Abstract
The objective of the 2008 Supermileage Team A engineering project was to design, test, and integrate an efficient engine and drivetrain system for competition in the 2008 Shell Eco-marathon. Upon benchmarking of the 2007 ME189 Supermileage vehicle, several areas for improvement were identified and in turn translated into our current design goals. In addition, further design requirements were set forth by the competition rules and regulations. Once these goals were established, in depth research was performed in order to accurately determine attainable design requirements. This year’s labors focused on maximizing vehicle fuel efficiency through weight reduction and mechanical efficiency, and in turn successfully competing in the 2008 Shell Eco-marathon.

Engine
Several small engines were considered for the vehicle. The engine chosen was the Aprilia SR50 scooter motor. This engine was a fuel efficient 50cc 2-stroke engine, featuring direct in-cylinder fuel injection, electronic fuel control, liquid cooling, and electric start. The stock fuel mileage of the scooter was determined to be 120 mpg. The direct fuel injection, added to the two-stroke power plant, made this an ideal high mileage engine by allowing for a large power to weight ratio. In addition, all excess material was removed to maximize fuel efficiency by reducing engine weight. Due to chassis restrictions, the engine was mounted transversely. This necessitated a gear box to reverse the direction of the engine drive.

Drivetrain
The overall goal of the drive train was to deliver the power of the engine to the rear wheel as efficiently as possible. The final design of the gear box used various components from the original scooter drive train, including the CVT designed for the use with our engine. In order to obtain the correct drive direction, one of the internal gears of the gearbox was re-designed to adapt an output shaft.

Component Design
Several system components needed to be developed in order to integrate the engine into the vehicle. The critical components included the engine and drivetrain mounting hardware and the drivetrain system. Each of these components needed to be designed to interface with the engine. This was accomplished by careful alignment and measurement of critical dimensions.

Analysis
Once a design was decided upon, ABAQUS and COSMOS were used to perform Finite Element Analysis. This indicated whether or not a design could withstand extreme loading due to forces and torque from the engine.

Prototyping
Once CAD modeling and FEA was completed, prototypes were constructed in order to perform validation testing. These prototypes served to prove the FEA predictions and eliminate unforeseen failure and manufacturing issues.

Results
The vehicle placed 11th out of 32 at the competition with a fuel consumption of 499.9 miles per hour. The engine and drivetrain successfully withstood all the design constraints of the competition. While there were no major malfunctions, vibrations in the gearbox caused misalignment of the belt and chain, resulting in some inefficiencies. It was determined that the gearbox bracket needed to be redesigned to decrease the amount of vibrations. All other designed components performed without problem during the competition.

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Parameter | Goal  | Result  |
-----------|-------|---------|
Engine/Drivetrain Assembly Weight | 30 lbs | 26.3 lbs |
Max Vehicle Speed (Verified with on-board computer) | 40 mph | 48 mph |
Average Vehicle Speed over 10 miles (Verified with successful competition run) | 15 mph | Successful |
Endurance Requirement (Verified with successful competition run) | 38 minutes per 10 miles | Successful |
Fuel Economy | 120 mpg | 499 mpg |
Engine Output Shaft Torque Requirement (Tested with static torque load on shaft) | 50 ft-lbs | >80 ft-lbs |
Engine Temperature after 30 minutes of use (Tested using laser temperature gauge) | <200°C | 70°C |
Engine Mounting Bracket Load Testing | 60 lbs at each load point | 75+ lbs |

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