Shell Eco-Marathon (BE)

Mechanical and Aerospace Engineering
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Abstract

We designed and tested a high-efficiency electric vehicle for the Shell Eco-Marathon at the Indianapolis Motor Speedway, held from April 2-6. The goal was to maximize energy efficiency within the framework of real-world vehicle standards. After passing rigorous inspections, teams competed to achieve the most efficient lap, with scoring based on electricity consumed. This competition provided an opportunity to tackle engineering challenges related to energy sustainability and vehicle design, all while prioritizing driver safety.

Customer Needs and Requirements

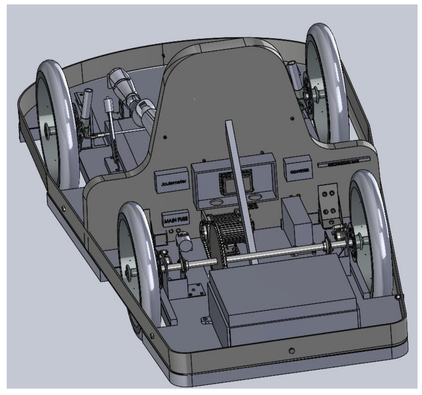
- **Meet all Shell Eco-marathon requirements**
  - Adhere to competition regulations for safety, design, and documentation
  - Prepare all required materials and pass pre-race checks
- **Ensure safe vehicle design and construction**
  - Incorporate proper driver restraints, visibility, and fire protection
  - Follow industry-standard practices for fabrication and system integration
- **Guarantee safe assembly of components**
  - Securely mount all electrical and mechanical systems
  - Validate system function and minimize hazards
- **Pass Shell's technical inspection**
  - Satisfy all inspection criteria before race day
  - Resolve any safety, control, or design deficiencies

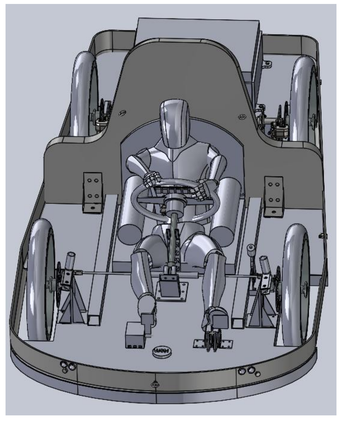
Concept Selection

Final components were selected using decision matrices based on Shell regulations, efficiency, weight, reliability, and manufacturability.

- **Motor & Controller:** High-efficiency BLDC motor with regenerative braking and custom-coded controller optimized for Shell requirements.
- **Battery**: 48V Li-ion pack selected for energy density, safety features, and compliance with voltage and discharge limits.
- **Drivetrain**: ANSI 40 chain with optimized 7.2:1 gear ratio for torque and energy efficiency.
- **Chassis & Base:** Foam and fiberglass composite chosen for high strength-to-weight ratio and ease of manufacturing.
- **Brakes & Steering**: Four-wheel hydraulic disc brakes and rack-and-pinion steering selected for safety, simplicity, and precision.

Design Solution



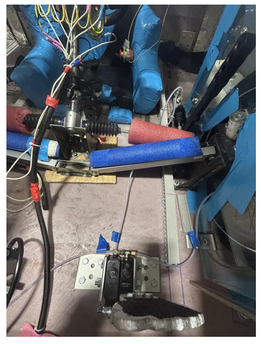


Manufacturing

Composites

- Fiber glass was used in the mold for the top
- The bottom was a wet lay over foam

Control Systems



- The steering systems and brake system has been overhauled this year, both passing tech

Motor Controller

- Adapted from the Duke easy controller
- Passed tech

- Final vehicle that went to competition
- Passed Technical Inspection

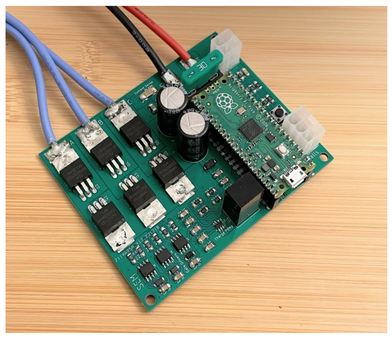
Testing and Validation

Test 1: Composites

- The base was tested up to 320lbs with 1.5 cm deflection
- The bulk head was tested up to 300lbs with no defection

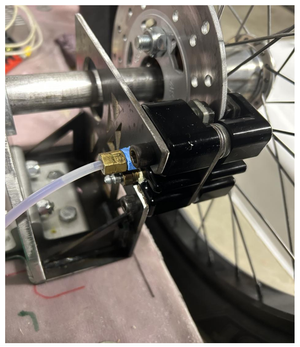
Test 2: Motor Controller

- The motor controller was a modified design from the Duke motor controller
- The controller worked enough to move the wheels to pass technical inspection



Test 3: Braking

- Braking was tested on a wedge of 20 percent, both dynamically and statically
- Breaking passed with minimum movement



Test 4: Steering

- The steering was tested in the same way it would be at competition
- Maximum of 6m radius arc, steering passed at 2.5 meters

Acknowledgments

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