› CASE STUDY AVL APPLICATION SERVICES

Drive Cycle Optimization Using Global DOE

@ Internationally operating OEMs

SUMMARY

Due to increasing environmental demands and shorter development time the need for efficient calibration methods is constantly increasing for all OEMs.
This case study describes the drive cycle optimization implemented with an internationally operating European OEM and includes all steps, from test design to optimization of emissions, using a global model.

CHALLENGE

Due to the high number of calibration variables in a modern ECU it is no longer possible to produce an optimal calibration by hand. The solution is to use a local DOE (Design Of Experiment).
In addition, one engine variant is nowadays installed in many vehicle variants covering a wide load spectrum while having to meet various emission legislation cycles depending on market. The limitation of Real Driving Emissions (RDE) will further increase the challenge.

Fast Facts	
Customer / Department:	Internationally operating OEM, Testing and Calibration Department
Region	Europe
Challenge	Enabling optimization of multiple emission cycles for a range of vehicle variants targeting minimal fuel consumption and premium powertrain attributes
Solution	1. Global test design using vehicle-based recordings 2. Data collection 3. Global modelling 4. Optimization All steps supported by AVL Application Services
Duration	~4-8 weeks, depending on request

This situation has led to an increase in the use of DOE methodology and has proceeded to the running of global DOEs, including speed and load as variations, to cover several legislation cycles and vehicle variants.

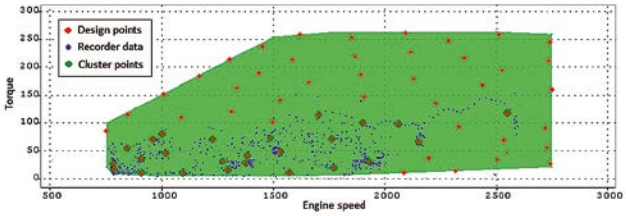

Fig. 1: Speed and load area for a global DOE

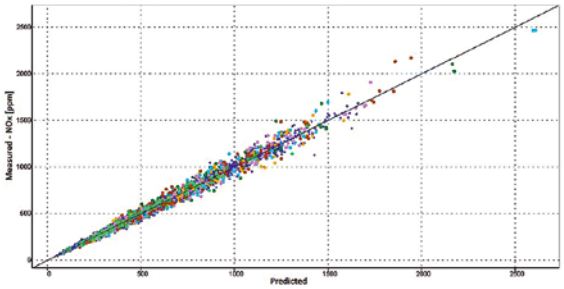

Fig. 2: Measured vs. predicted NO_x

SOLUTION

In this case a global DOE was chosen, complying with the following main points:

- Evaluation of calibration requirements, e.g. load spectrum and variation ranges
- Test design calculation
- Data collection in test cell
- Continuous evaluation of data quality (online and offline)
- Modelling and verification
- Optimization

The powertrain calibration tool CAMEO was used for all steps of the process.

1. Design of experiment

The speed and load area was defined using basic engine data and a vehicle recording from the main emission legislation cycle. An example of a global design can be seen in Fig. 1.

2. Data collection

The data was gathered using the combined experiences of the OEM and AVL. The test strategy was CAMEO Adaptive Online DOE® with the start points determined by the initial ECU calibration. This CAMEO feature together with application service know-how made it possible to successfully run the test unattended for long periods of time.
To maximize data quality, measures were taken to reduce secondary effects of the variations. The particulate filter was handled by running burn off points when needed. Smart automation features in CAMEO were used to detect and minimize the effects of the actual drift in the engine over time and to maximize the data collection rate. Repetition points were frequently executed to monitor data quality and detect faults and drifts.

3. Data quality monitoring

During the data collection phase the data was continuously evaluated – online as well as offline – to look for errors, drifts and any other unwanted effects. Thanks to the established process, faults could quickly be discovered and re-runs avoided or minimized.

4. Modelling and verification

With data of high quality the modelling was straightforward and precise using the automatic modelling in CAMEO. An example of a global NOx model can be seen in Fig. 2.

5. Optimization

Using the drive cycle recording, the main emission operating points and their corresponding weight was calculated in CAMEO and used for the optimization. The results indicated a possible reduction in fuel consumption of more than 2%.

RESULT

The result was a global model usable for emission calibration of multiple vehicle variants and legislation cycles, including RDE.
Having a global model facilitates offline recalibration, e.g. on a test trip, whilst being able to predict the effect on emissions. If required, a new drive cycle optimization using updated constraints can be performed.
In addition, a global model of the engine allows for:

- A structured and traceable calibration process
- Optimization without an engine mounted in a test cell
- Quick response to upcoming changes in requirements such as new noise or smoke constraints
- The sharing of data and models with other departments
- An increase in knowledge among members of the calibration group, owing to experience gained by working with the model instead of in the test cell

OUTLOOK

The demand for efficient calibration methods will continue to rise. AVL Application Services offer the necessary knowledge and experience to support our customers in moving forward.
AVL Application Services is seen as a long-term partner for know-how support and the introduction of new approaches to development and testing.

FOR FURTHER INFORMATION PLEASE CONTACT:

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