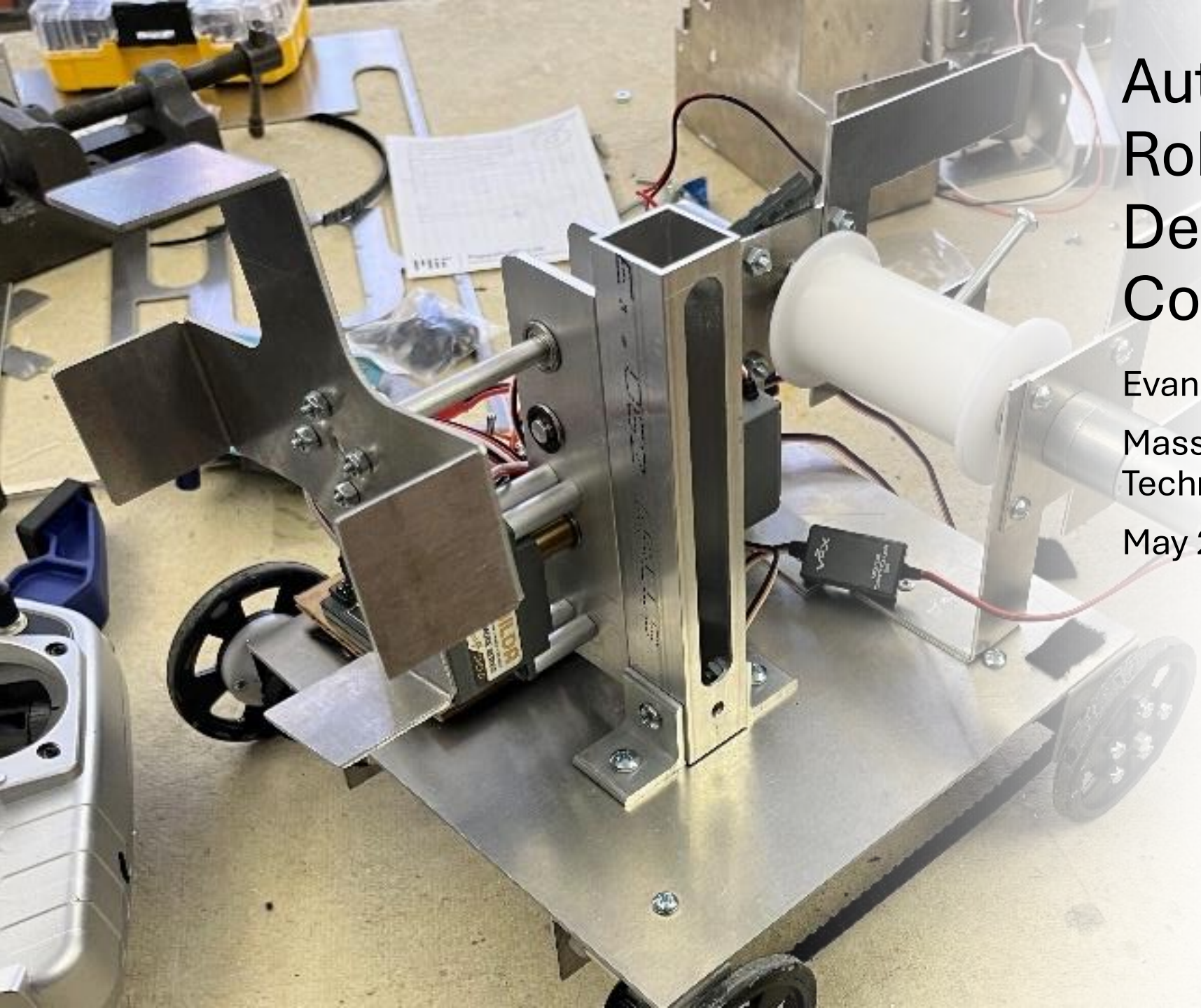

Autonomous Robotic Vehicle Design Competition

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Objective: Design, fabricate, and program an autonomous robot capable of scoring points by completing challenges on a game board in a 2-minute time limit, all in under 10 weeks.

My approach: Create a robot capable of spinning two centrifuges with varying mass moments of inertia at 150+ RPM and 200+ RPM respectively. Additionally, pull a tensioned rope out of a wall with 60N of force over 1m to earn a 2x multiplier to all points scored

The outcome: Placed 6^{th} out of 138 MIT undergraduate entrants

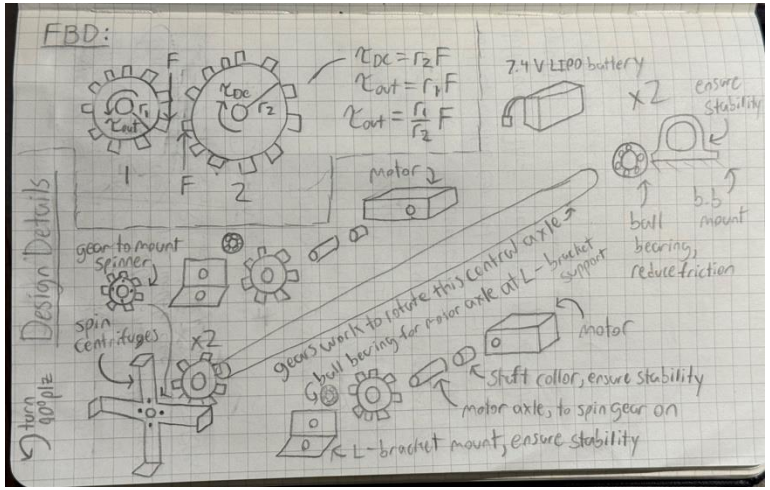
Relevant challenge components

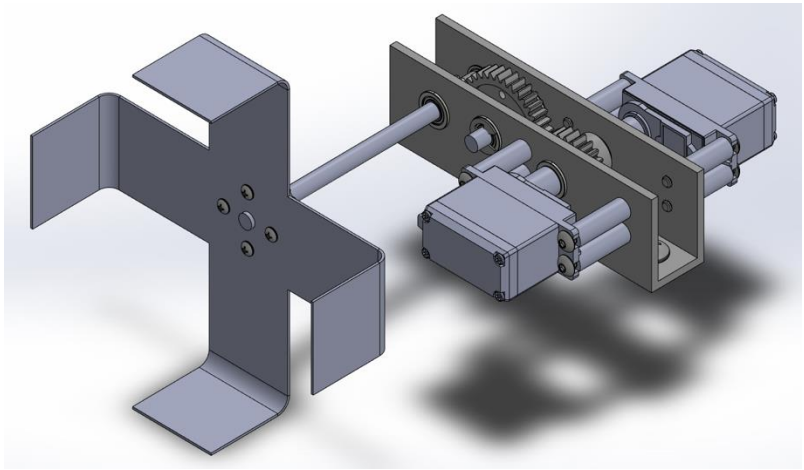
Game Board

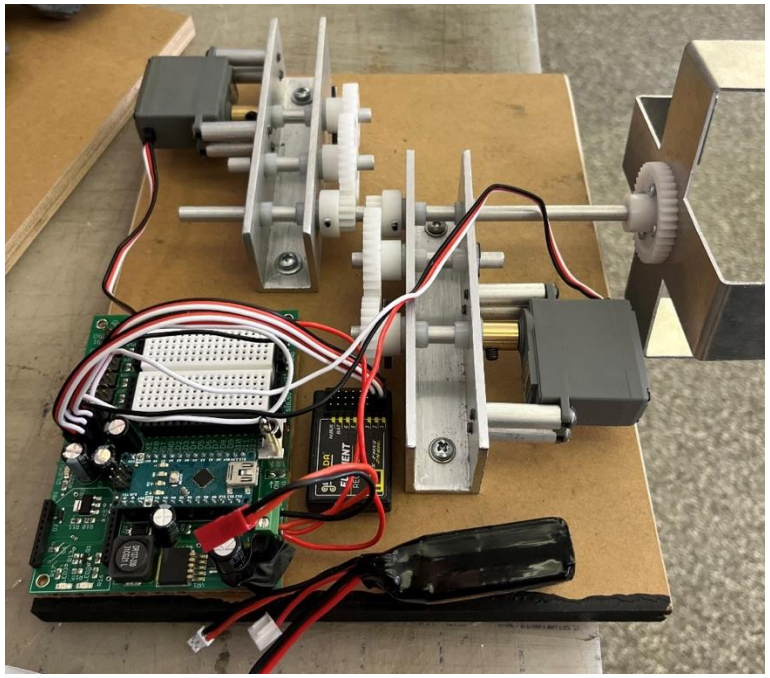
Centrifuges

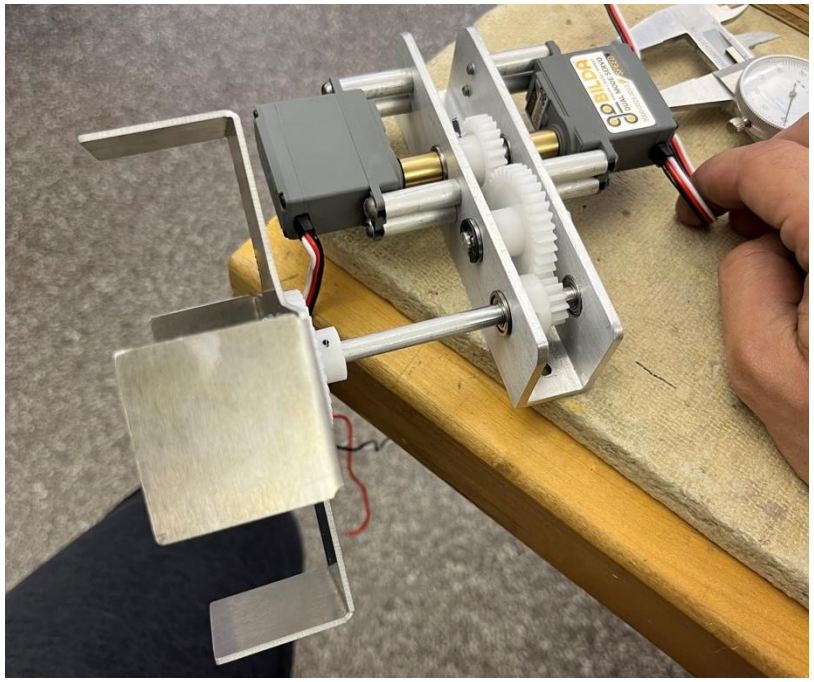
Modeling and prototyping

- **Used MATLAB to simulate** different variations of the possible ODEs governing **the interaction between the torque provided by the motor(s) and the torsional force** necessary to spin the wheels.
    - Informed me that I ought to use a 2:1 gear ratio using 2x GoBILDA 25-3 speed motors.
- My initial double gearbox prototype design (drawn at the top left, fabricated at the bottom left) failed because it created too much friction and too many over-constraint possibilities.
- **I simplified the design** to one in both right-side images, which achieved **the same torque-speed curve but featured fewer potential failure points** while also being simpler to fabricate!



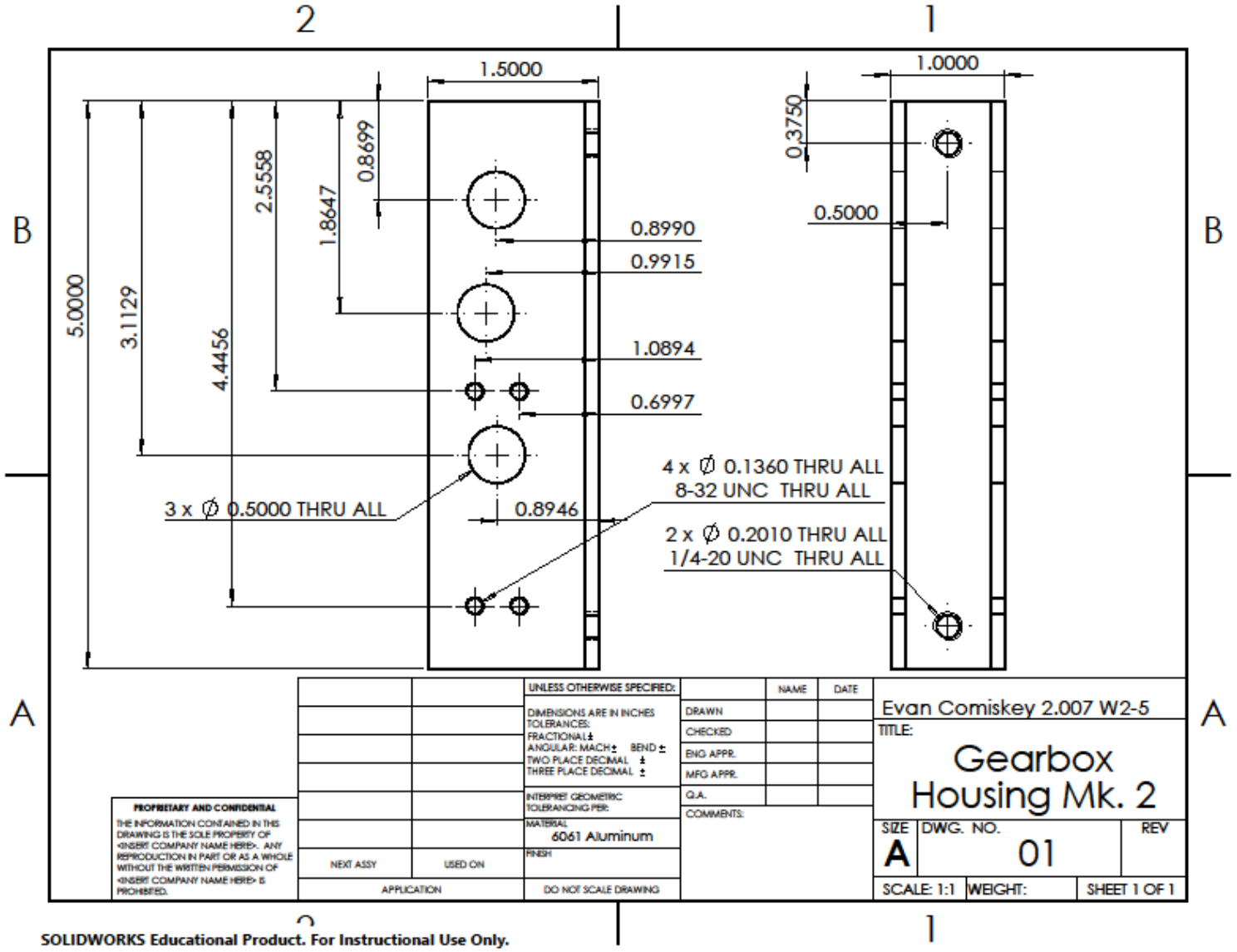






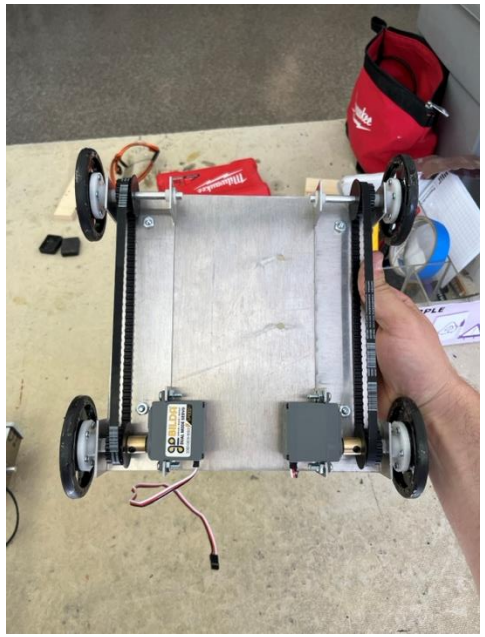
Fabricating

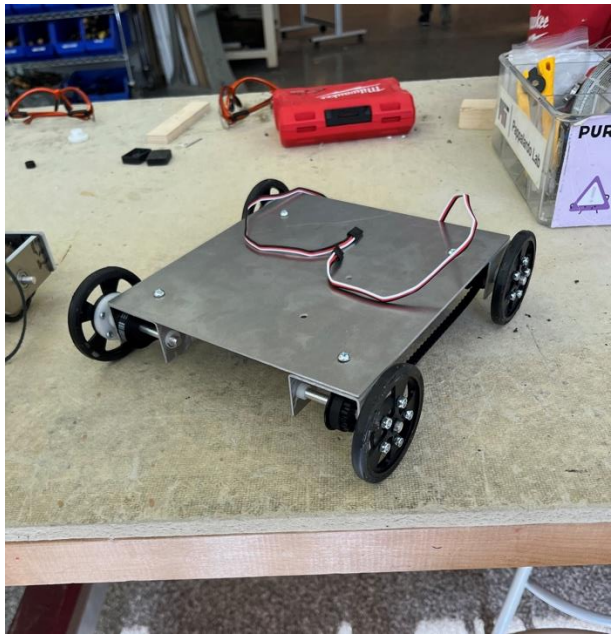
- Generated solid models and engineering drawings in SolidWorks of my custom parts which required me to use **CNC Milling to fabricate.**
- Minimized my datums to keep the machining process simple when working at the mill.
- Created reference drawing of the gearbox housing used to transfer the torque from the two motors used to the output shaft.
    - Explicitly did not include machining tolerances since the part was a one off for a custom design.

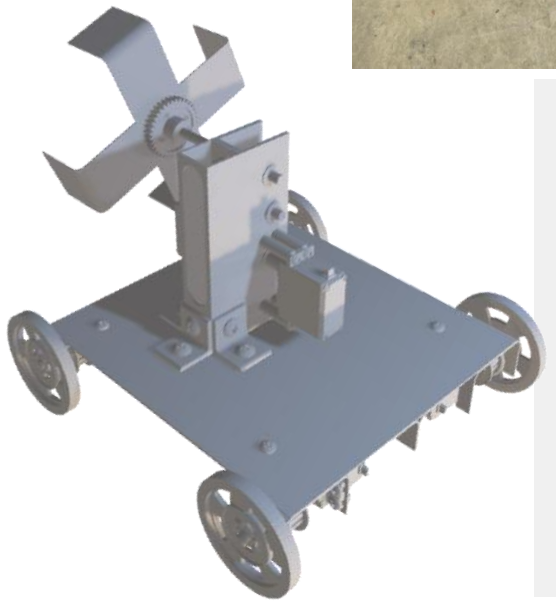


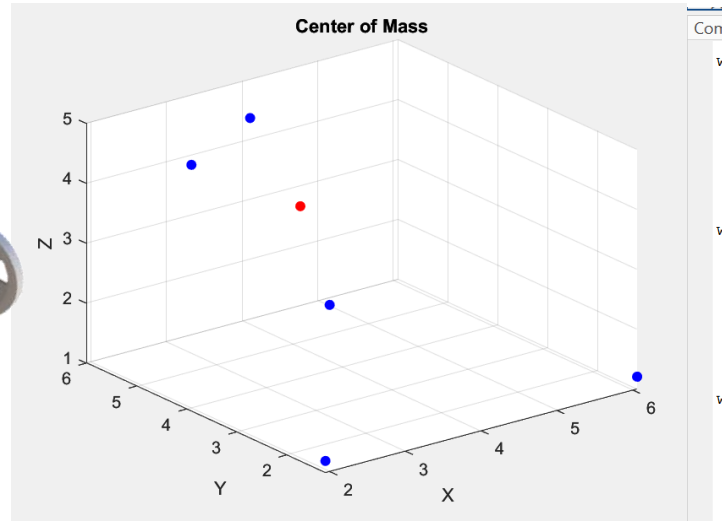
Drive-train development

- To earn points through spinning the centrifuges, my robot needed to be able to reach them by climbing 45-degree slope.
- Designed a gear pulley system to provide torque to both the front and back wheels to overcome competition's motor count limit.
- Verified my design wouldn't slip or tip during the climb by assigning appropriate density to various areas of the CAD model, then running no-tip and no-slip calculations in MATLAB using simulated centers of mass









Command Window

```
wont_tip =

  logical

   1


wont_tip_high_accel =

  logical

   1


wont_slip =

  logical

   1
```

The final product

- Finished with over a week to go before the final competition thanks to **careful planning** and **time management**
- Used extra time to fabricate a winch to pull a tensioned cable out of the wall for a score multiplier bonus by bracing the robot against the wall itself.
  - **Using the force of the wall allowed me to keep the robot light** (a point of emphasis in the competition)
  - Fabrication and manufacturing skills learned throughout the competition allowed me to develop this system in under a week, which I could not have possibly done in the beginning