College of Engineering
Department of Mechanical & Industrial Engineering

College of Engineering
School of Electrical Engineering & Computer Science

To Predict ▶ To Design ▶ To Perform

ME, ECE Capstone Design Programs

Team #33: 2019 Shell Eco-Marathon

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Objectives

- Compete in Shell Eco-Marathon using 2018 LSU SEM vehicle frame and body to triple previous mpg of 101
- Create an energy consumption model to develop an optimal driving strategy
- Use results of vehicle testing plan to modify tuning of Ecotrons ECU
- Improve areas of previous year's vehicle, specifically the starter, performance modeling and ECU tuning.

Safety Considerations

- Driver fully isolated from drivetrain components and road surface
- Critical electrical components run through fuse box
- Roll hoop must withstand 157.3 lb loading
- 3 emergency shut-off switches located on vehicle

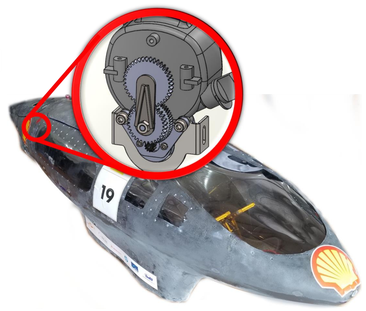
Engineering Requirements

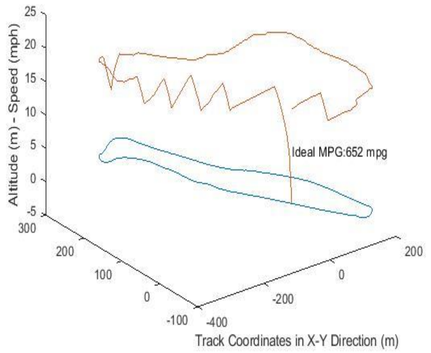
- Use 2017/2018 Frame and Body
- Fuel must be provided by Shell
- Must use Electronic Fuel Injection
- Clutch to be used to disengage engine from drivetrain at idle state
- Performance of engine analyzed using Ecotrons ECU
- Dynamic analysis of frame performed with ANSYS FEA simulation
- Dynamic analysis of car body and windshield performed using Solidworks Simulation

Embodiment

Redesigned starter assembly manufactured to allow on/off cycles needed for optimized driving strategy from performance model.

Gear train manufactured using 6061 T6 Aluminum, utilizing a one-way bearing design to isolate starter from engine while running.



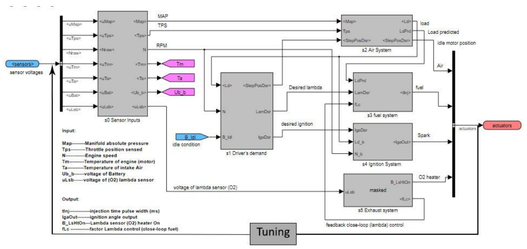


Performance model program takes inputs of the track/conditions, car specs and coastdown test results to output a velocity behavior utilizing the acceleration-coast driving strategy, resulting in the best mpg possible.

$$P_{mechanical\ energy} = P_{resistances} + P_{gravity} + P_{acceleration}$$
$$F_{resistances} = C_0 + C_1 V + C_2 V^2$$
$$\dot{m} = f \times \frac{RPM}{120}$$

$P = power$
$V = instantaneous\ velocity$
$\dot{m} = mass\ fuel\ flow\ rate$
$f = mass\ per\ combustion$
$RPM = engine\ revolutions\ per\ minute$

Engine Control Unit (ECU) tuned to modified engine, primarily to optimize fuel consumed during start-up and acceleration. Adjustments also made for start-up, after-start, and warm-up fuel factors, as well as transient fuel, volumetric efficiency, and LOAD mapping.



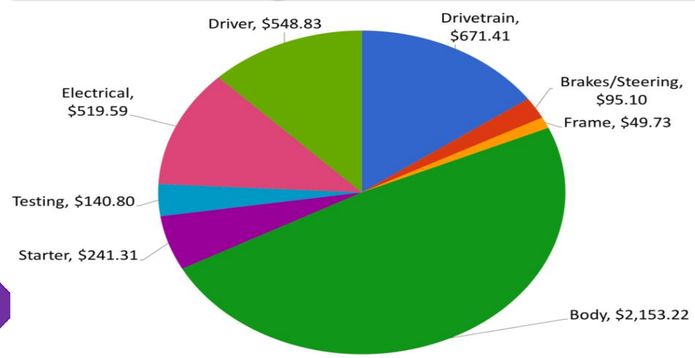
Specifications and Results

MPG	591 mpg
Overall Weight	107 lb
Average Speed	16.576 mph
Horsepower	1.4 hp
Torque	1.18 ft-lb
Transmission Gear Ratio	22:1

Testing and Validation

- Front/Rear Brakes tested on 20% slope.
- Starter tested for necessary endurance
- Electrical system tested to ensure correct soldering, crimping and functionality
- Coastdown tests used to find velocity and acceleration profiles
- ECU tuned for modified engine and analyzed EcoCal output data
- Egress Testing passed with a mean of 6.5 seconds
- Rollover testing showed an average tipping angle of 25.4°, max cornering speed of 12.2 mph
- Wind tunnel showed 0.22 drag coefficient

Budget: $8,000



09/01/2018 Project Selection → 10/02/2018 Phase 1 Registration → 12/04/2018 Phase 2 Registration → 02/25/2019 Gearset Manufactured → 03/11/2019 Steering Wheel Manufactured → 03/19/2019 Phase 3a Registration → 03/19/2019 Coastdown Analysis → 03/25/2019 ECU Tuning Completed → 03/26/2019 Starter Manufactured → 03/26/2019 Phase 3b Registration → 03/26/2019 Performance Model Completed → 04/02/2019 – 04/06/2019 Shell Eco-marathon Competition

Sponsors: Shell, Jack Rettig

Advisors: Dr. Dimitris Nikitopoulos, Dr. Keith Gonthier