user story

global sensitivity analysis of fuel consumption

accounting for key IC engine & vehicle design parameters

The fuel consumption of modern vehicles is measured by performing tests over standardised drive-cycles and recording key performance and emissions data. However driver feedback reveals that reported fuel consumption rates are much better than observed in real-world and on-road conditions.

THE CHALLENGE

To build a virtual vehicle and to run the vehicle over multiple standardised and real-world drive-cycles. Identify the most important design parameters in minimising fuel efficiency.

DRIVE CYCLE AND SENSITIVITY ANALYSIS

The virtual vehicle was run over the 160 drive cycles to determine the rate of fuel consumption. Results are presented in Figure 1, showing a high dependence on the type of journey. Each of the design parameters listed in Figure 2 was given realistic design constraints and a Sobol sequence was constructed over the design space to yield 8000 different engine/vehicle design configurations.

A High Dimensional Model Representation (HDMR) was constructed using these points. Such a representation was used to interpolate between various vehicle designs and to carry out a global sensitivity analysis. The results of this analysis are presented in Figure 2. The two charts show that different design enhancements yield different performance improvements over alternative drive cycles.

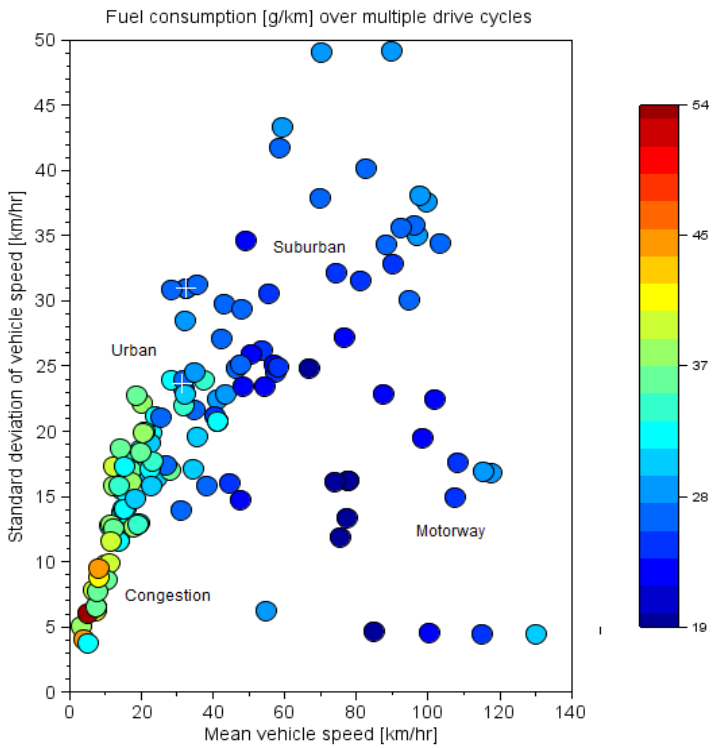

Figure 1: Mean and standard deviation of vehicle speed over 160 standard and real world drive cycles. Fuel consumption [g/km] of these cycles are presented in colour.

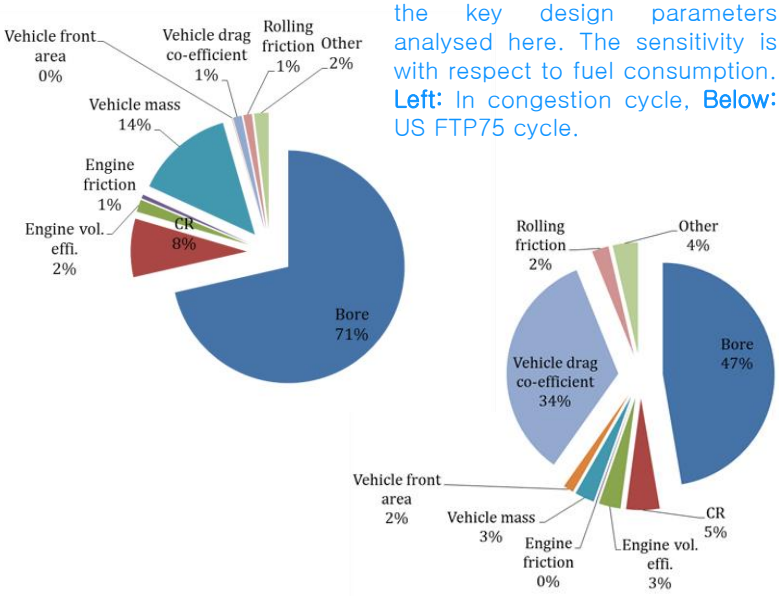

Figure 2: Global sensitivities of the key design parameters analysed here. The sensitivity is with respect to fuel consumption. **Left:** In congestion cycle, **Below:** US FTP75 cycle.

SUMMARY

- A numerical model of an 1.6 litre gasoline engine and vehicle was built
- The vehicle was run over 160 different drive cycles to determine fuel consumption
- A global sensitivity analysis was carried out to identify the key design parameters for minimising fuel consumption

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