2.007 - Robotic Vehicle Design Competition

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Project Overview

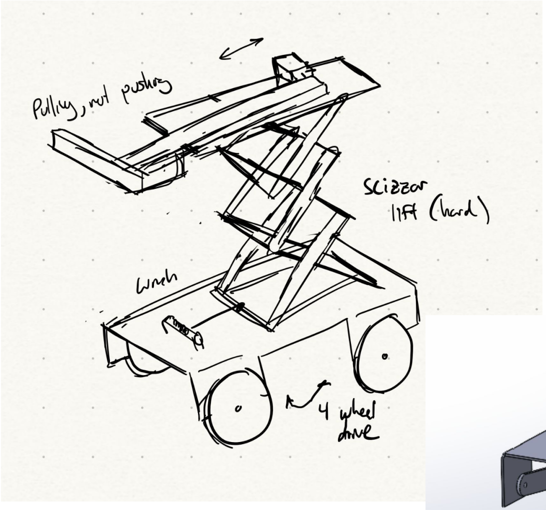
- **Problem:** Students are presented with a gameboard with a variety of ways to score points in an end-of-semester competition

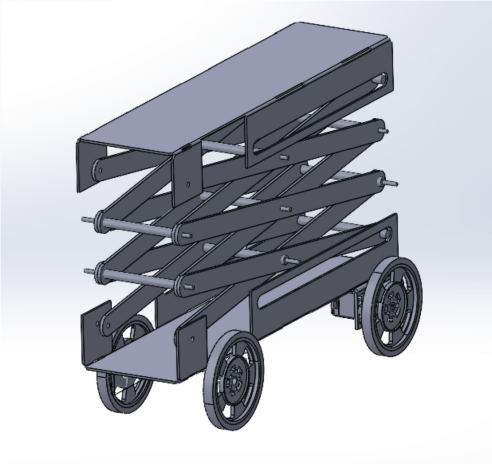
- **Objective:** Design, fabricate, and test a remote-controlled robot capable of scoring points by completing challenges on the game board in a 2-minute time limit, all in under 10 weeks

- **Outcome:** Successfully competed in the first round of competition and won a design award for innovative robot

Design and Analysis - Initial Concepts

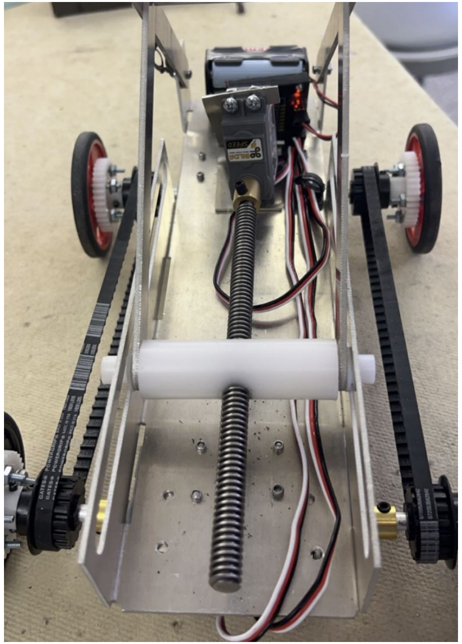
- The original design featured a winch mechanism to actuate a scissor lift for reaching tall heights
- I chose the scissor lift despite its accompanying complexity because I wanted a challenge during fabrication
- Also wanted 4WD to assist with steeper inclines on the gameboard



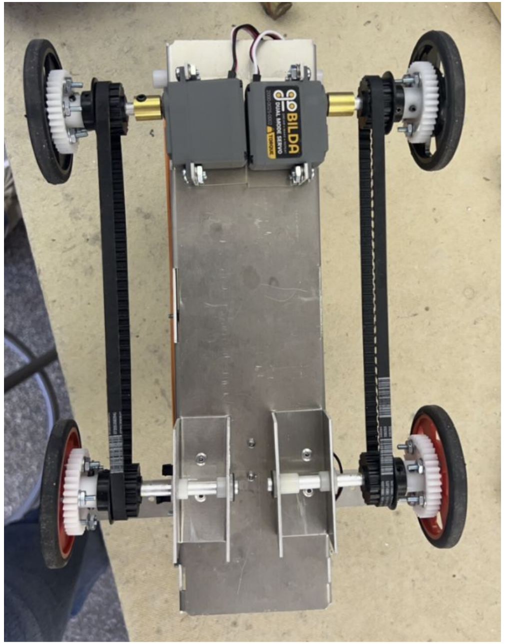


Design and Analysis - Key Features

1) Scissor Lift Mechanism



2) Lead Screw Actuation



3) 4WD Drivetrain

Design and Analysis - Key Features

1. **Scissor Lift Mechanism** was chosen for the ability to reach tall heights and the capacity to apply high vertical force near full extension. Rubber bands were used on the scissor lift to use stored elastic energy for actuation assistance.

2. **The Lead Screw Actuation** was chosen in place of a winch because of the high transmission ratio and horizontal force, which I learned was necessary for the scissor lift

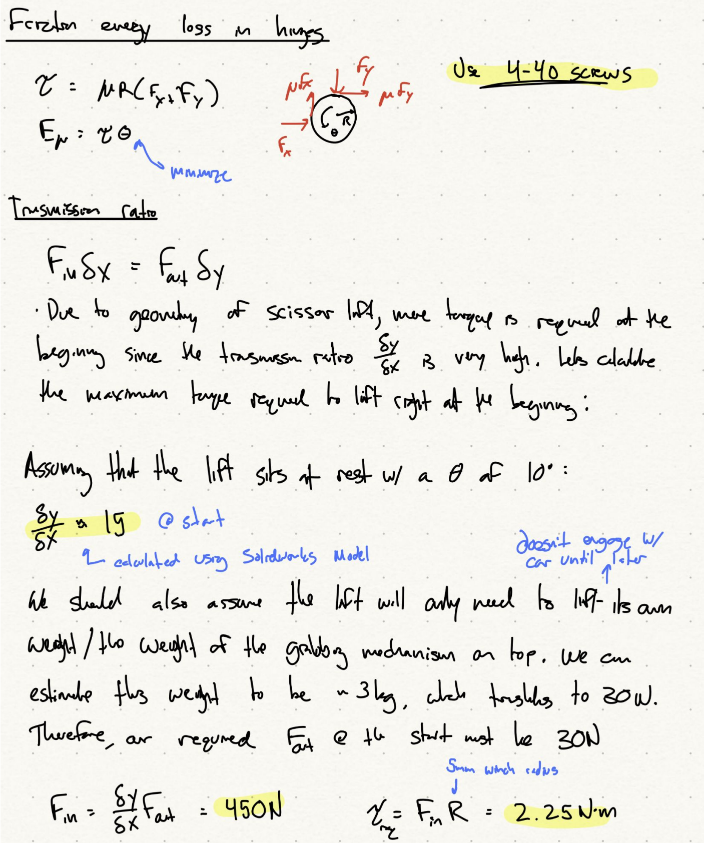
3. **4WD Drivetrain Assembly** took advantage of a gear pulley system to apply torque to both the front and back wheels; this feature helped the robot climb steep inclines without slipping or tipping

Design and Analysis - Accompanying Calculations

- Needed to minimize the radii of joints for scissor lift to minimize frictional energy losses

- Lead Screw Torque Input vs. Force Output
  - F = η*[τ*2π/l]
  - F = 0.6*[(0.37 N*m)*2π*0.00254m] =**548 N**

- Scissor Lift Virtual Work
  - F_in = 548 N
  - δx/ δy = 15 (at start)*
  - F_out = η*(δx/ δy)* F_in
  - F_out = 0.3*(1/15)*548 N = **15 N**



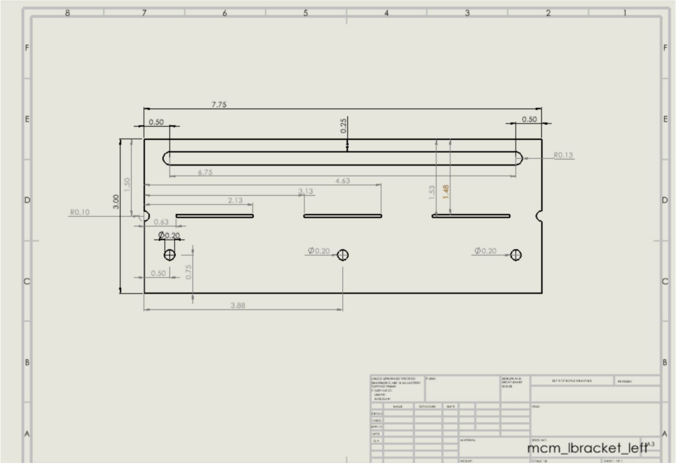
*transmission ratio for scissor lift was determined via SolidWorks simulation

Fabrication and Prototyping

- Several sheet metal parts had to be fabricated, including the scissor lift links, bases, and servo mounts. I used water jetting and sheet metal bending techniques.

- I initially prototyped and tested the scissor lift on a mount to test effectiveness and performance.

- Prototyping and testing showed me that I needed to use lead screw actuation with a lower torque motor to increase speed.



Final Design and Outcome

- The final machine, Bevo, was a fully integrated robot with a scissor lift, a four-wheel drive system, and last-minute "horns" for lifting.

- The scissor lift worked reliably and as expected, successfully reaching a height of over three feet. The four-wheel drive allowed the robot to easily climb inclines. The "horns," a last-minute addition, allowed the robot to successfully lift the car doors and the car multiplier.

- This project highlighted the importance of being adaptable and avoiding a "sunk-cost fallacy". The initial winch design had to be scrapped and replaced with a lead screw mechanism.

Final Design and Outcome