Powertrain Calibration

**APPROACH**

Modern powertrain development creates significant challenges for the automotive industry. Essential vehicle attributes – performance, dynamics, fuel consumption, emissions and acoustics – depend on an optimized tuning of control units. Those calibration tasks are becoming more complex, while optimal results are required more quickly. To master the wide range of tasks in everyday work, calibration engineers need efficient tools that put new methods into practice.

**TASK**

More than ever, completing calibration tasks reliably requires modern software tools that can manage complex tasks and applications.

Those tools have to meet requirements such as data quality, reproducibility, stability and safety when used in the development process. This is the only way to solve tasks, such as the dynamic operation of modern powertrains in combination with low emission requirements, in a satisfactory way.

To be able to meet the increasing calibration requirements, constant and continual development of methods is the key. AVL has years of experience and is leading in the development of high-performance tools and methods in xCU calibration. Our aim is to provide a complete workflow for each single calibration task. AVL calibration software has delivered significant increases in efficiency for implementations worldwide.

**BENEFITS AT A GLANCE**

- Software tools to support development engineers during the entire calibration workflow
- Models can be reused throughout the different stages of the development process
- Full utilization of the test facility due to intelligent test runs – even in unmanned 24-hour operation
- Tools are supported and maintained on a global scale (roll-out capability for test facilities and different locations)
- Development focus on calibration tasks rather than the development of calibration tools
REFERENCES

AVL CRETA 4™ – Calibration Lifecycle Management
As Calibration Lifecycle Management, AVL CRETA 4™ supports a traceable application process that is indispensable for series projects. Short access times, high levels of stability and safety as well as easy operation are key criteria. More than 10,000 installations prove the high quality of AVL CRETA 4™.

AVL CAMEO 4™ – With intelligent automation to calibration results
With almost 800 licenses in use worldwide, AVL CAMEO 4™ is the leading tool for efficient, automated test procedures in calibration. The complexity of calibration is visualized in the software, and therefore allows easy handling.

AVL Virtual Testbed™ – Modelbased Development
AVL Virtual Testbed™ combines models, a Hardware-in-the-Loop system and a testbed to create an integrated system. Significant cost reduction in testing and enhanced calibration have already convinced users from different fields.

AVL CONCERTO 5™ – Data processing platform
The brand new generation of AVL CONCERTO 5™, the generic data processing platform, specializes on visualization, analysis and reporting of simulation and measurement data. For specific applications, AVL CONCERTO 5™ provides individual solutions: Pro Apps and toolboxes.
Given the increased number of mechatronic systems in today's vehicles, an increase in the complexity of engine, transmission and hybrid control functions is inevitable. With calibration for steering, suspension and ADAS-Systems, the number of factors to be calibrated for a single vehicle has increased significantly. The large number of parameters add a new level of complexity to modern calibration projects and generate a need for new methods to maintain a clear overview and enhance standardization where possible.

**APPLICATION**

AVL CRETA 4™ enables the simple handling of calibration data throughout the vehicle development process and ensures conflict-free and traceable integration of xCU parameters throughout the calibration project. Clearly assigned parameter responsibilities avoid conflicts when merging calibration data from different sources and guarantee consistent results. A common data repository forms the backbone of AVL CRETA 4™ and helps calibration teams around the world to share project relevant information easily and ensure a smooth collaboration with partners. Standardized methods for pre-calibration of new projects, monitoring of calibration projects and reuse of calibration knowledge guarantees high efficiency.

**BENEFITS AT A GLANCE**

- Traceable, secure and simple administration and documentation of control unit data
- Worldwide collaboration and data exchange between team members, partners, suppliers and customers
- Quick pre-calibration of initial datasets and re-use of data
- Plausibility check of datasets using data-mining algorithms
- Easy project and quality monitoring through integrated reporting mechanisms

**AVL CRETA 4™ APPLICATION PROCESS EXAMPLE**

AVL CRETA 4™ helps meeting today’s challenges in calibration projects while reducing data management costs by more than 50 percent and is a highly intuitive and easy-to-use software with a strong focus on the application.
**KEY FEATURES OF AVL CRETA 4™**

**PROCESS WORKFLOW SUPPORT**
AVL CRETA 4™ supports your calibration process by reducing time for every step of your workflow.

**COLLABORATION**
Work together anytime from anywhere with alerts, notification subscriptions and team information.

**RESPONSIBILITY MANAGEMENT**
Clear responsibilities safeguard the complete process and overlapping work is eliminated.

**CONFLICT-FREE DATA MERGING**
Clear responsibilities enable a simple and easy creation of new merged datasets without conflicts.

**TRACEABILITY & VERSIONING**
Understand the "who, what, when and why" of any change during the calibration process.

**REPORTING & DOCUMENTATION**
Simple creation and reuse of reports help you save time when reporting to the management or customer.

**PROJECT STATUS CONTROL**
Find the status of every calibration task easily and check if your project is on track.

**KNOW-HOW MANAGEMENT**
Ensure that your calibration knowledge is reused and does not disappear due to changes in staff.

**QUALITATIVE METRICS**
Monitor your quality and processes and optimize them where potential is identified.

**EXTENSIBILITY**
Open, pre-defined APIs let you connect to your in-house systems and apps.
AVL CAMEO 4™ – much more than DoE! With the new generation of AVL CAMEO™ the road for the future is set and prepared. AVL CAMEO 4™ offers a complete solution for powertrain testing and optimization demanded by the RDE legislation.

WHAT DOES AVL CAMEO 4™ OFFER?
Transient calibration is supported in combination with the integrated data processing platform AVL CONCERTO 5™. Enhanced usability and a new software user interface allow users a faster parametrization and execution of their tasks. AVL CAMEO 4™ offers a standardization concept to handle the data needed to deliver world-class engine calibration. A standard test in AVL CAMEO 4™ made for multiple use cases and users, is easy to set up for the individual needs, also for the testbed operator themselves, leaving room for the engineering team to concentrate on innovation. A test sequencer allows to start different test runs in an automated sequence to utilize the test facility 24 hours, 7 days a week. Furthermore, an advanced interface to AVL PUMA Open 2™ offers outstanding integration and performance of daily automated calibration work.

APPLICATIONS
AVL CAMEO 4™ offers a wide range of applications:
- Gasoline engine calibration (e.g. charge or torque calibration)
- Diesel engine calibration (e.g. torque structure, base calibration, emissions calibration)
- Exhaust aftertreatment calibration (e.g. LNT, SCR)
- Drivability calibration (e.g. power on/off, tip in/out)
- E-motor calibration
- Battery management calibration
- Inverter calibration
- Fuel cell calibration

BENEFITS AT A GLANCE
- Steering calibration
- Chassis calibration
- ADAS calibration
- Simulation model parametrization
- Vehicle concept selection and optimization
- Test sequencer and standardized tests ensure high utilization and efficiency
- Optional programming interfaces for user-specific solutions and adaptions
- Real-time controllers for faster and more efficient calibration

AVL CAMEO 4™ MAKES COMPLEXITY EASY
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AVL CAMEO 4™ Test & Measure is much more than a DoE tool. Artificial intelligence is used through online global modeling to shorten the testing time while increasing the quality of the results. Little prior knowledge is needed to achieve the desired results. Standardized tests for multiple use cases and users ensure highest utilization in the test facility by means of exchangeable parameters and profiles reducing the parametrization effort.

**KEY FUNCTIONS**
- Active DoE with online global modeling
- Intelligent test sequencer
- Central test configurations and layouts
- Real-time controllers
- Programming interfaces
- Central data storage
- Scripting interfaces (e.g. iDoE, Matlab, .net)
- Vehicle and traffic simulation system (e.g. CarMaker, AVL VSM 4™)
- Model.CONNECT™ interface
- AVL CONCERTO 5™ interface

AVL CAMEO 4™ Model & Map supports to calibrate xCU labels based on all kind of measured or simulated data, using efficient behavior models and powerful optimization technology. By intuitive parametrization, best-in-class label calculation and easy-to-use result analysis, complex multidimensional calibration tasks can be solved in very little time and at highest quality. The results are achieved right first time thanks to the integrated data and process flow.

**KEY FUNCTIONS**
- Data analysis with graphical support
- Outlier detection
- Global and local models
- Model export
- Interactive model graphics
- Global optimization
- Map calculation
- Real driving prediction