CHOP SHOP
MERRIMACK HIGH SCHOOL ROBOTICS

DOWNFORCE

FIRST TEAM 166 CHOP SHOP

CRESCENDO 2024 SEASON

TECHNICAL BINDER

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Game Analysis

Before the season, our team held a mock kickoff to prepare newer members and streamline Kickoff Day. During Week 1, we spend time analyzing the game together then split into groups to analyze the pros and cons of different strategies. This ensures that everyone's voice can be heard and each strategy is given due consideration.

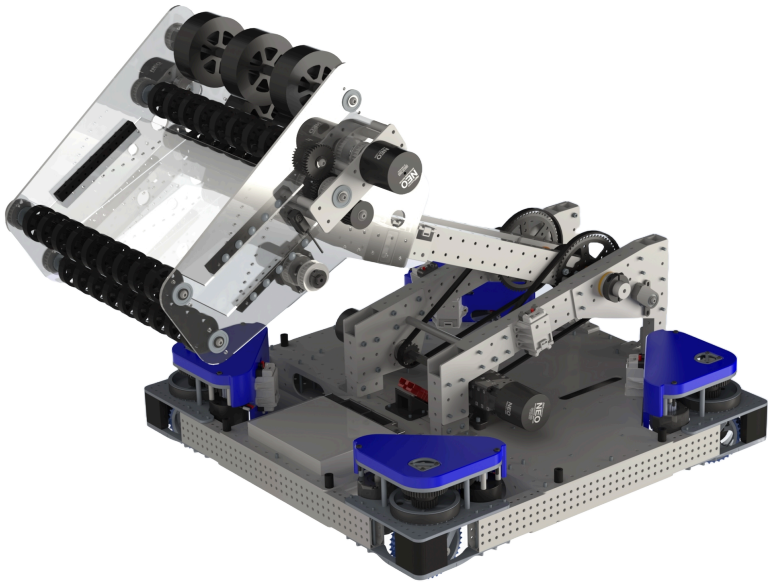
Strategy

This year our goal was to build a robot that can adapt to our alliance partner's strategies while keeping our design as simple as possible and avoiding unnecessary degrees of freedom. As a result, we built a robot that can score in both the amp and the speaker reliably with only one degree of freedom, our arm pivot.

Priority List

1. Move
2. Ground intake
3. Auto scoring in speaker
4. Teleop scoring in amp
5. Climb
6. Teleop scoring in speaker
7. Multipositional shooting
8. Driver-aid camera
9. Vision auto-alignment
10. Scoring in trap
11. Harmonizing with buddy climb

Alpha Robot: Coldstart



Priorities

- Simple design to allow for more drive practice and software time to work on autonomous routines
- Flexible scoring positions on minimal degrees of freedom
- Test “brain board” concept (inverted electronics board)

Lessons Learned

- Alpha’s over the bumper intake was susceptible to damage outside frame
- Arm rotation speed was undesirable for quick cycles
- Shooter was reliable at close range but lacked long range consistency
- Dead-axle arm rotation was not as maintainable as desired

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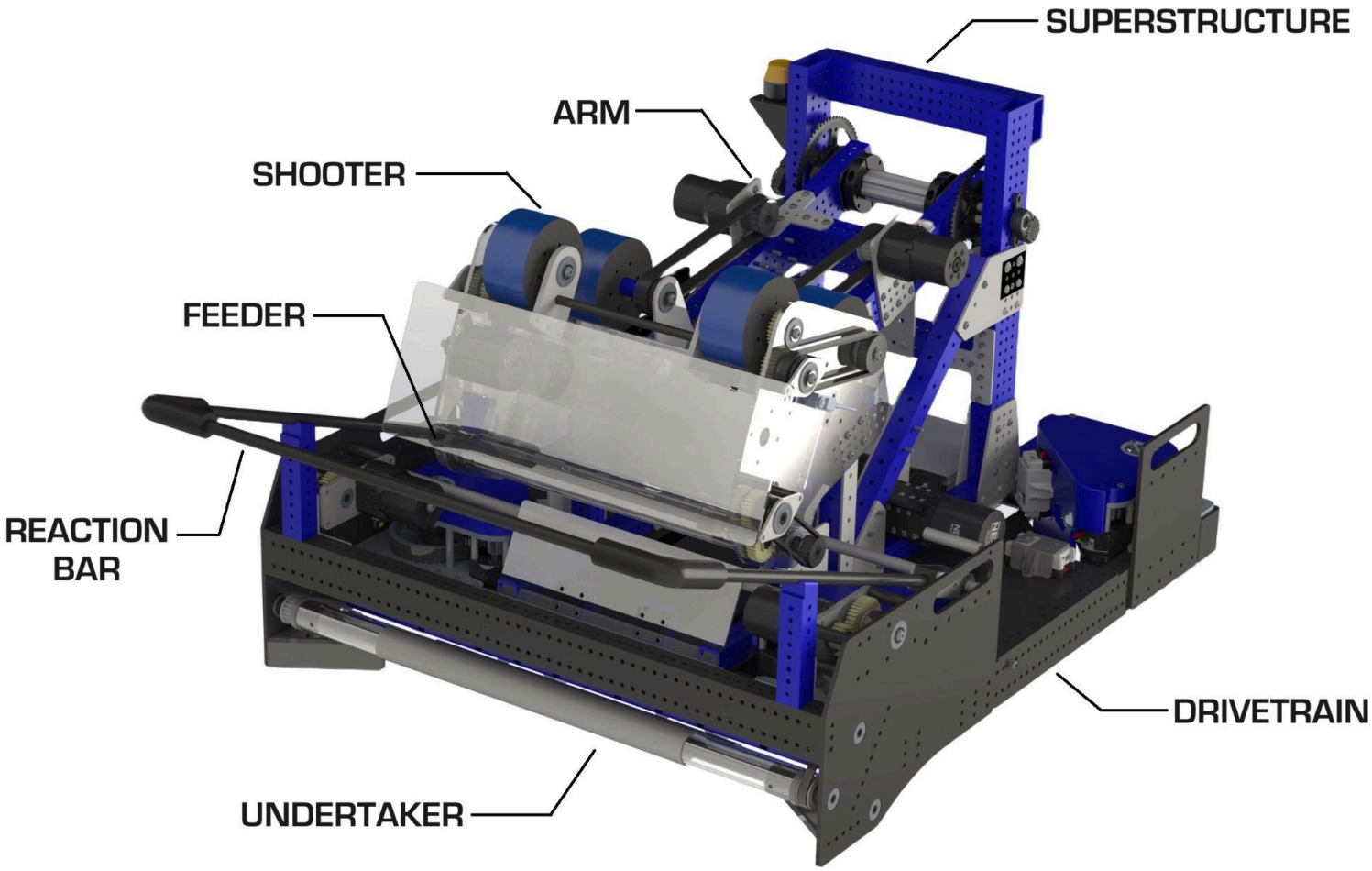
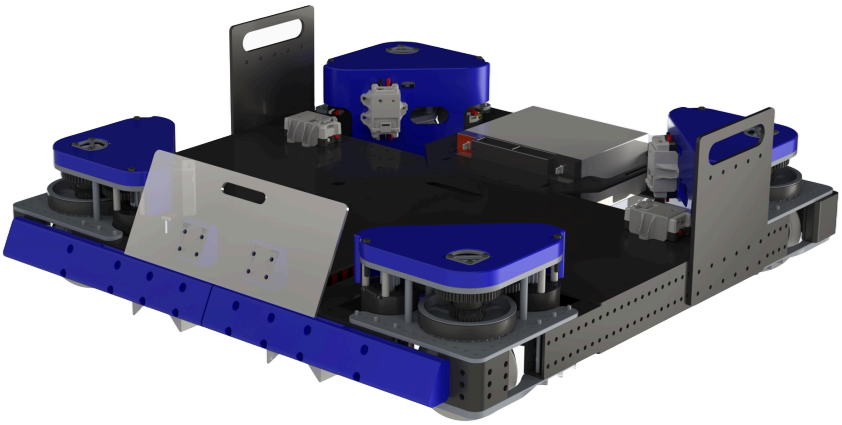
Competition Robot: Downforce



Drivetrain



This year we chose a swerve drivetrain because the field is completely flat with no cable covers or other obstacles. Swerve also allows us to maneuver around defense and quickly complete full-field cycles.

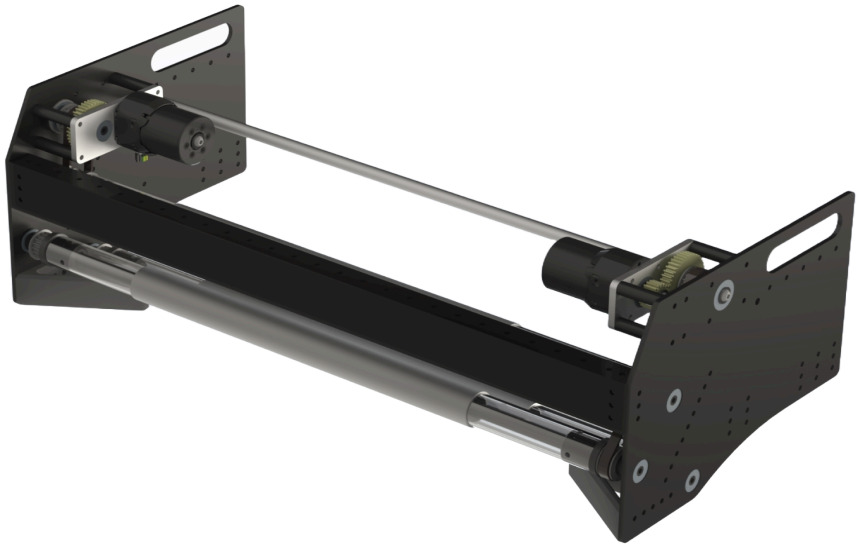
- **Hardware**
  - 17.6 feet per second max speed
  - 27 in. square swerve chassis
  - 27.375 in. x 32.125 in. frame perimeter
  - MK4i SDS Swerve modules with L2 gear ratio
  - NEO Vortex motors for drive, NEO 1.1 motors for rotation
  - Custom swerve module covers to keep debris out of modules
  - 3D printed ramp for Undertaker
  - Robot handle plates for easy transferring
  - Underside brackets to secure robot to robot cart

Drivetrain Cont.

This year, we implemented an inverted “brain board” design for the electronics with a lexan plate underneath to shield debris. This helped keep our center of gravity low while leaving extra room on top of the drivetrain for upper assembly components.

- **Software**
  - Variable speeds set by driver during match: 30%, 75% (main), 100%
  - PID control for easy maneuverability and maximum control
  - Rotation: 360 degrees per second
  - Robot-centric mode set by driver for precision and testing purposes
  - Driver button to reset field-based gyro position
  - Automatic drive pit test for offsets, speeds, and general functionality

Undertaker/Intake



In iteration 1, we found that our intake was damaged easily. As a result, we switched to an under the bumper design on iteration 2 to protect the intake and allow for greater functional width.

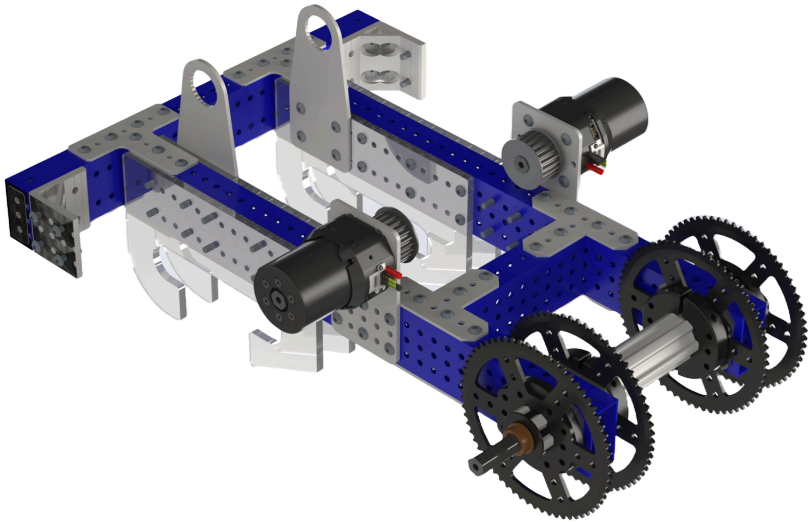
- **Hardware**
  - Two Neo Vortex motors with a custom gearbox 2.2:1 reduction
  - Three 1.25 in. diameter polycarb rollers with a silicone cover for increased grip
  - 3D-printed triangles guide notes on the carpet to the undertaker's center for passive note centering to hand-off to the shooter
  - 27 in. functional width
  - Integrated robot handles

Superstructure

The superstructure was designed for a higher arm pivot than Alpha to shorten the arm and obtain more optimal arm control. The motors and gearboxes were moved lower to maintain a low center of gravity. We also switched from a dead-axle arm pivot to live-axle using REV Spline to reduce the number of parts on the stack-up for improved maintainability.

- **Hardware**
    - Radio and RSL mounted on the Superstructure by 3D printed parts
    - Hard stops for top and bottom arm rotation at amp scoring and undertaker handoff positions
    - Live axle MaxSpline and integrated absolute encoder

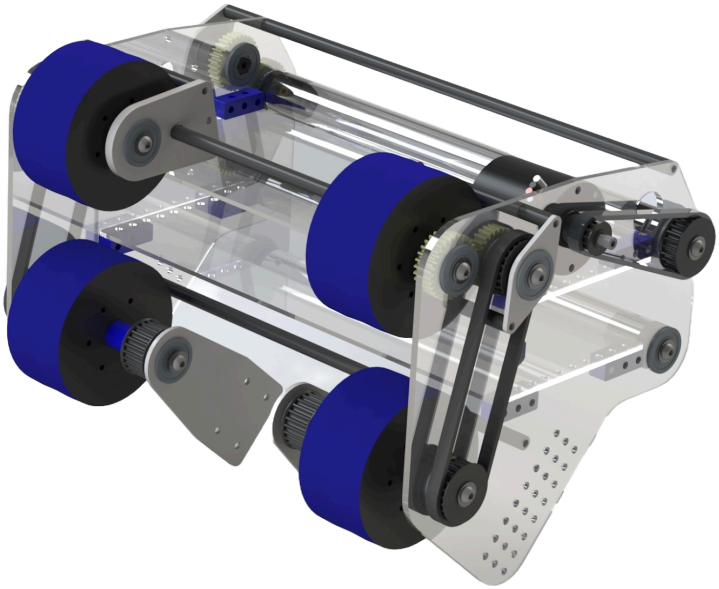
Arm



Our arm is capable of scoring in both the speaker and the amp while also acting as our climbing mechanism. With the shooter mounted on a pivot, our robot is able to score from multiple locations around the field.

- **Hardware**
  - 17.5 in. arm length for an easy handoff from the undertaker
  - 110° of rotation from undertaker handoff to amp scoring positions
  - Driven by two NEOs on a 60:1 MAXPlanetary gearbox reduction consisting of 5:1, 4:1, and 3:1 stages, with a 4:1 chain reduction for overall 240:1 arm pivot reduction
  - Shooter motors mounted low on arm to keep weight closer to pivot
- **Software**
  - PID control to keep arm from falling and maintain smooth motion
  - Arm rotation has a 108° range of motion with soft and hard limits
  - Preset angles for scoring from subwoofer, podium, and center line

Shooter/Feeder



Our shooter can score in the amp and speaker. In iteration 2, we implemented isolated control of the two sides to put spin on the notes for more consistent shots.

- **Hardware**
  - Feeder rollers grasp note from undertaker with 1/4 in. compression
  - Guiding plates transition from feeder roller to shooter wheels
  - 4 In. Diameter AndyMark Stealth Wheels
- **Software**
  - Feeder is equipped with a beam break sensor to detect a note
  - PID control keeps the shooter vortexes at a steady consistent rpm
  - Different speeds for specific locations across the field
  - Copilot button held to spin up wheels, released to feed and shoot game piece

Climber

Our robot climbs using hooks on the arm combined with passive “reaction bars.” When we climb, our spring-loaded reaction bars contact the stage and flip down as the arm lowers, keeping the robot level.

- **Hooks**
  - Four hooks on the arm made of 3/16 in. lexan
  - Climbing hooks have a 140 degree angle to easily climb onto the chain with the reaction bars
- **Reaction Bars**

  - Extend 8.15 in. from the frame perimeter when down
  - Pivot passively when in contact with the stage
  - Spring-loaded with surgical tubing to stay within the frame perimeter until we climb

Programming

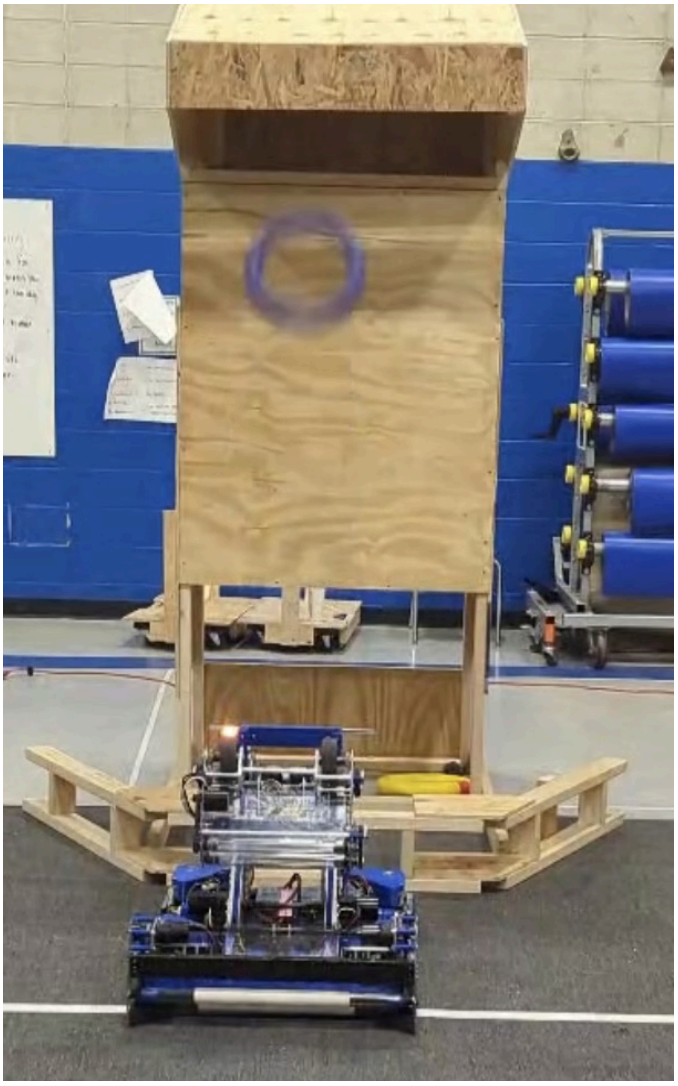
- **LED Signaling**
  - LED's are used to signal the drive team with the different functions of the robot. These can also be used to figure out problems in our command sequences.

Led color	Action
Green spinning	Intake spinning
Green flash	Grabbed game piece
Purple spinning	Shooter spinning
Purple flash	Shooter at speed
Red/Blue solid	Alliance color
Light blue flash	Arm to preset
Light blue solid	Arm at preset
Not in use (yet)	
Rainbow	Vision aligning
Orange solid	Moving to game piece (Auto)
Yellow solid	Moving to speaker (Auto)
Pink solid	At Speaker (Auto)

- **ChopShopLib**
  - We maintain our own software library, reusing common code from year to year. Our similar code includes things such as drivetrain, LEDs, recording and outputting data, specific commands, and a "map" abstraction layer to store hardware data.

Autonomous

We have developed advanced autonomous programs using PathPlanner with specific commands integrated into pathing sequences. We have a variety of auto programs to complement our alliance partners, capable of scoring up to 22 points.



Our Auto Programs:

4-Piece Wing: 22 points

Perfect for leading the alliance in auto, yielding a high point value from center subwoofer

2.5-Piece Centerline: 12 points

Wonderful for complementing a team which works primarily inside the wing

1-Piece Score + Leave: 7 points

Great for getting out of the way and letting other robots show their auto prowess