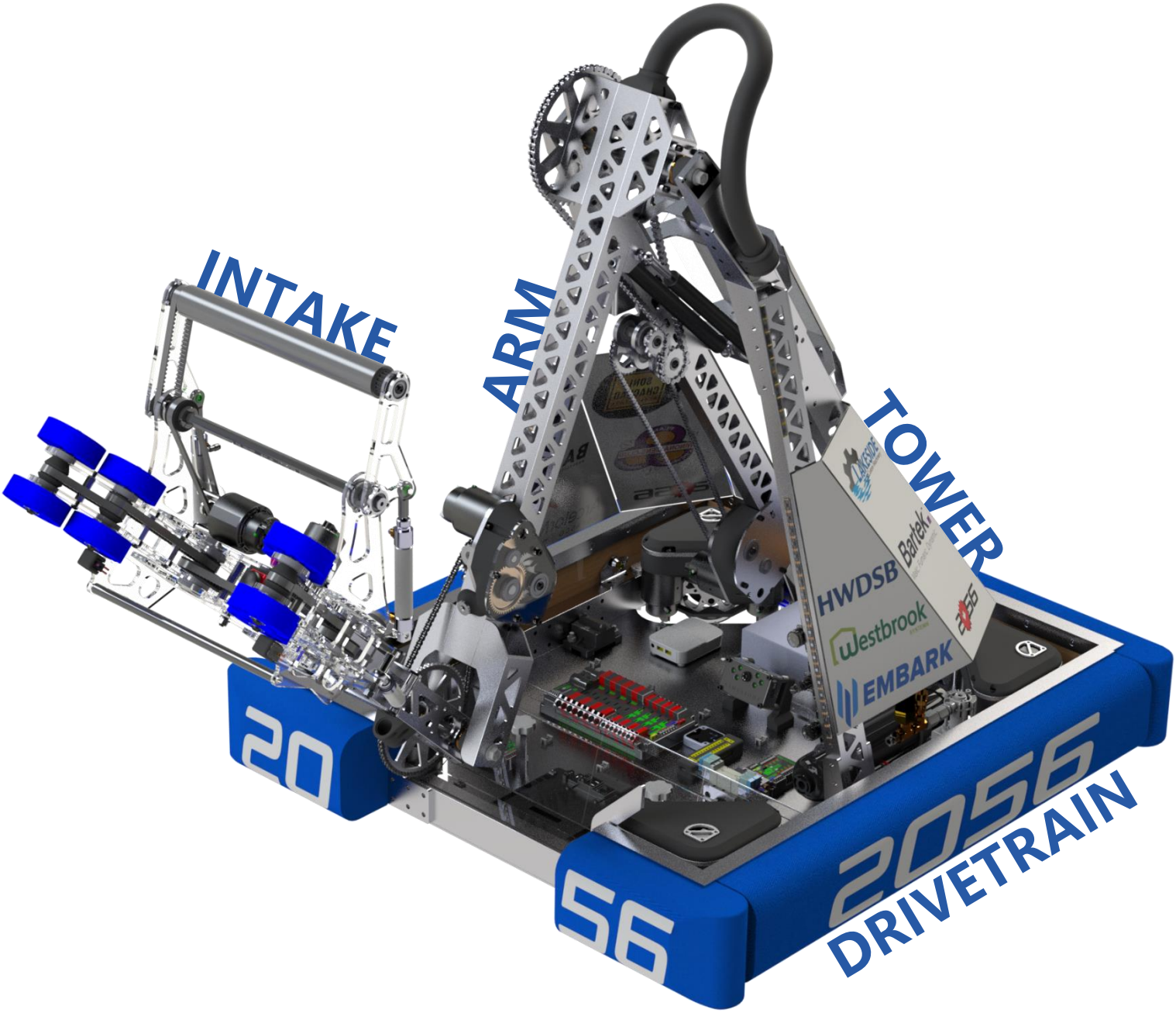
Robot Architecture



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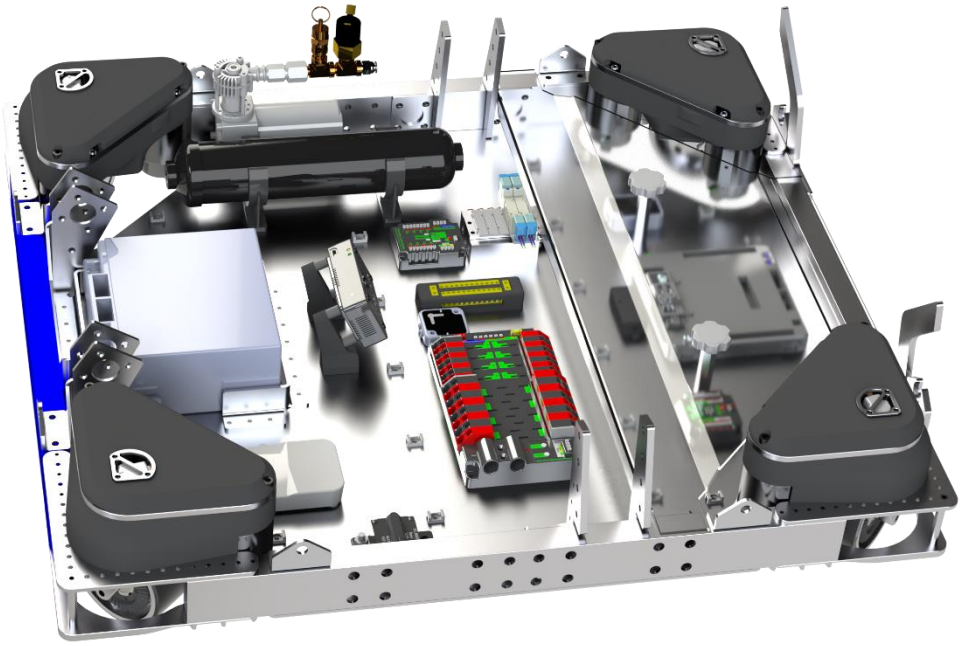
Drivetrain

Requirements:

- Robust, rigid, low maintenance and reliable.
- Able to traverse cable track, charge station, and easily maneuver in the community requiring traction, agility, and stability.

Chassis:

- SDS MK4i L2 Swerve modules with a speed of 15 ft/s driven by Falcon 500s. These were chosen due to their lower centre of gravity, increased stability, and known reliability in FRC.
- 27-3/4” wide by 31-3/4” long.
- Swerve modules were completely enclosed with 3D printed covers to prevent debris getting in and grease getting out.
- 2 x 1 x 1/8” Aluminum tube construction, 2 x 1” steel bar was later added to the rear to lower the centre of gravity.
- 1/8” Solid aluminum baseplate for low centre of gravity.



Electrical:

- All components were laid out in CAD prior to fabrication and Zip Tie holders were included to ensure clean cable management.
- Polycarbonate cover to prevent damage to any electronics.
- A Terminal Block was used to run multiple low current devices from one PDP slot.

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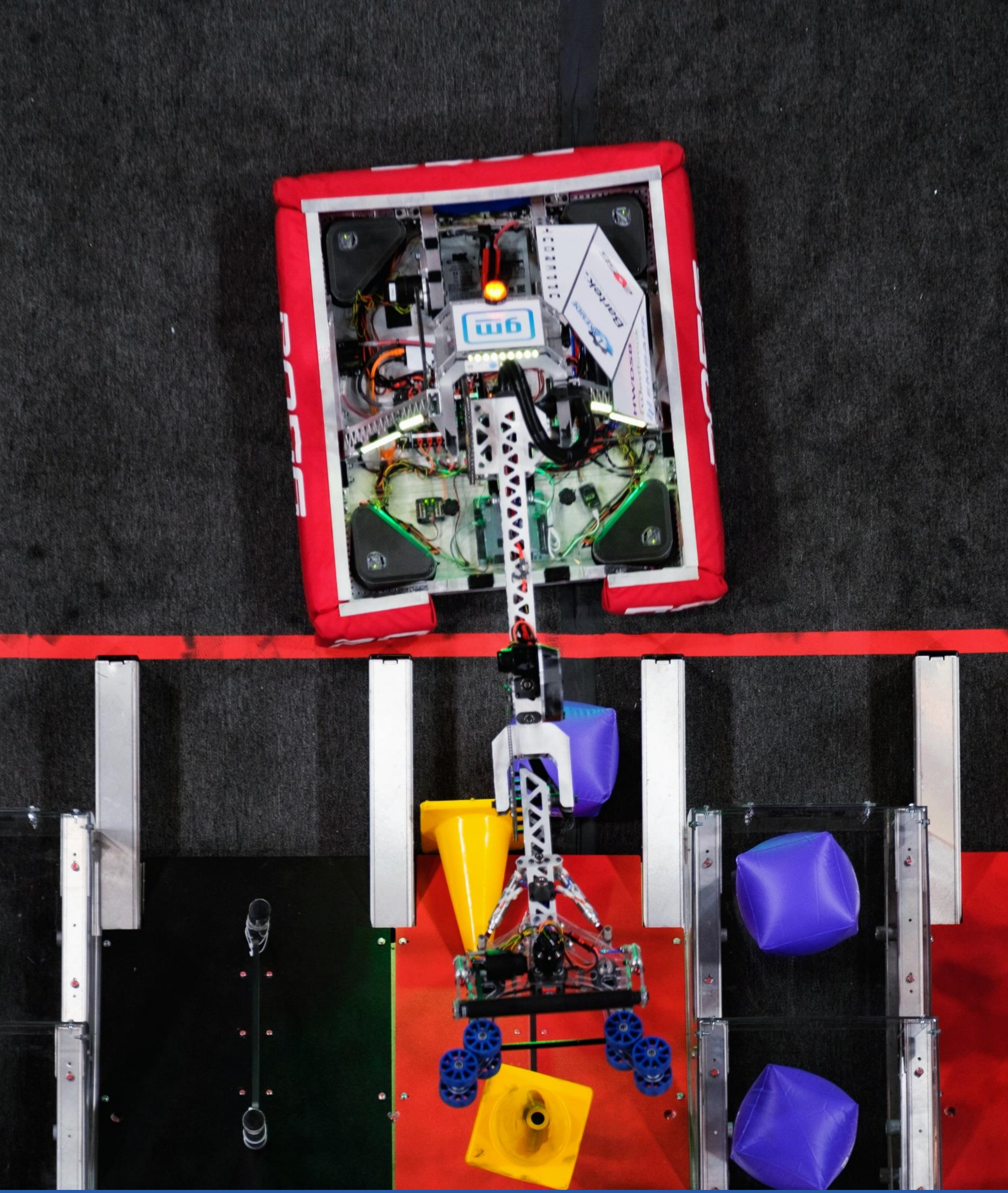
Tower

Requirements:

- Robust and Rigid.
- Provide a stable pivot at the correct height and angle for the Arm.

Construction:

- Main structure is made of Lightened 2 x 1 x 1/8” Aluminum to lower centre of gravity.
- Rear lower support is constructed of 2 x 2 x 1/8” aluminum for rigidity and upper support for gas shock clearance.
- The tower is fastened with 1/4” aluminum rivets and then bolted to the drivetrain with 1/8” formed aluminum sheet metal.
- 7/8” dead axle bolted to the tower using 3/8” bolts providing strength and rigidity to the tower and arm.
- Internal cable routing up tower to arm.



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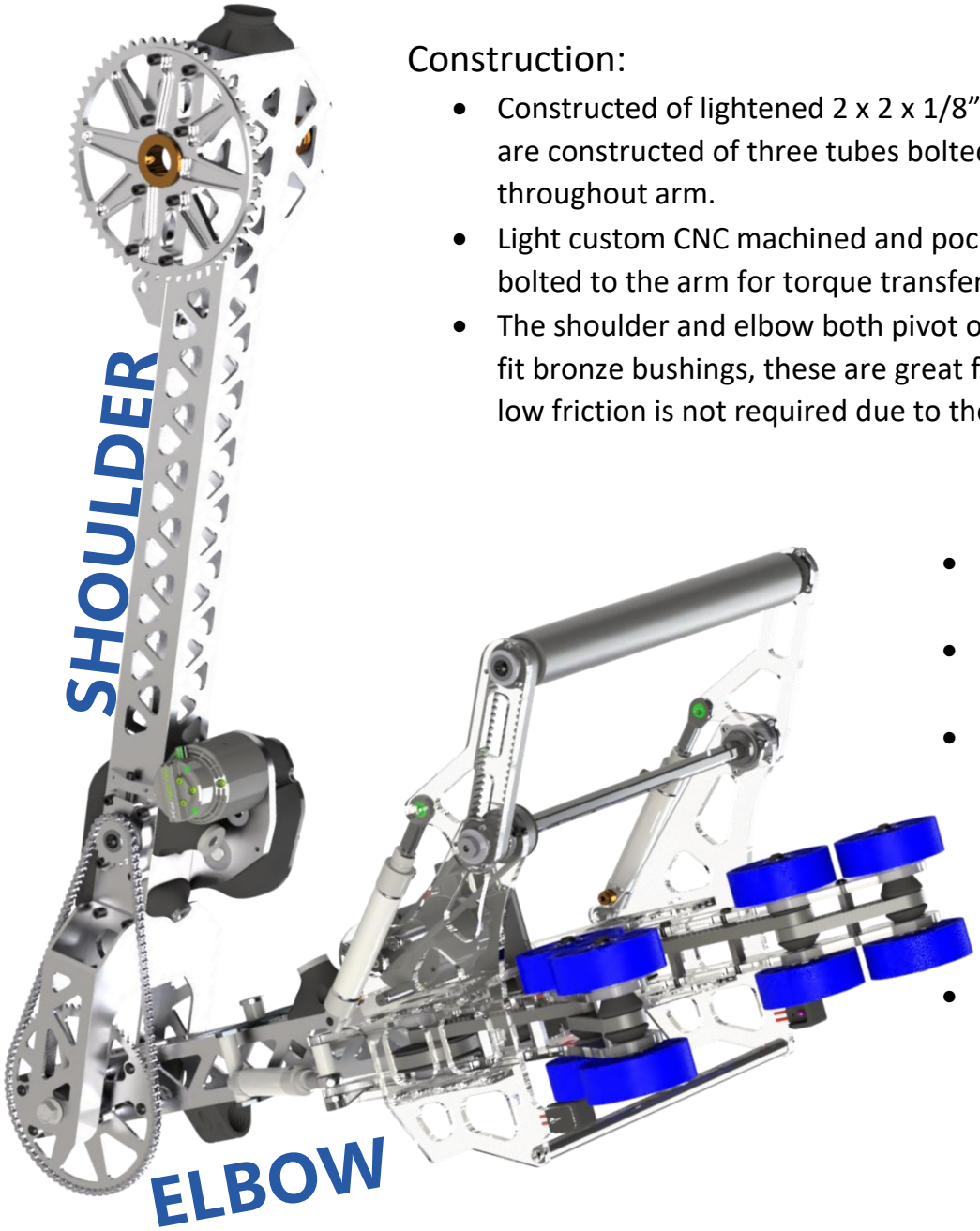
Arm

Requirements:

- Robust, Rigid, Light, and Reliable.
- The correct geometry and range of motion to score in any position, pick up from the floor and from the single Human Player Station.

Construction:

- Constructed of lightened 2 x 2 x 1/8” aluminum tubing, pivot points are constructed of three tubes bolted together to transfer torque throughout arm.
- Light custom CNC machined and pocketed aluminum sprockets are bolted to the arm for torque transfer.
- The shoulder and elbow both pivot on a solid dead axle with press fit bronze bushings, these are great for high load application where low friction is not required due to their size and weight.



- #35 Chain final stage reduction.
- #25 chain elbow and shoulder intermediate reduction.
- The Shoulder is precisely counter balanced using two 50-pound nitrogen gas shocks while also holding the shoulder in the starting configuration.
- Two magnets are used to hold the elbow in the starting configuration.

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Shoulder Gearbox

Requirements:

- Drive the shoulder to the required position at high speeds.
- Minimal backlash to eliminate the need for any external encoder allowing us to rely on the motor encoders.

Gearbox:

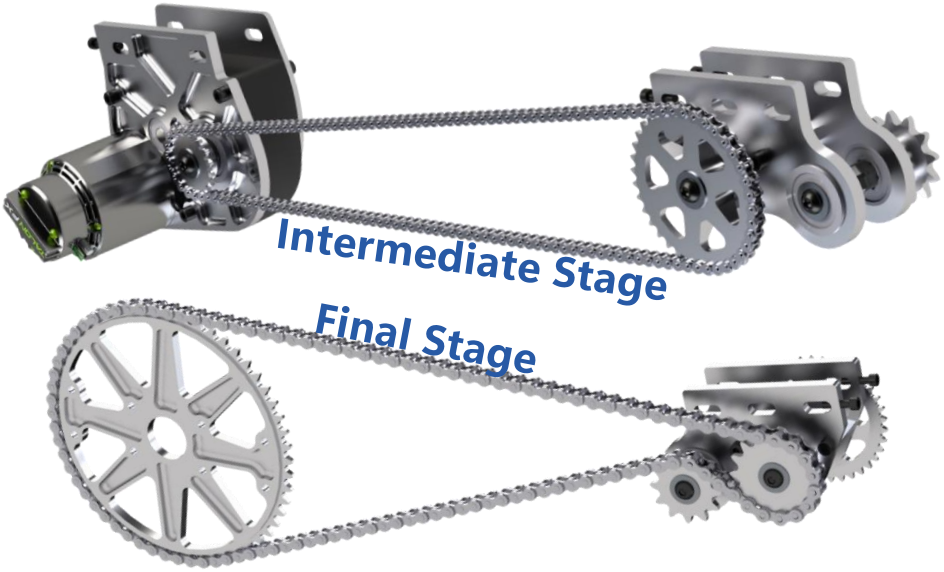
- The gearbox is driven by a Falcon 500 and is constructed of two aluminum plates bolted together with aluminum standoffs.
- A custom 3D printed cover completely encloses the gearbox to prevent debris getting in and grease getting out.
- Approximately 18:1 gear reduction, the gears were bonded to the shaft using retaining compound to eliminate backlash. The final gear had a custom broached hub made for it. The wider hub and tight hex fit eliminated backlash and wear on the hex shaft interface.

Intermediate Stage:

- 2:1 reduction #25 chain.
- Sprockets were custom machined and broached to eliminate backlash.

Final Stage:

- Nearly 4:1 reduction with #35 chain and custom sprockets.
- Idler sprocket was added to provide increase wrap on the driving sprocket.
- Overall reduction of 133:1



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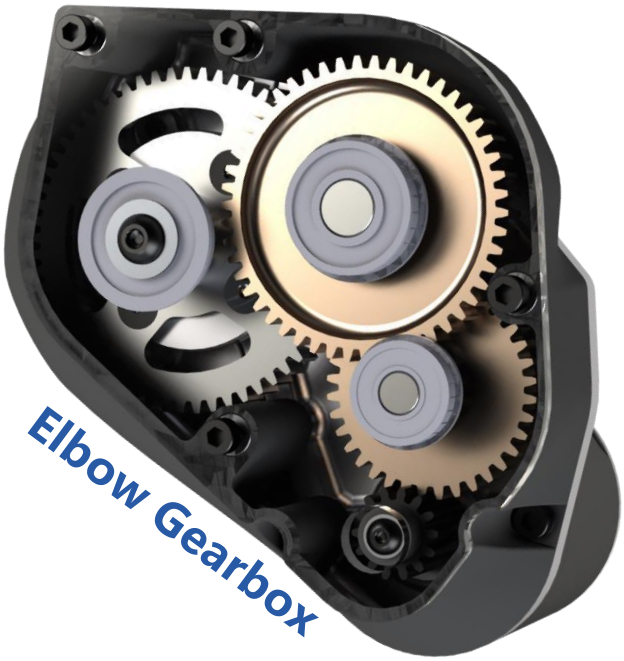
Elbow Gearbox



Requirements:

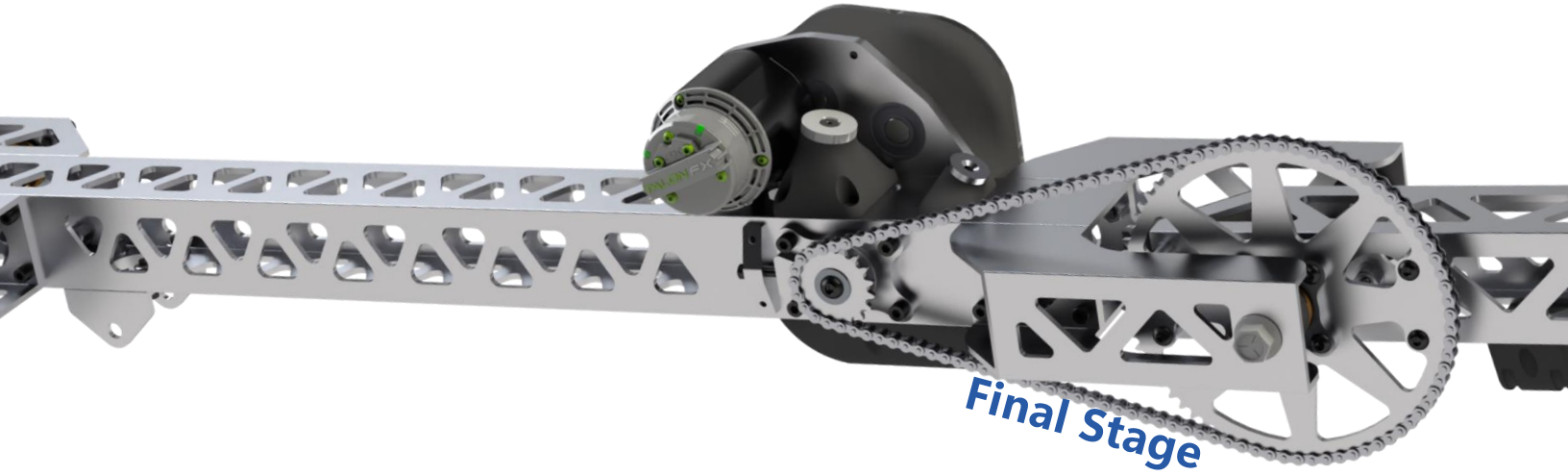
- Drive the elbow to the required position at high speeds.
- Minimal backlash to eliminate the need for any external encoder allowing us to rely on the motor encoders.

Gearbox:

- The gearbox is driven by a Falcon 500 and is constructed of a 1/4" pocketed aluminum plate with a 3/16” polycarbonate top plate.
- A custom 3D printed cover completely encloses the gearbox to prevent debris getting in and grease getting out.
- Approximately 34:1 gear reduction, the gears were bonded to the shaft using retaining compound to eliminate backlash. The final gear had a custom broached hub made for it, this gave it much more surface area to eliminate wear over time and a much tighter hex fit.

Final Stage:

- 4:1 reduction with #25 chain and custom broached sprockets to eliminate backlash.
- Overall reduction of 138:1



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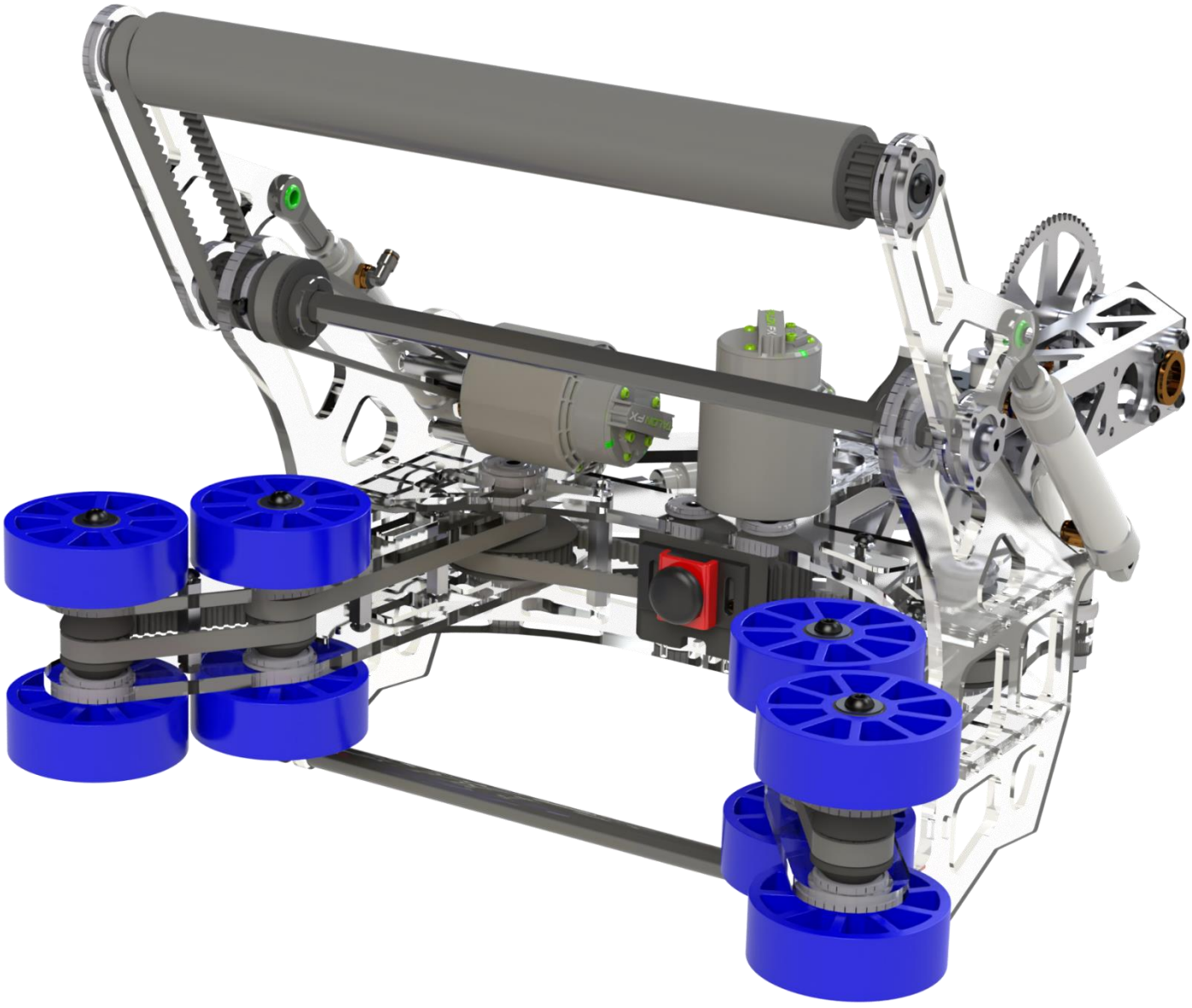
Intake



Requirements:

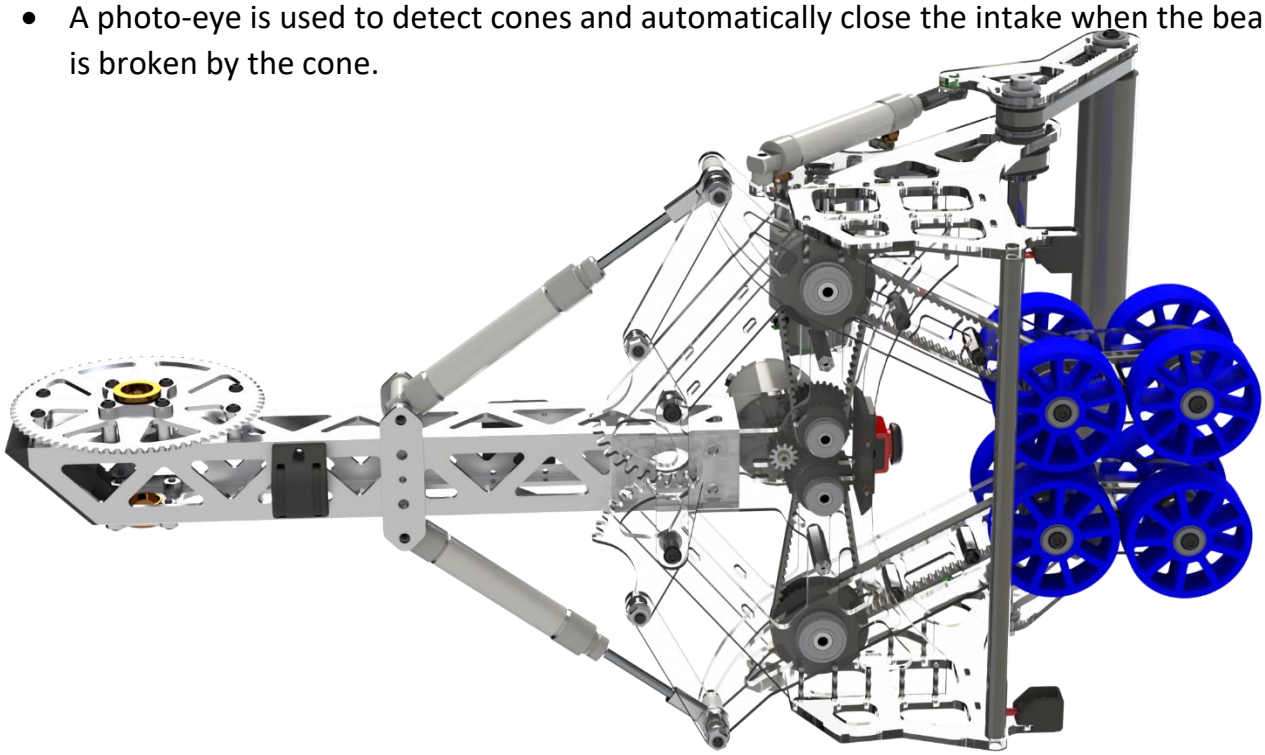
- Robust, Compliant, Light, and Reliable.
- Effectively and quickly pick up cones and cubes from the floor and single human player station.
- Keep a hold of cones and cubes while traversing the field.
- Score cones and cubes on any node effectively and quickly.

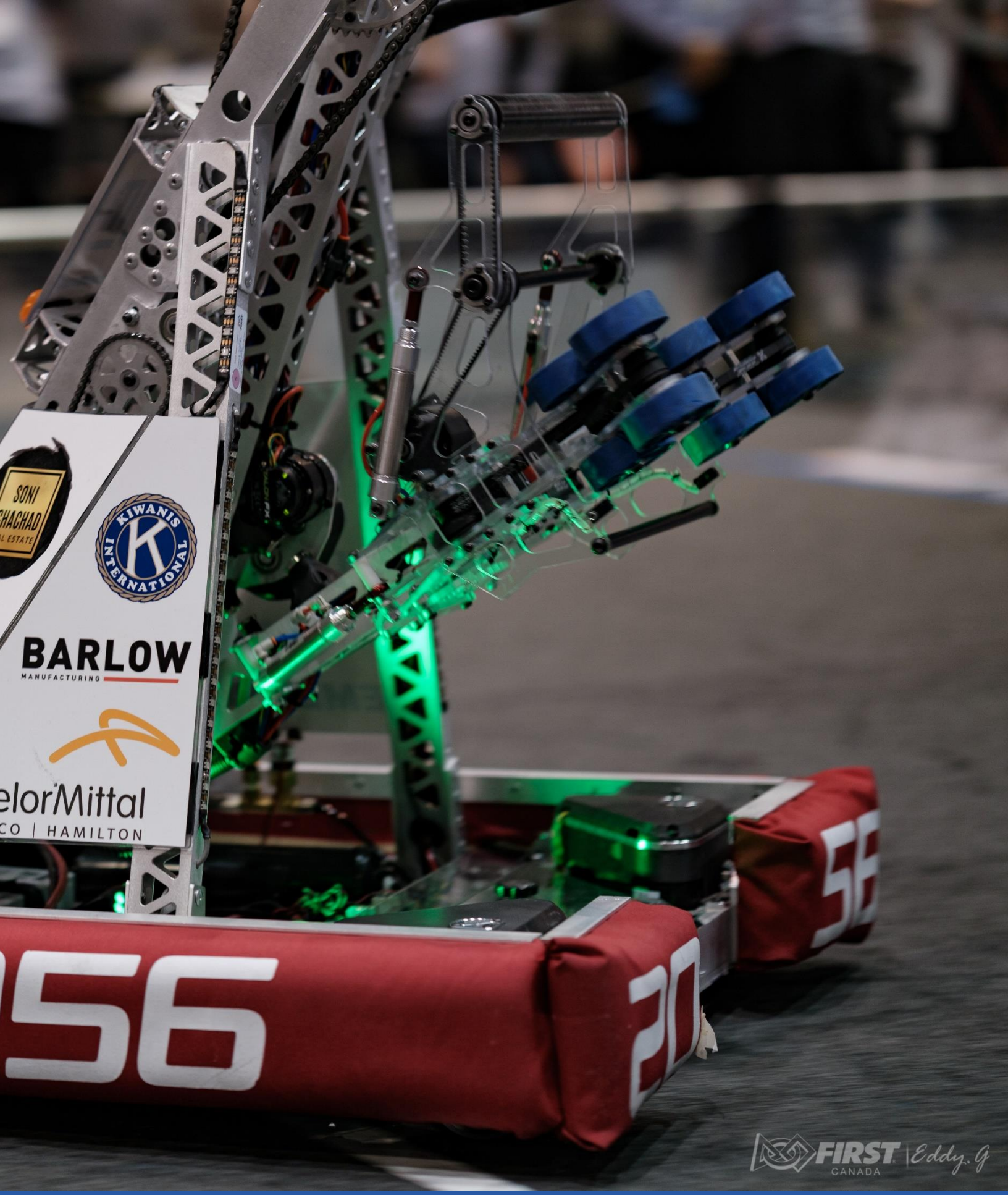
Construction:

- Almost exclusively constructed of pocketed 1/4" polycarbonate for a balance of weight, compliancy, robustness, and rigidity.
- Side polycarbonate plates are joined to the main polycarbonate plates with five 8-32 bolts into the tapped edge of the 1/4" polycarbonate thus eliminating the need for any aluminum brackets.

Details:

- Pneumatically actuated top roller made of carbon fiber and covered with silicone friction tubing to provide grip and compression when intaking cubes and assisting the 4” compliant wheels.
- The top roller is driven with a Falcon 500 and timing belts which require no tensioning and are lighter than chain.
- Pneumatically actuated side rollers to pinch and auto centre cones, a 4-bar linkage with two polycarbonate sector gears were added to time the two sides together and ensure the cone is held tightly.
- The side rollers are both driven by one Falcon 500 with gears and timing belts, the gears ensure the side rollers rotate in opposite directions.
- All gears and pulleys are 3D printed to reduce weight.
- Bumper Switch is used to detect when the cube has been acquired and to disable the rollers to prevent any damage to the cube.
- A photo-eye is used to detect cones and automatically close the intake when the beam is broken by the cone.





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Fabrication Resources

In House Resources

CNC Mill:

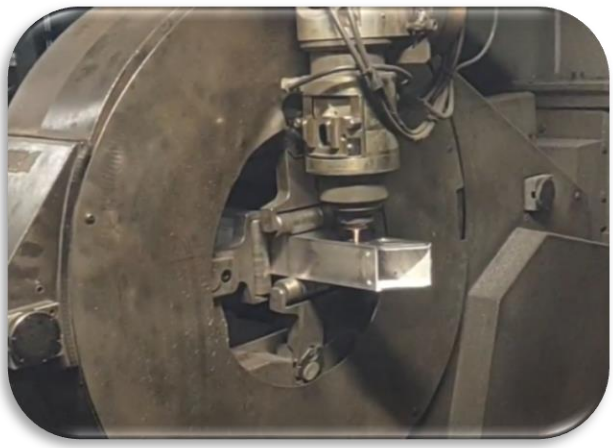
- For manufacturing small parts with high precision and good surface finish.
- Commonly used to machine 1/8” to 1/2” flat bar such as a sprocket.

CNC Router:

- For manufacturing medium sized parts with precision and speed.
- Commonly used to cut out 1/8” to 1/4" polycarbonate such as the intake.

Manual Lathe:

- For machining and end facing round stock.
- Commonly used to machine, drill and tap Hex and Round shaft.



Sponsor Manufacturing Resources

CNC Tube Laser:

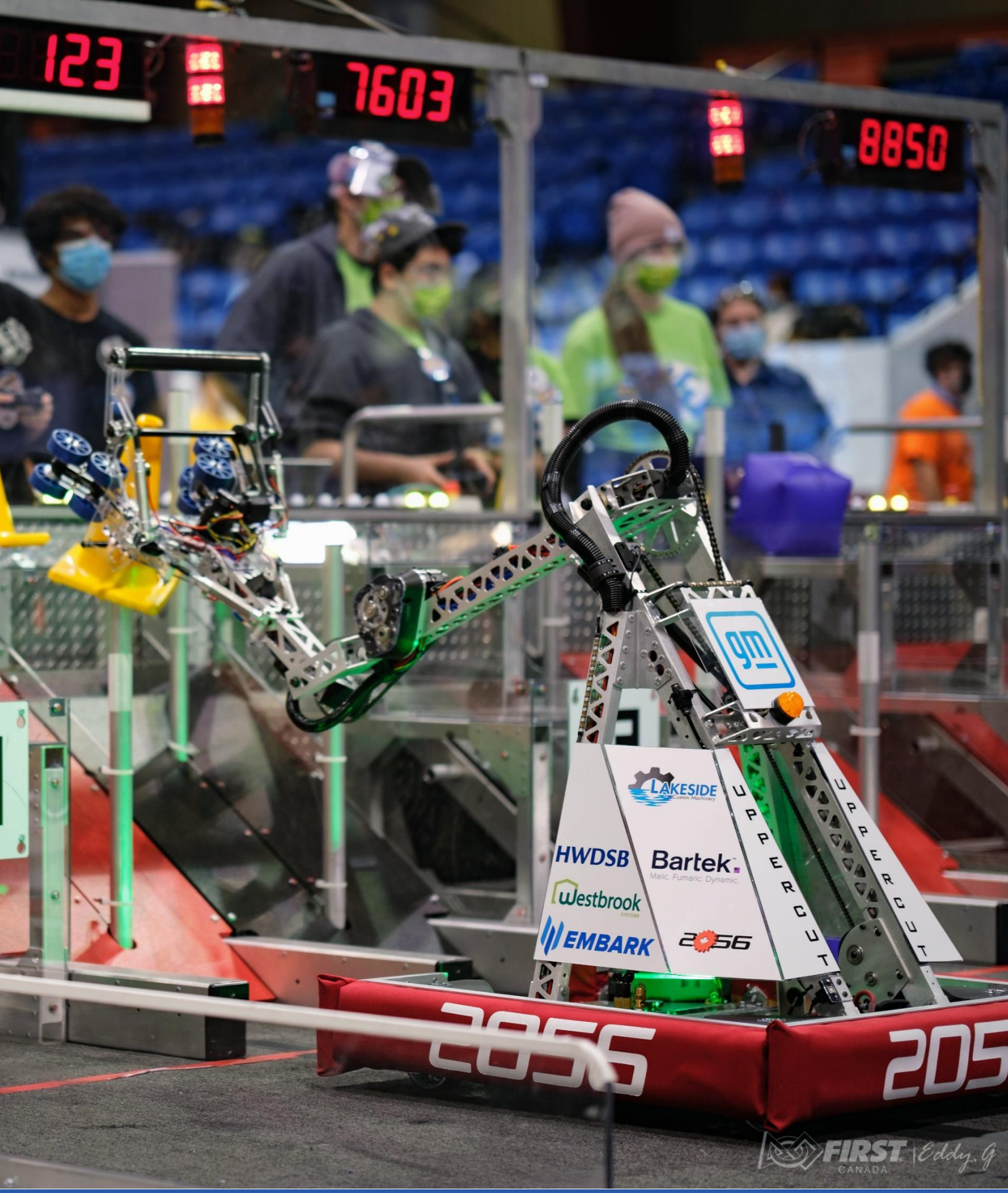
- Cuts all sides of aluminum tubing of any length at high speeds.
- All tubing such as the drivetrain, tower, and arm were cut on the tube laser.

CNC Laser:

- Cuts large sheets of sheet metal at high speeds.
- The belly pan, brackets, and gussets were all cut on the CNC laser.

CNC Brake:

- For precisely bending and forming sheet metal.
- Tower brackets were all formed with the CNC brake.



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Driver Controls

Baselock
(Wheels at 45°)

Cone Flip Sequence

Arm Home

Arm Score High
(Hold For Auto Aim)

Arm Score Mid
(Hold For Auto Aim)

Arm Score Low

Translate
(Push Down for Field Centric)

Rotate
(Push Down for Robot Centric)

Cube Floor Pickup

Cone Floor Pickup

Release Game Piece

Single HP Cone Pickup

Operator Controls

Software

C++ Programming Language

Self developed swerve control & odometry with Phoenix Pro

- FusedCANcoder control mode with continuous wrap for Steering
- Velocity FOC Control Mode for Drive
- Odometry with Phoenix Pro Time sync for accurate swerve odometry
- Field relative Teleop Driving
- Simple drive to point auto driving algorithm.

Finite state machine controls arm and gripper

- Stator Current limits on intake
- Motion magic control modes on elbow and shoulder
- Smart positions for elbow and shoulder

Auto Aim:

- Limelight V3
- The limelight is used to track the retro-reflective tape when scoring cones and to track the April tag when scoring cubes.
- The robot uses the distance and heading to target from the Limelight to calculate the desired robot pose scoring position. The chassis drives there while the arm is moving to position.

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