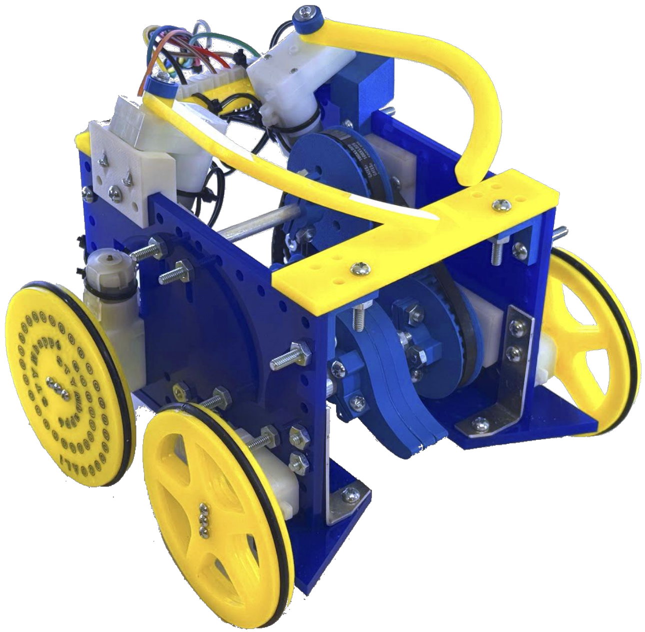
# Team 25 - STYMBappé

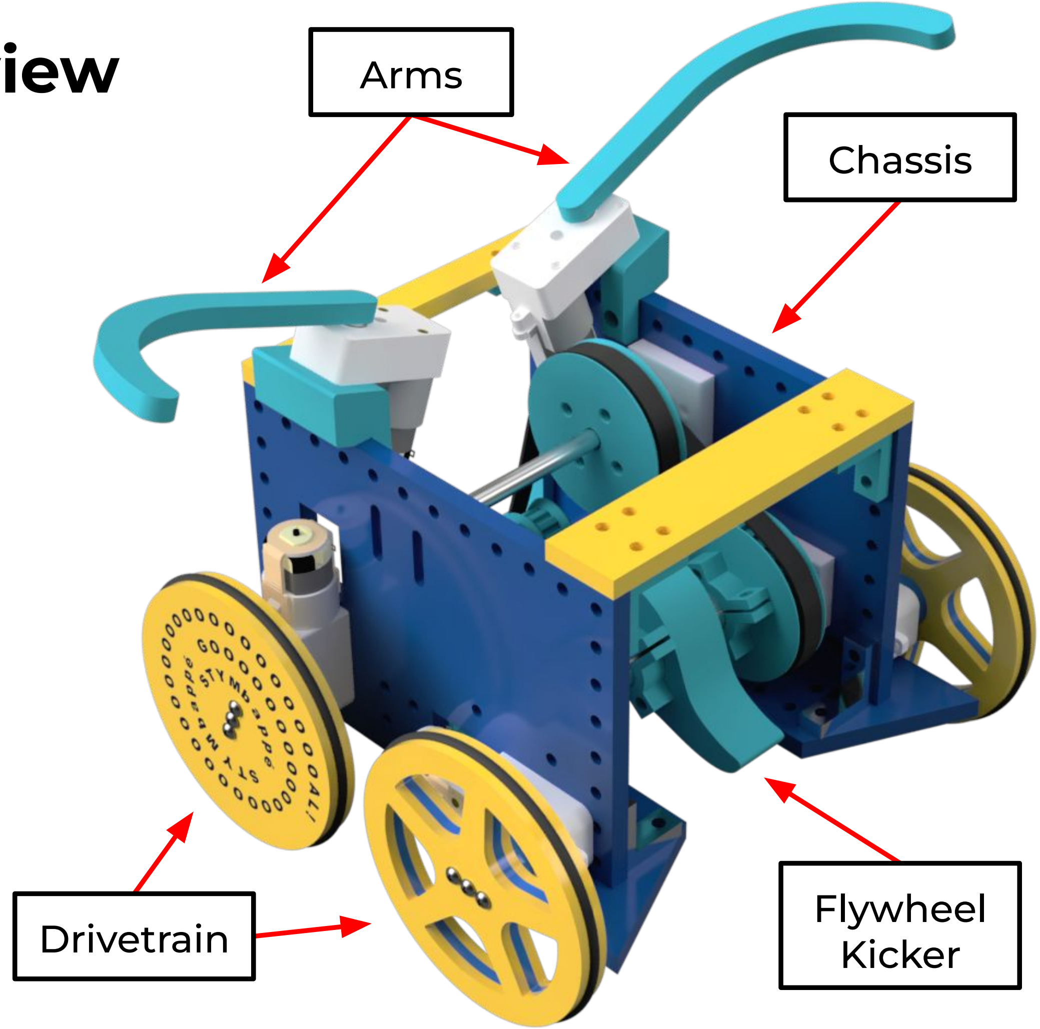


**S**herwin, **T**aylor, **Y**ahya, **M**iles

# STYMBappé Overview

## Requirements

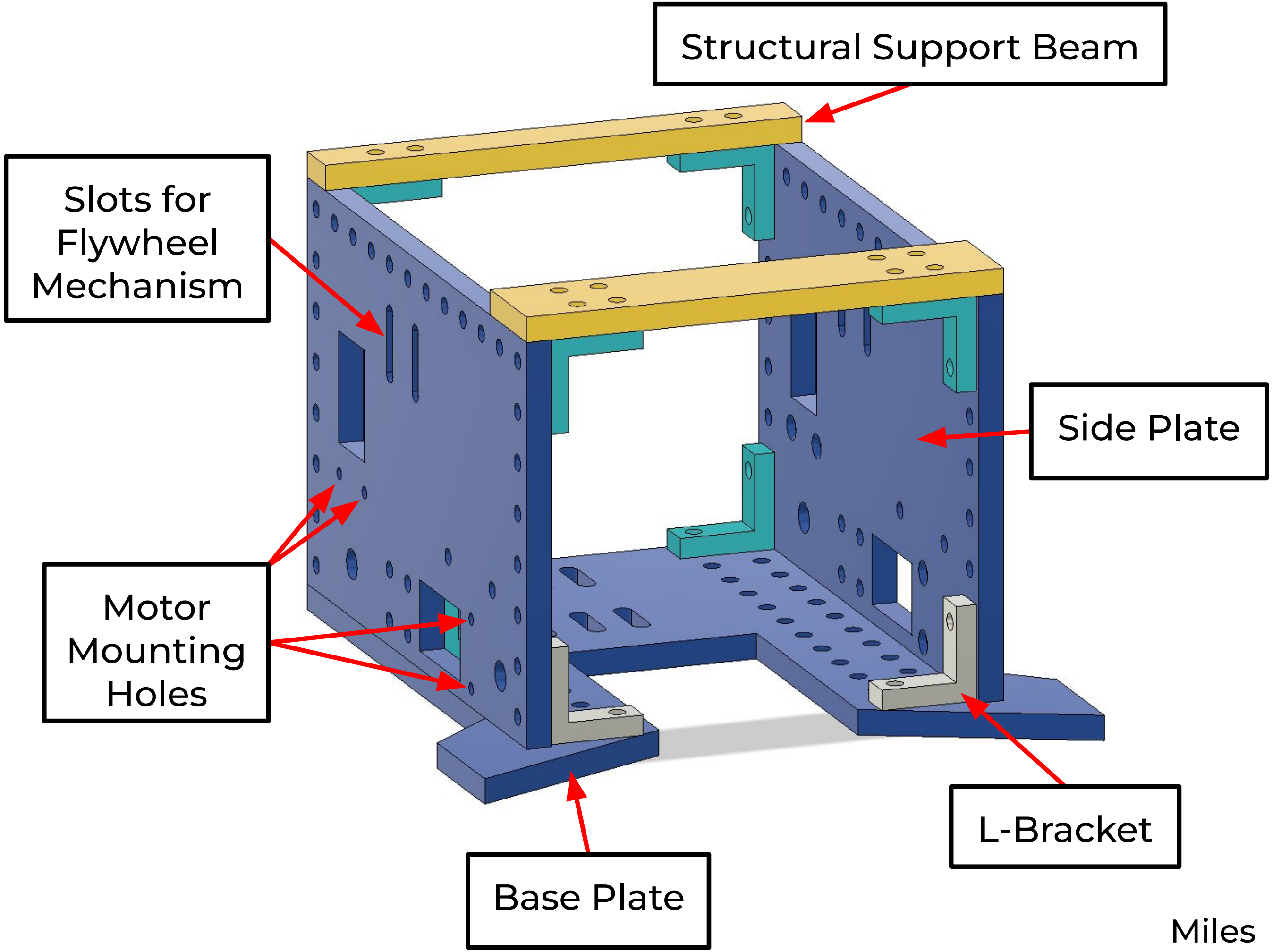
- Quickly traverse the field
- Knock down boundary balls onto the field
- Kick balls accurately and consistently into goal
- Maintain defensible position on field



# Chassis

## Requirements

- Hold components
- Allow for component position adjustment

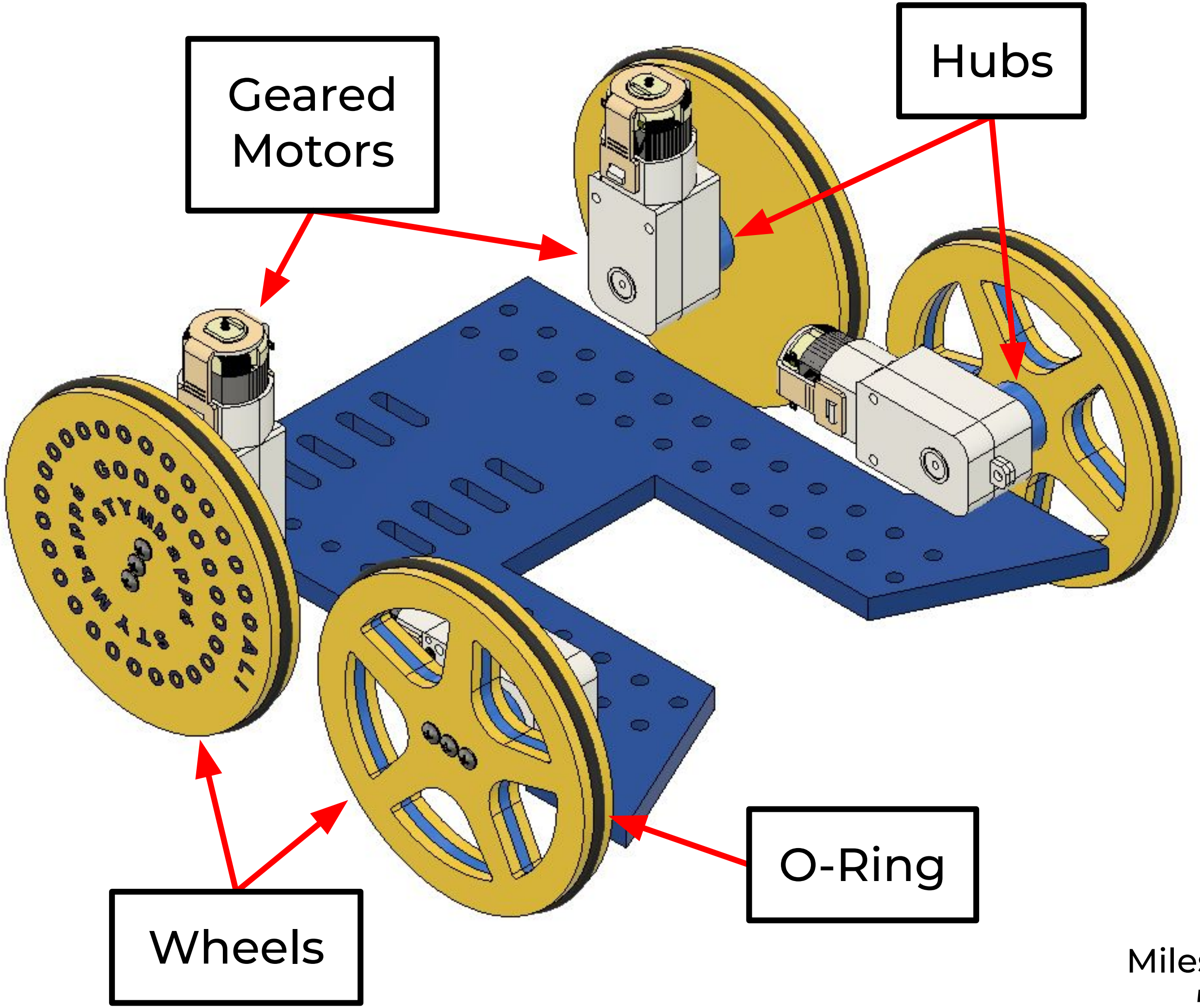



Miles

# Drivetrain

## Requirements

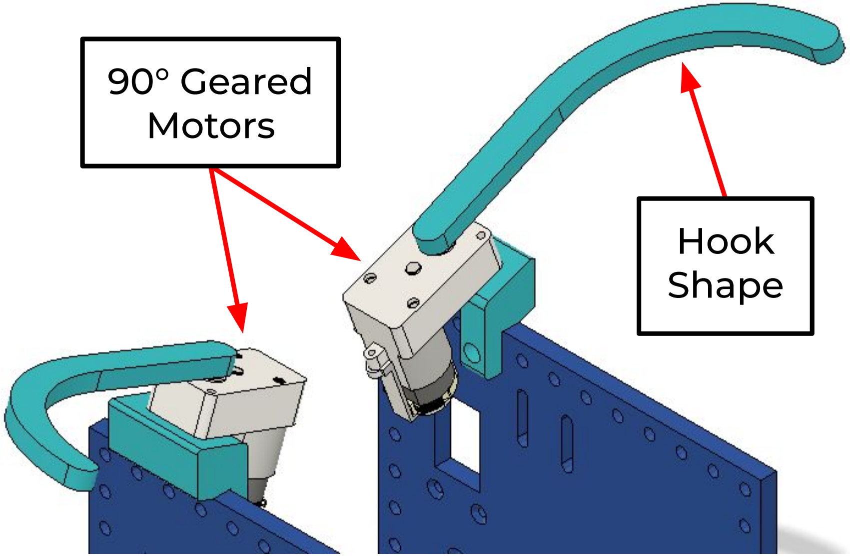
- Quickly traverse the field
- Minimize complexity

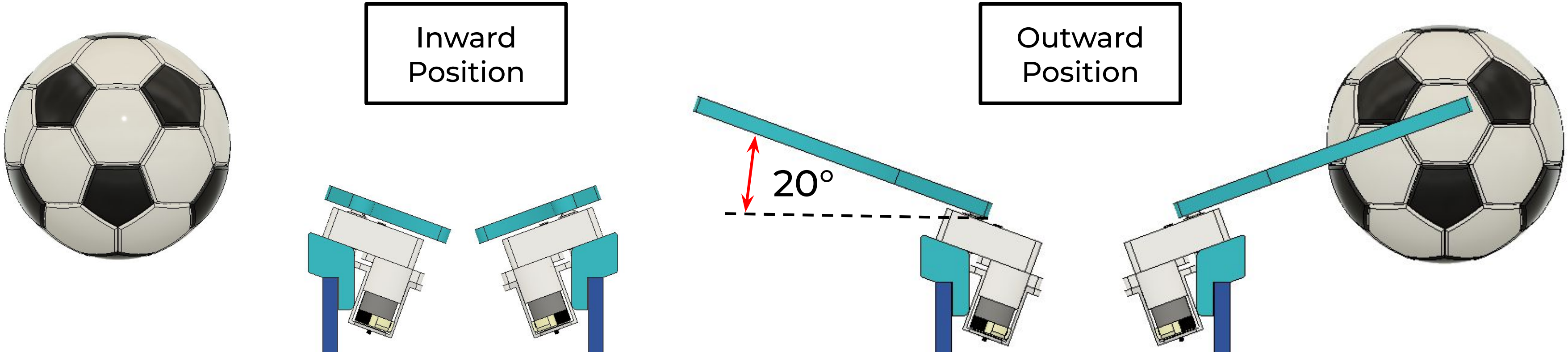


# Arms

## Requirements

- Knock balls down into the playing field
- Reach above field boundary railing in outward position

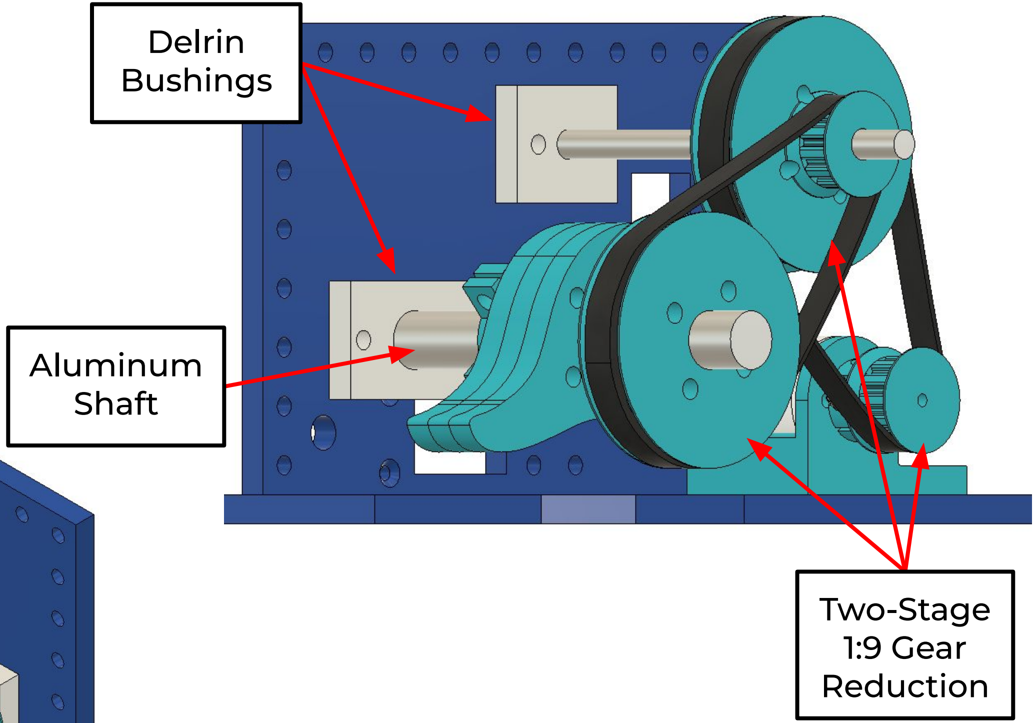


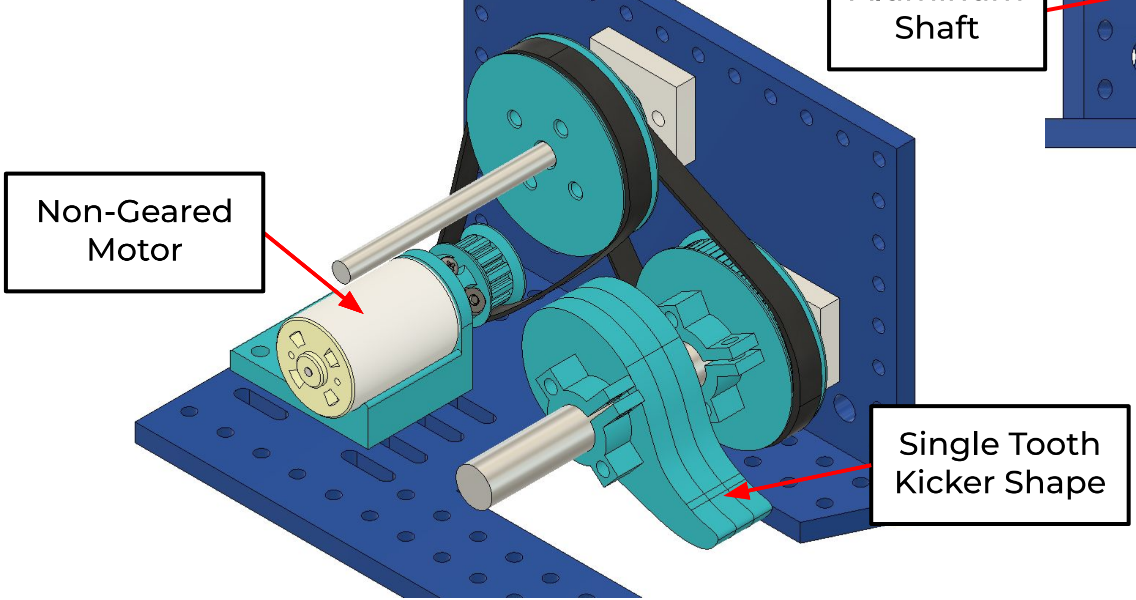



# Flywheel

## Requirements

- Kick soccer balls across the field
  - 45° angle launch
- Reliable kicks



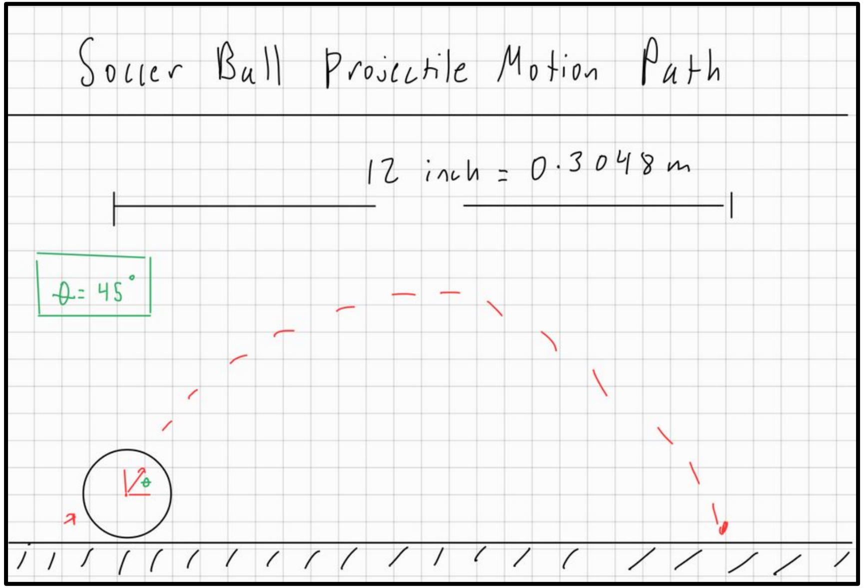

Yahya

# Analysis: Objective and Assumptions

**Objective**: Provide enough energy through the flywheel to launch the ball with a **12-inch** displacement

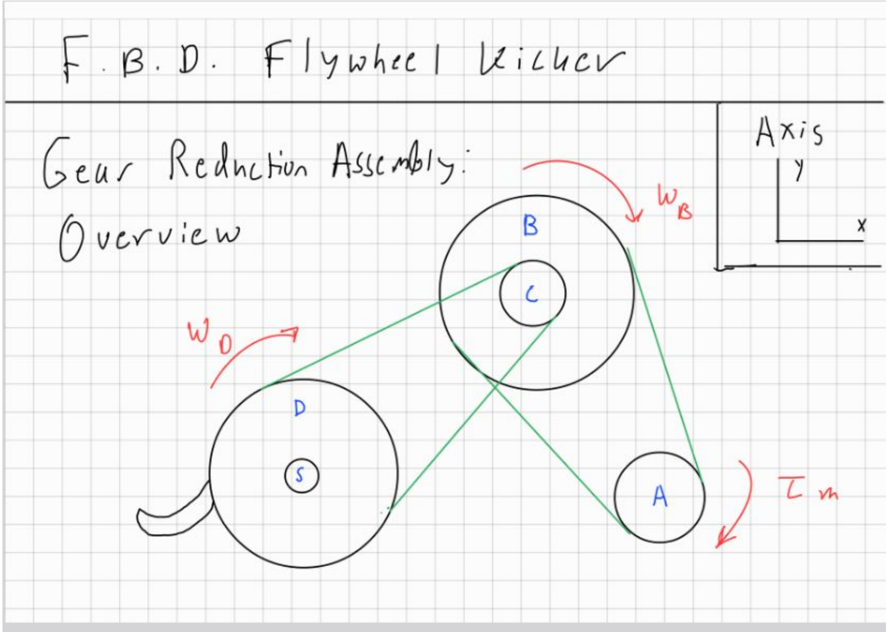
**Assumptions**:

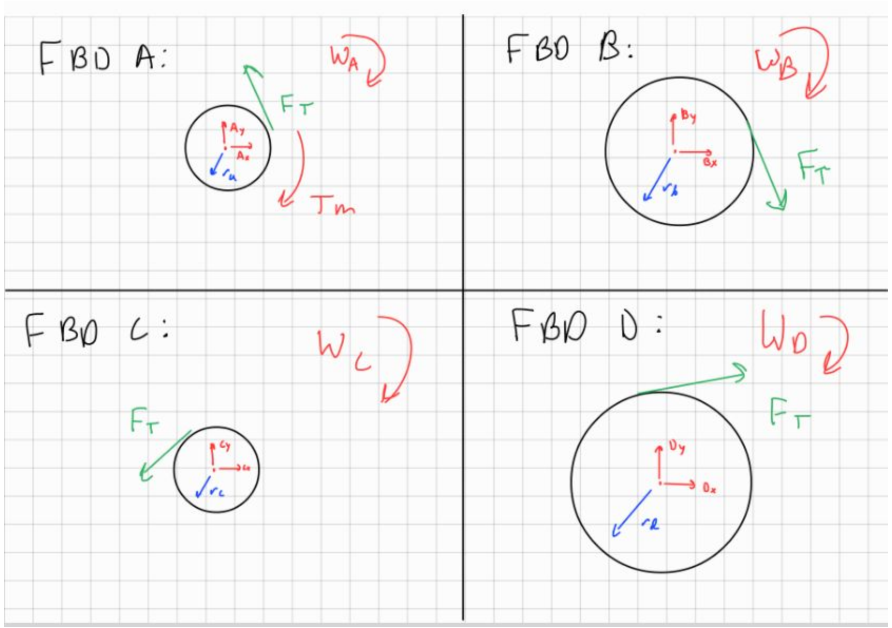
- 1:1 transfer of kinetic energy between the flywheel kicker and the ball
- 45 degree launch angle for ball
- Air resistance and friction are negligible
- Mass of the pulleys can are negligible
- The ball launches and lands at the same height



# Analysis: Free Body Diagrams

- Angular speed ω decreases with the gear reduction from motor to flywheel



# Analysis: Numerical Results

$$R = \frac{V_{ball}^2 \sin 2\theta}{g}$$

$$V_{Ball\ Needed} = \sqrt{\frac{R * g}{\sin 2\theta}}$$

$$V_{Ball\ Needed} = \sqrt{\frac{0.3048\ m * 9.81\ m/s^2}{\sin(2 * 45°)}}$$

$$V_{Ball\ Needed} = 1.729\ m/s$$

$$KE_{Ball\ Needed} = \frac{1}{2} m V_{ball}{}^2$$

$$KE_{Ball\ Needed} = \frac{1}{2}(0.046\ kg)(1.729\frac{m}{s^2})$$

$$KE_{Ball\ Needed} = 0.0397\ J$$

$$KE_{Ball} = KE_{Flywheel\ Kicker}$$

$$KE_{Flywheel\ Kicker\ Needed} = 0.0397\ J$$

$$KE_{Flywheel\ Kicker\ Needed} = \frac{1}{2} I w^2$$

$$W_{Flywheel\ Kicker\ Needed} = \sqrt{\frac{2KE_{Spinner}}{I}}$$

$$W_{Flywheel\ Kicker\ Needed} = \sqrt{\frac{2 \times 0.0397\ J}{0.00002977\ kg \times m^2}}$$

$$W_{Flywheel\ Kicker} = 51.64\ rad/s$$

$$T_{Kicker} = I\alpha$$

$$T = 0.00002536\ kg * m^2 \times \frac{51.64}{2.5}$$

$$T = 0.000523\ N \cdot m$$

# Analysis: Experimental Results & Factor of Safety

Experimental Calculations:

$$R = \frac{V_{ball}^2 \sin 2\theta}{g}$$

$$V_{ball} = \sqrt{\frac{R * g}{\sin 2\theta}}$$

$$V_{ball} = \sqrt{\frac{0.4191\, m * 9.81\, m/s^2}{\sin(2 * 45°)}}$$

$$V_{ball} = 2.027\, m/s$$

$$KE_{Ball} = \frac{1}{2} m V_{ball}{}^2$$

$$KE_{Ball} = \frac{1}{2}(0.046\, kg)(2.027 \frac{m}{s^2})$$

$$KE_{Ball} = 0.0466\, J$$

$$KE_{Ball} = KE_{Flywheel\ Kicker}$$

$$KE_{Flywheel\ Kicker} = 0.0466\, J$$

$$KE_{Flywheel\ Kicker} = \frac{1}{2} I w^2$$

$$W_{Flywheel\ Kicker} = \sqrt{\frac{2KE_{Spinner}}{I}}$$

$$W_{Flywheel\ Kicker} = \sqrt{\frac{2 \times 0.0466\, J}{0.00002977\, kg \times m^2}}$$

$$W_{Flywheel\ Kicker} = 55.95\, rad/s$$

$$T_{Kicker} = I\alpha$$

$$T = 0.00002536\, kg * m^2 \times \frac{55.95}{2.5}$$

$$T = 0.000567\, N \cdot m$$

$$Factor\ of\ Safety\ (Kinetic\ Energy) = \frac{0.066\, J}{0.0397\, J} = 1.66$$

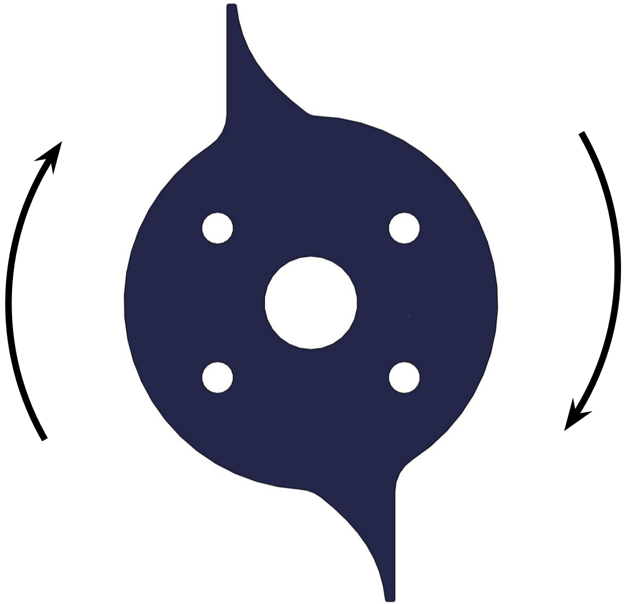
$$Factor\ of\ Safety\ (Torque) = \frac{0.000567\, J}{0.000523\, J} = 1.08$$

Taylor

# Flywheel Risk Reduction

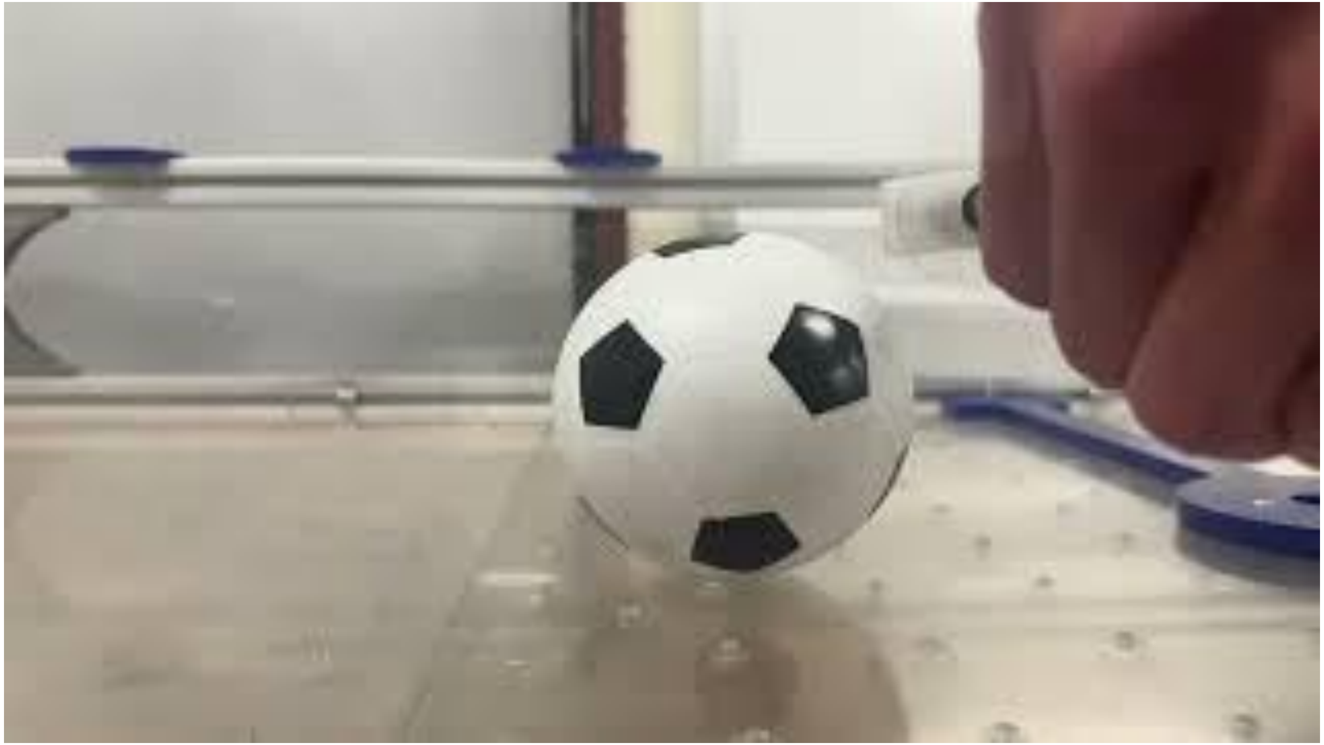
- Flywheel is highest risk component

- Prioritized rapid prototyping
    - Find out potential problems ASAP
    - Didn’t worry about making the first version optimal



**V1 Flywheel**

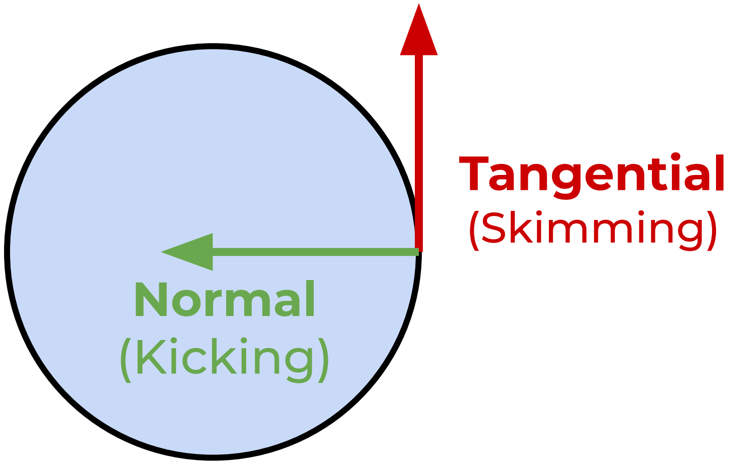
# Flywheel Risk Reduction

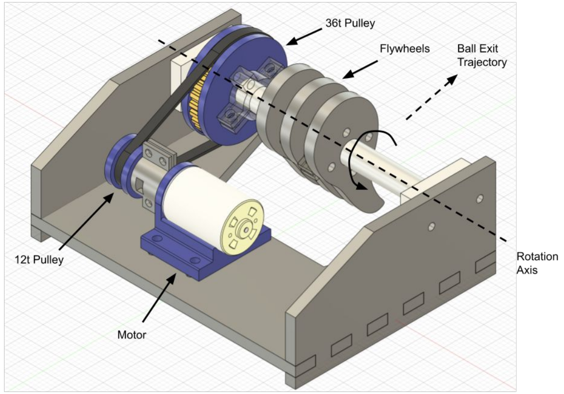


# Flywheel Risk Reduction

- Skimming vs. Kicking
  - Problem revealed through slow motion video

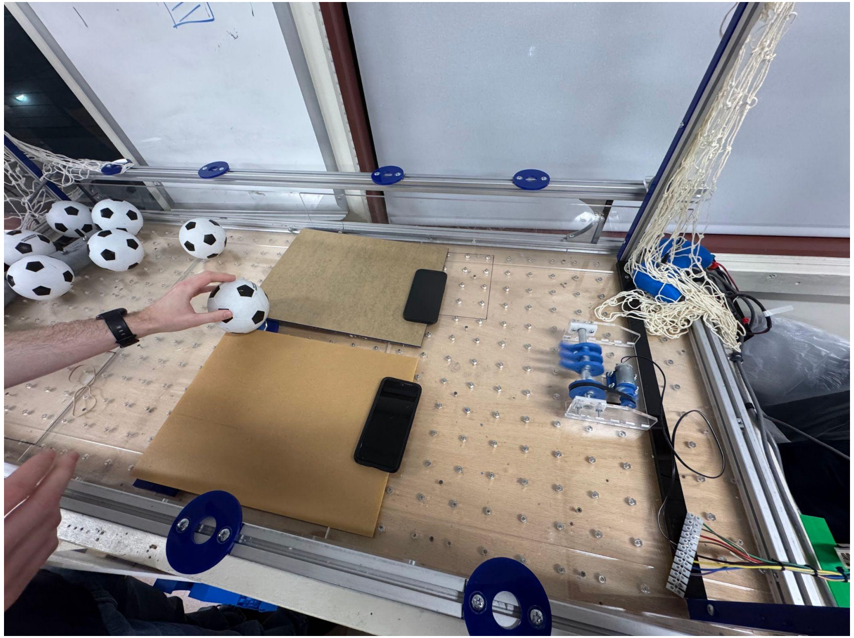
- Minimize tangential, maximize normal
  1. Lower flywheel RPM
  2. Single tooth flywheel
  3. Maximize ball velocity towards flywheel




**V2 Flywheel**

# Flywheel Risk Reduction



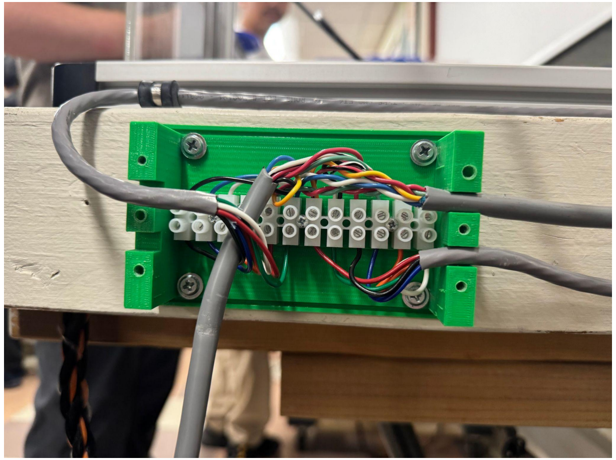
Ramp Setup

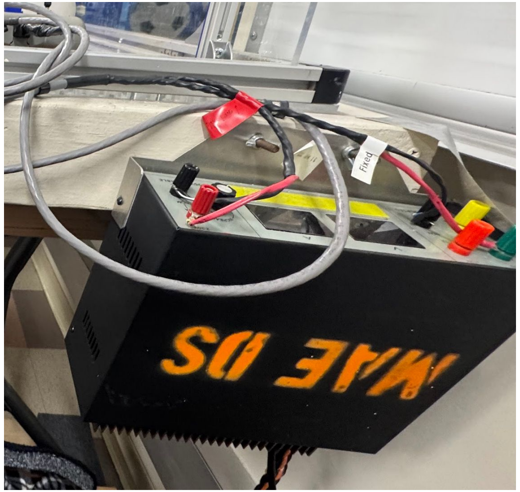
Kickstart Issue

# Flywheel Risk Reduction

- Motor couldn't start itself
  - Suspected faulty motor
  - We began planning to make a motor kickstart mechanism

- Problem cause found
  - High speed motor connected to 2A variable supply, not 3A fixed supply
  - Massive relief



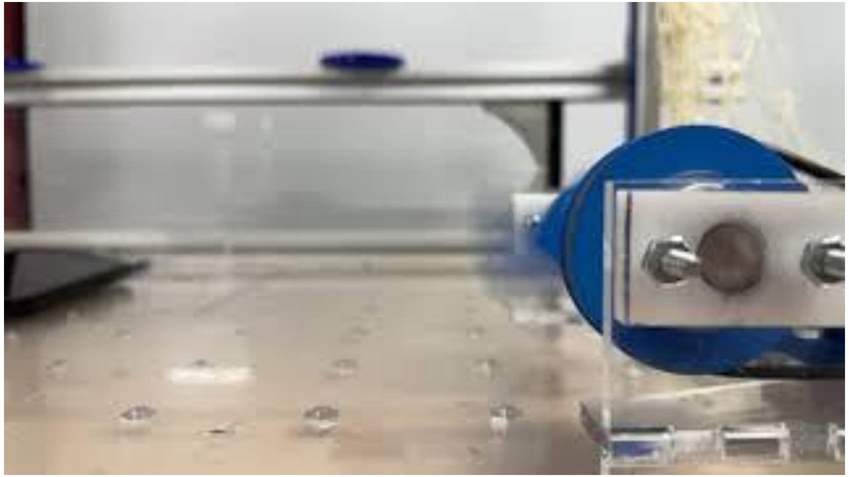


Sherwin

# Risk Reduction Conclusion

**Design Takeaways**

1. Slower flywheel reduces skimming
2. Flywheel shape should allow ball to seat
3. 3A supply necessary for high speed motor
4. Robot must drive towards ball fast to avoid skimming



Sherwin

# Summary

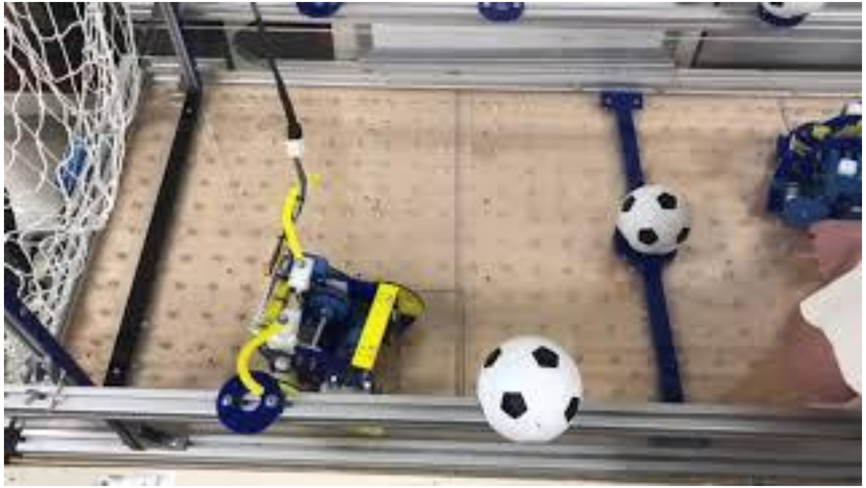
Score without an opponent: 900

Flywheel Kicker

- Rapid iteration & risk reduction

Future Improvements

- Flywheel Optimization



# Robot Solo Run

(this video was recorded after we presented)

# Thank you for listening

Any questions?