The primary task for this project is to design and build a small vehicle, converted from gas to an electric-powered motor. To determine the viability of gas to electric vehicle conversions on small vehicles, the team pursued a minimalist design to simplify comparisons of our results to the gas version. The electric drive design consists of a single BDC motor, BDC motor controller, and sealed lead-acid battery pack. The end goals of this project are to design a vehicle with safety and performance features that meet or exceed those of the original, and to quantitatively and qualitatively determine the effectiveness of the gas to electric conversion.

### Specifications
- **Battery Pack**: 36V (3 x 12V), 110 amp hour, 1650A max discharge.
- **BDC Motor**: 10.75 HP, 48V @ 3600 RPM.
- **Motor Controller**: Single channel, 300A output, PWM operation.

### Modeling and Simulation
To best approximate the performance outcomes of the vehicle we created a model of vehicle using Simulink. This model is created using equivalent circuit parameters of the BDC drive motor and includes blocks for specifying gear ratio, wheel size, and vehicle mass. Using this model, we can run simulations based on different road parameters such as grade and traction conditions to yield performance information, including speed of the vehicle, motor RPM, and power consumption.

The Simulink model emulates the PWM operation of the actual motor controller used. The motor equivalent circuit was modeled using equivalent series impedances due to measurement restrictions. The model also simulates for vehicle weight (700 lb.), road grade (2%), and traction conditions (dry).

### Fault Tree Analysis
Fault analysis allows for examination of possible component failures. Two major fault cases were developed to guide the design process with safety as a prime goal: Control Failure, and Power Failure. These trees illustrate the initial assumptions of major system failures that may affect safe operation of the cart.

### Design Goals
- Integration of power safety features.
- Minimum run time of 20 minutes or minimum drive range of 2 miles.
- Top speed of 40 MPH
- Determine minimum distances for turning and braking.

### Project Outcomes
- Power safety features implemented:
  - 200A automatic circuit breaker
  - Manual break switch
  - Software current limits in motor controller
- 30 minute run time and 2 mile minimum range met.
- Acceleration is currently limited at low RPM.
- Current design achieves 90% of top speed goal

### Future Work
- Integration of control system with UI.
- Modify current gearing to enhance low RPM acceleration (currently 3.75:1).
- Modify battery pack to provide rated motor voltage of 48 V.
- Align steering to minimize turn radius.
- Upgrade braking system to reduce minimum distance.

### Broader Impacts
- Gas to electric vehicle conversions could further expand demand for electric vehicle battery packs.
- Emissions due to gas powered engines would be reduced by gas to electric conversions.
- With further refinement of a conversion process and vehicle load assessments, currently gas powered vehicles could more easily be converted to electric drives.

### Glossary
- **BDC**: Brushed direct current
- **RPM**: Revolutions per minute
- **PWM**: Pulse-width modulation

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**Team Dyneema**