



TOPEXPERT SUITE

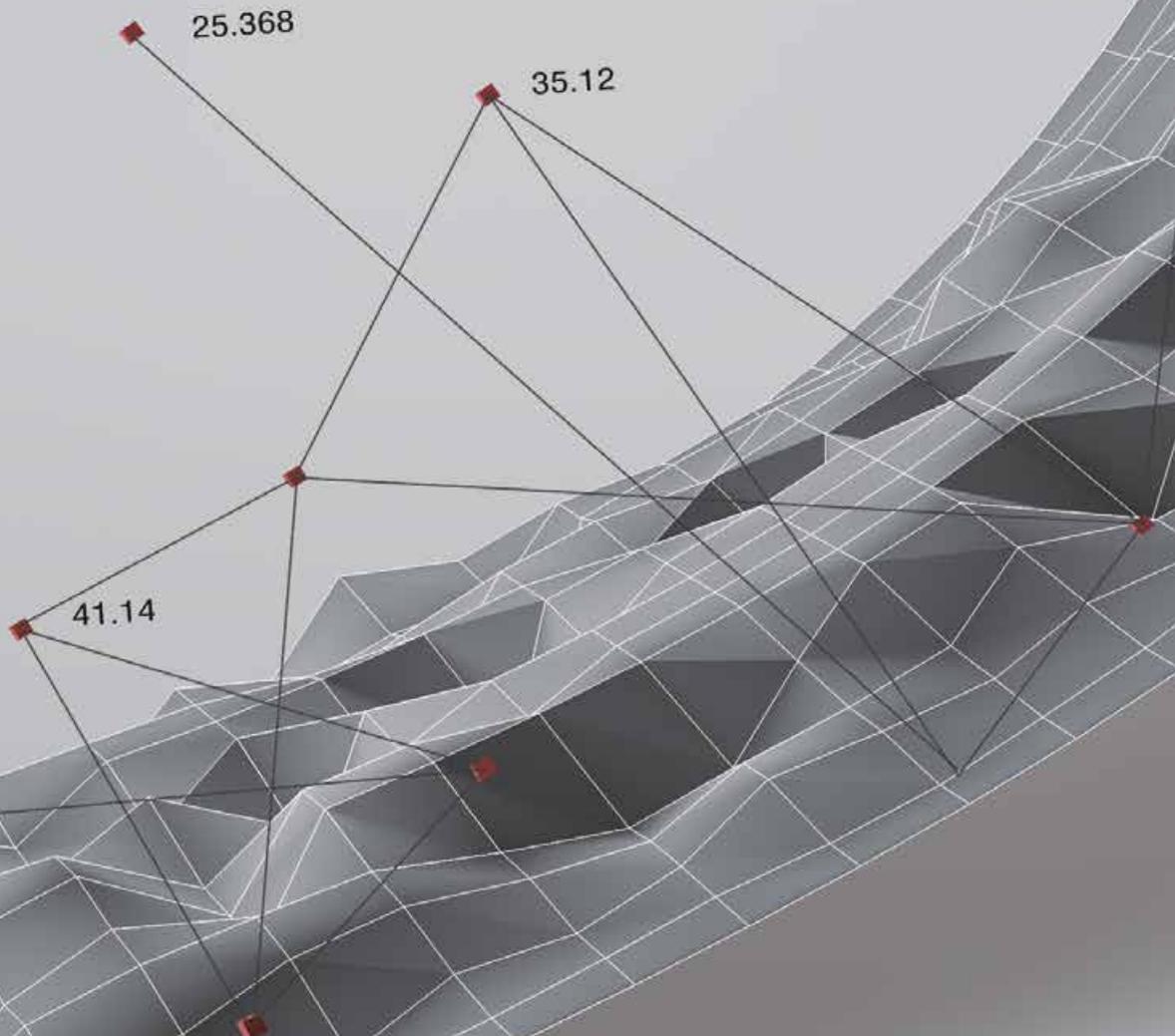


ADVANCED TOOLSET

FOR MODEL-BASED CALIBRATION



TOPEXPERT



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YOUR SOFTWARE DEVELOPMENT PARTNER

Advanced software products based on engineering expertise

Engineering and software development by FEV

FEV is an internationally recognized leader in design and development of powertrain and vehicle systems. Professor Stefan Pischinger, President and CEO of the FEV Group, maintains the company's focus towards sustainable and significant contributions to the design and development of advanced gasoline, diesel and hybrid powertrains as well as alternative propulsion systems. FEV has decades of experience in calibration and, in particular, in the application of model-based methodologies. The corresponding tool-set has been incorporated into the TOPEXPERT Suite, FEV's central platform for calibration tools.

Think global, act local

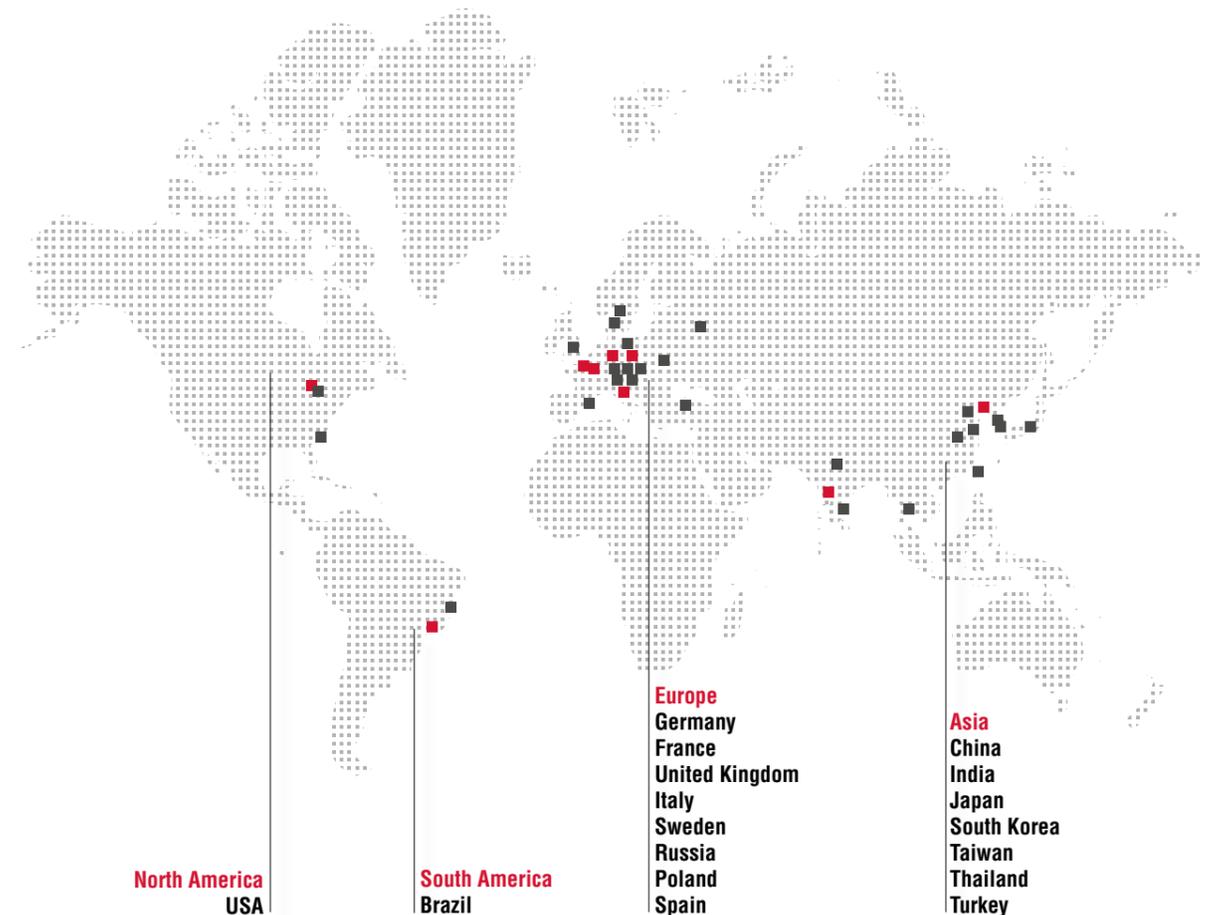
Our global customer support, is essential to the mutual success of both FEV and its customers. With its World Headquarters and European Technical Center in Aachen, Germany, the FEV Group operates globally with its local Technical Centers in suburban Detroit in the USA, and our Asian facilities in Dalian, China and in Pune, India.

Partner for professionalism

FEV is dedicated to keeping its position as a technology leader, and to maintaining that leadership. The company continually reinvests in internal R&D programs, developing value-orientated solutions to meet tomorrow's mobility and transportation demands. These activities are strictly aligned to customer demands through focus on the individual definition and adaptation of development and business processes, while observing the highest standards of confidentiality.

FACTS YOU SHOULD KNOW – FEV AT A GLANCE

- > Leader in design and development of powertrain and vehicle systems
- > Expert knowledge in software development for model-based calibration
- > Founded in 1978
- > Privately-owned global enterprise
- > More than 35 subsidiaries on four continents



FEV TOPEXPERT SUITE

Innovative software solutions for model based calibration

The complexity of modern control units along with the increasing diversity of powertrain application and the demand for shorter development cycles require novel approaches to calibration. Model-based calibration focussed on transferring major parts of the calibration work from the vehicle to the calibrator's desktop is a way to address these contemporary challenges.

FEV TOPEXPERT Suite facilitates optimal planning of measurement campaigns, enables the automatic execution of test maneuvers either in the vehicle or on the test bed, provides numerous routines for efficient data analysis, and offers the possibility of automated data set optimization. Using these tools, costly engine and vehicle tests can be minimized and several manual iteration loops can be avoided. Tasks that previously required several days for testing, data evaluation and verification can now be accomplished within few hours.

The TOPEXPERT Suite is delivered with calibration guidelines, individual training courses, service, and maintenance and can be customized to accommodate your requirements. Utilizing TOPEXPERT allows our customers to benefit from cutting-edge methodologies to reduce development time and increase calibration quality.



FACE

Guided desktop calibration



VTA

Vehicle test automator



TraCE

Transmission calibration



FEVcal

Design of experiments



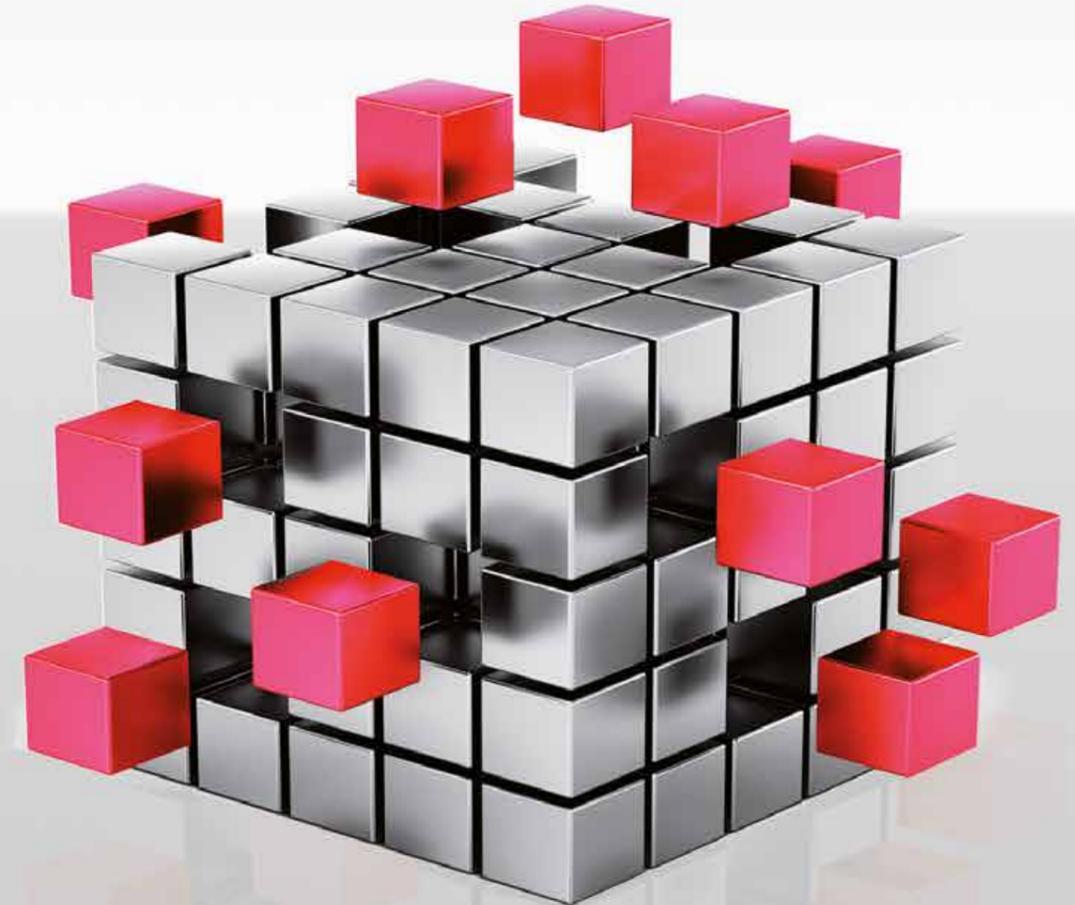
ASM Box

OBD failure simulation



BENEFITS OF TOPEXPERT

- > Apply advanced model-based calibration approaches
- > Minimize costly engine and vehicle tests
- > Shorten development time
- > Increase calibration quality
- > Standardize calibration procedures





FACE – FRAMEWORK FOR AUTOMATED CALIBRATION AND EVALUATION

Standardizing calibration procedures through
guided desktop calibration

Modern vehicle calibration has become more extensive than ever before. A growing number of calibration labels and powertrain variants, combined with the continuous increase in xCU complexity, require numerous test runs and the involvement of large calibration teams.

The FEV TOPEXPERT Framework for Automated Calibration and Evaluation (FACE) is a novel framework for guided data evaluation and desktop calibration. It achieves a rapid, standardized, and automated calibration process. FACE offers a large library of data analysis as well as xCU simulation and calibration functionalities. Its data I/O routines and batch functions are specifically optimized for efficient RAM and CPU usage.

The unique workflow-based concept includes a set of data analysis functions that can be combined into complex calibration sequences using a comfortable, graphical tool configurator.

HIGHLIGHTS

- > Workflow-based calibration
- > Straightforward graphical data analysis
- > Easy handling of basic data processing such as resampling and merging
- > Conversion and analysis of data with predefined basic statistical functions and advanced scripting
- > Automatic optimization of calibration label's content

>> Easily mastering even the most complex
challenges in today's xCU calibration <<

BENEFITS

- > Reduced development times
- > Rapid, automatic processing of several hundred data files
- > Rich library of predefined calibration algorithms
- > Open environment to create self-defined algorithms
- > Bespoke workflows for implementation and distribution of individual user expertise
- > Harmonization of applied procedures and corresponding documentation





VTA – VEHICLE TEST AUTOMATOR

Empower automation in vehicle calibration

In-vehicle calibration will remain an important part of the development of new vehicle generations. A wide range of testing procedures, road trials and functional checks are necessary to consistently fulfill all of the development targets and ensure high calibration quality.

The FEV TOPEXPERT Vehicle Test Automator (VTA) is a newly developed solution to increase testing and calibration efficiency in vehicle calibration. It thus enables the transfer of successfully applied automation approaches from the test bed environment to the roller dynamometer or proofing ground.

VTA facilitates the well-known data analysis methods from FACE. Together with own MATLAB or Simulink algorithms the engineer is empowered to close the loop and automate any calibration task to its fullest extent.

HIGHLIGHTS:

- > Plan experiments on the desktop using a comfortable graphical workflow editor
- > Workflows guide the engineer or completely automate the maneuver
- > Rich library of calibration specific blocks fastens the conception of procedures
- > Open environment for customized evaluation algorithms
- > Connects to most common calibration tools (INCA, CANape, ControlDesk, VISION)
- > Connects to test benches and roller dynamometers via standard ASAM ACI

>> Accurate, flexible and easy control – VTA does the job <<



BENEFITS

- > Boost efficiency and quality of in-vehicle calibration through high test reproducibility
- > Standardized testing procedures
- > Easy documentation and transfer of calibration expertise
- > Enables model-based calibration approaches for in-vehicle calibration





TraCE – TRANSMISSION CALIBRATION EXPERT

Efficient model-based transmission
calibration

Similar to combustion engines, the complexity of modern transmission systems has increased dramatically. New transmission concepts, hybridization, a greater number of available gears, and intelligent control functions pose new challenges for calibration engineers.

The FEV TOPEXPERT Transmission Calibration Expert (TraCE) provides a unique model-based solution for efficient transmission calibration. It offers extensive algorithms and visualization options for complete analysis and parameterization of the various aspects of shift strategy and shift quality. In contrast to other competitive tools, TraCE provides the calibration engineer with full flexibility and configurability.

A typical example is computation of the final shift points, resulting from the combination of several base shift programs that depend on the current driving situation and driver characteristics. In the past, such an analysis of these relationships was nearly impossible.

HIGHLIGHTS

- > Simulate complex TCU functions for acceleration performance, climbing capacity, shift hysteresis, etc.
- > Library of standard drivetrain models
- > Methods for objective shift quality analysis and calibration
- > Open environment for creation of self-defined evaluation algorithms
- > Interfaces to all common calibration tools



BENEFITS

- > Analyze basic label calibration, interactions and effects on the drivetrain
- > Specially prepared methods for transmission analysis
- > Completely understand the effect of TCU-internal calculations
- > Easy adaption to any transmission and vehicle type (AT, AMT, DCT, CVT, etc.)



>> TraCE is tailored to my project
needs and performs like a well-tuned
transmission <<



FEVcal – FEV's DoE solution

Virtual powertrain development based on DoE techniques

Today it is hard to imagine automotive development without Design of Experiments (DoE). The main challenge, though, is to make this powerful technique easily applicable. Automotive development poses particular challenges that require specific adaption of the generic DoE methodology.

FEVcal calculates optimized test plans based on statistical considerations, minimizing test bed usage while, at the same time, supporting high model quality. Based upon measured data, FEVcal creates models that capture the engine's characteristics and serve as a basis for optimization of the offline calibration. Special emphasis was placed on developing highly reliable and rapid modeling algorithms which are unique to the market. Today's standard global modeling techniques based on Gaussian Processes have been augmented by dedicated enhancements to address also the specific characteristics of engine and powertrain modeling. This novel approach, combined with intuitive visualization and user guidance, enables the calibration engineer to quickly investigate and optimize the engine's behavior.

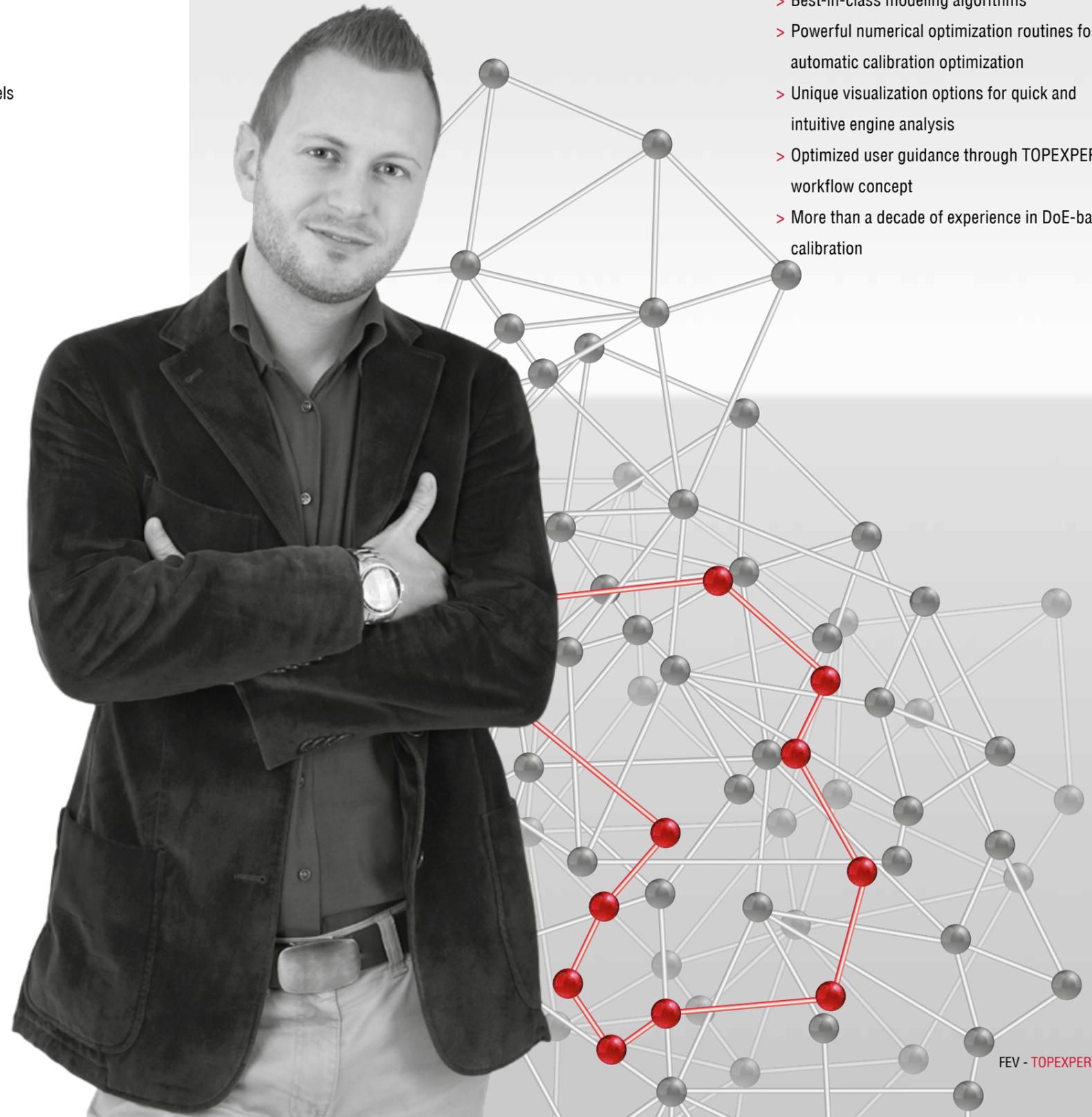
HIGHLIGHTS

- > Optimized planning of measurement campaigns
- > Reductions in test bed testing effort by up to 80 percent
- > Reliable local and global data-driven engine models
- > Reliable engine behavior prediction at individual operating points or over complete drive cycles
- > Offline calibration optimization for a variety of calibration tasks

>> The outstanding DoE capabilities of FEVcal significantly speed up the powertrain development processes <<

BENEFITS

- > Best-in-class modeling algorithms
- > Powerful numerical optimization routines for automatic calibration optimization
- > Unique visualization options for quick and intuitive engine analysis
- > Optimized user guidance through TOPEXPERT's workflow concept
- > More than a decade of experience in DoE-based calibration





ASM Box – ACTUATOR AND SENSOR MANIPULATION BOX

Efficient signal manipulation for
homologation and calibration

During vehicle homologation, correct operation of engine diagnostic functions must be demonstrated. In order to do this, increasingly complex fault scenarios need to be identified. The realization of these failure patterns, using established procedures with faulty hardware, is inflexible and requires greater effort. Manipulation of the software calibration itself represents an alternative. However, it is prohibited during homologation in some countries (USA/CARB). The manipulation of electrical signals that are exchanged between the actuators/sensors and ECU represents yet another solution for generating realistic failure patterns in the engine and exhaust system.

For this purpose the TOPEXPERT ASM Box has been developed. The ASM Box is a versatile and robust tool, designed for in-vehicle use and applications close to the engine. The ASM Box is able to manipulate a wide variety of signals including the capability of manipulation of injection, crankshaft sensor and ignition signals. This enables the realization of complex injection fault patterns such as cylinder-specific AFR deviations or misfires. Additionally it provides interfaces for the manipulation of new-generation smart sensors and actuators connected via CAN, LIN and SENT.

A breakout box is used to conveniently connect the sensors and actuators. The usage of only one hardware for all tests in a production vehicle evaluation (PVE) testing increases development efficiency. The ASM Box is delivered with a MATLAB Simulink® toolkit, allowing for a customized, bespoke development of the customer's own failure models.

HIGHLIGHTS

- > Injection signal manipulation for solenoid and piezo injectors
- > Ignition signal manipulation
- > Oxygen sensor signal manipulation
- > Crankshaft sensor signal manipulation
- > SENT, LIN and CAN message manipulation
- > Base set of failure models included
- > XCP access for comfortable parameterization of failure models

>> Easy manipulation of almost every signal – from injection parameters to NOx or particle sensors: The ASM Box is a milestone in vehicle homologation and PVE <<

BENEFITS

- > One hardware covering nearly all failure patterns
- > Easy realization of complex misfire scenarios including
 - > Injection turn-off
 - > Hiding of injection events
 - > Changing start of injection and injection duration
 - > Ignition turn-off
- > Convenient handling by versatile breakout box
- > Full flexibility by bespoke failure pattern development in Matlab/Simulink®



SOFTWARE DEVELOPMENT

Tailored software solutions for custom calibration processes

In addition to the TOPEXPERT tool chain, FEV offers software development services to optimally design tool solutions based on customer needs and processes for data analysis and calibration.

FEV's software development services combine its broad technical and mathematical expertise with excellence in software engineering for optimal technical software solutions. Efficient and high quality software development is ensured through the application of certified CMMI processes and an advanced application lifecycle management tool chain. Agile development principles based on SCRUM ensure close interaction with the user community. FEV believes that this is a key to successful software tools.

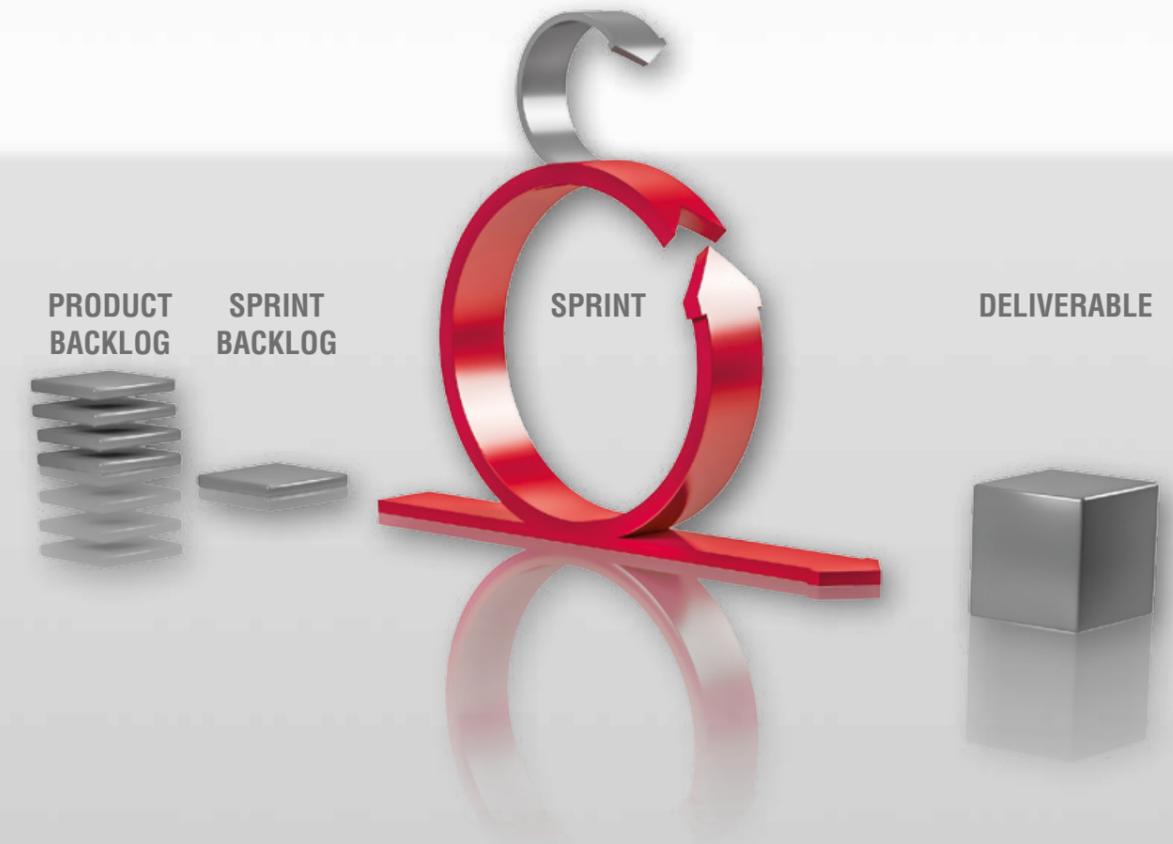
HIGHLIGHTS

- > Individual customization of the TOPEXPERT environment
- > Tailor-made software tools for desktop and mobile devices
- > Support during the complete development process including
 - > Analysis of status quo
 - > Concepts for optimized processes and tool chains
 - > Design, implementation and testing of software
- > Roll-out and training strategies
- > Long-term support and maintenance of software solutions



BENEFIT FROM RICH TOPEXPERT LIBRARIES FOR

- > Process automation
- > Data mining
- > Statistics
- > Charting
- > Numerical optimization



>> User-centered software engineering for optimized individual tool solutions <<



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