Advanced Vehicle Development

FULL CHAIN OF HIGH-QUALITY ENGINEERING SERVICES
Company profile

Founded in 1978, FEV is an internationally recognized leader in design and development of powertrain and vehicle systems and a supplier of advanced testing and instrumentation systems. Professor Stefan Pischinger, President and CEO of the FEV Group, oversees the privately-owned global enterprise and maintains the company’s focus towards sustainable and significant contributions to the design and development of advanced gasoline, diesel and hybrid powertrains and alternative propulsion systems.

FEV’s founder, first president, and CEO, Professor Franz Pischinger, developed these company principles, which provide the foundation of our sustainable company development. The original four-person team, that analyzed the combustion system of internal combustion engines quickly evolved into a highly skilled engineering company with a service base that grew to include engine design, testing, calibration, vehicle integration and the development of test facilities for OEMs. Through a natural progression from engine to powertrain to vehicle, FEV’s engineering competencies have continuously ex-
expanded to provide customers with turnkey solutions. 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. This philosophy, combined with 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 North American Technical Center in suburban Detroit in the USA, and our Asian facilities in Dalian, China and in Pune, India.
Vehicle engineering services

Attributes

- Aerodynamics
- Body
- Vehicle target book & Technical specs
- Interior & Exterior Trim
- Styling

Systems

- NVH
- Energy
- Driving performance
- Powertrain
- Thermal management
- Manufacturing engineering

- Passive safety
- Chassis
- Electrics/Electronics

Quality management

Release & Change management

Cost and Weight management

Supplier management
Based upon its worldwide leadership in engine design and development FEV consistently expanded its range of expertise in vehicle engineering and development. Nowadays, FEV’s expertise in vehicle engineering is appreciated worldwide and more than 500 engineers in Germany and the US are involved in vehicle development programs.

The full chain of high-quality engineering services includes vehicle systems layout, technical specification, design, functionality and integration as well as the corresponding vehicle attribute development and validation. The scope of projects ranges from powertrain integration and calibration up to turn-key development of complete vehicles in co-operation with our development partners.

Highly skilled specialists of FEV, familiar with OEM’s development processes, as well as reliable project methodologies allow for cost and time effective systems and vehicle engineering.
FEV offers – in co-operation with its development partners – the comprehensive development capacity and competence for all vehicle systems and components. The scope of worldwide activities leads from development and integration of single component or module up to the complete vehicle. Highly skilled specialists in combination with well proven and effective development processes allow for realization of technological and economic development targets.

Within the development process the amount of virtual validation by CAx methods is increasing significantly as development timings and quantity of prototype vehicles are reducing more and more. FEV and its partners stay abreast of this change by extensive use of simulation tools with respect to component and system layout and performance validation.

From the beginning all main vehicle attributes as e.g. fuel consumption, performance, driveability, NVH and durability are already in the focus of the component/system development in order to minimize re-engineering efforts and to assure product quality targets.

**System design and integration**

- System Technical Specifications
- Concept layout and design
- Package, DMU, DDMU and tolerance chain
- 3D data/drawing management, check and release
- Manufacturability and serviceability
- D/P-FMEA
- Release management
- Change management
- Supplier management
- BOM
- Testing at system and vehicle level
- On-site coordination and appliance of development process (customer specific)
- Physical Mock-Up and prototype build
- Launch support

<table>
<thead>
<tr>
<th>System Development &amp; Integration</th>
<th>Body</th>
<th>Exterior</th>
<th>Interior</th>
<th>E/E</th>
<th>Powertrain</th>
<th>Chassis</th>
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</thead>
<tbody>
<tr>
<td>B&amp;W</td>
<td>glass</td>
<td>interior trim</td>
<td>architecture</td>
<td>intake syst.</td>
<td>axles</td>
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<td>surfaces</td>
<td>closures</td>
<td>seats</td>
<td>body electronics</td>
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<td>brakes</td>
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<td>corrosion</td>
<td>bumper</td>
<td>cockpit</td>
<td>cable harnesses</td>
<td>PT cooling</td>
<td>suspension</td>
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<td>fender</td>
<td>air con/heat</td>
<td>board supply</td>
<td>fuel systems</td>
<td>steering system</td>
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<td>headliner</td>
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<td>sound pack</td>
<td>infotainment</td>
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<td>OBD/EMS diagnostics</td>
<td>engine</td>
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System design and integration – references

Opel Meriva development in co-operation between GM, EDAG and FEV

Integration and calibration of Renault 3.0L V6 diesel engine into Nissan Pathfinder and Navara, Infiniti EX, FX and M.→SOP 2010

Plug-In electric vehicle development and integration of battery module and range extender

SAAB 9-3 XWD
NVH AWD integration

Mercedes Sprinter Vehicle
NVH development support Chassis tuning and testing for ride and handling

Engine and hybrid calibration of BMW X6 V8 in co-operation with BMW
Vehicle safety

- Interdisciplinary engineering approach for optimum interaction between passive and active systems
- Crash simulation and testing
- Development and integration of crash safety relevant components and restraint systems
- Supplier management
- Active safety systems
- Functional safety of High Voltage systems for HEV and BEV
- D/P-FMEA
- Certification support

In spite of recent success in reducing traffic deaths the European Commission set-up a new program for a bisection of fatal automobile accidents until 2020. The program includes – among others – improved safety measures for automobiles and the encouragement of “intelligent technologies” for cars. FEV and its co-operation partners take care of these approaches by intensifying vehicle safety efforts with respect to passive, active safety as well as with respect to safety aspects of new technologies, e.g. functional safety of electric vehicles. Target of the safety development process is the optimum interaction of all safety modules and systems, thus based upon a comprehensive and interdisciplinary engineering approach.

To ensure best results, FEV interacts as partner during all stages of optimization and integration of safety modules and systems, initiated with simulation till testing. Intensive supplier and interface management, eminently at early developing phases, reduces test and validation efforts thus cost. FEV and its co-operation partners are well experienced to comply with the needs of the highest safety standards beyond certification in line with cost effective management.
Coming from combustion engine internal cooling system FEV consequently extended its competence with regard to the external cooling system and the interior heating/cooling system. Today, FEV’s scope of engineering services in vehicle thermal management leads from cooling module layout and technical specification up to series production development and launch support in co-operation with the OEM’s system suppliers.

The services include 1D and 3D simulation with respect to coolant circuits, optimum external air flow guidance and interior compartment air flow distribution to achieve best heating and cooling system performances in the vehicle.

Specific knowledge for our customers can be offered with regard to the thermal management of battery systems for HEV and BEV.
Powertrain and vehicle calibration

- ECU, TCU and HCU calibration
- Emission and fuel consumption
- On-Board-Diagnostics (OBD)
- Driveability
- Safety concept
- Certification and after-launch support
- Standardized and automated tests on test bench and vehicle
- Defined development processes supported by appropriate tools

The complexity of modern control units is no longer manageable using traditional calibration processes. When generating optimized data sets and testing, the calibration engineer needs the support of adequate software tools. FEV uses several in-house tools (streamlined in TOPexpert suite), developed by a creative team of highly-skilled engineers, scientists and software engineers, for the calibration of exhaust emissions, fuel consumption, on-board-diagnostics, driveability, safety issues, certification and after-launch support.

Several iteration loops of costly engine and vehicle tests can be avoided, through the application of these tools, by shifting the major of the activities to the desktop. This includes tasks such as performing offline calibration and verification, while repetitive calibration tasks can be processed automatically online.

FEV’s test bench methods support the projects by utilizing mathematical processes such as Design of Experiment (DoE), model-based engine analysis, and numerical optimization.
Noise Vibration Harshness (NVH)

- NVH benchmark incl. NVH target cascading from vehicle to component level
- Highly skilled NVH troubleshooting
- Powertrain induced NVH
- Road NVH
- Aeroacoustics
- Body acoustics
- Noise quality (components and systems)
- Sound insulation layout and refinement
- Pass-by noise testing and optimization
- Sound design
- Squeak & Rattle

Key methodologies for systematic vehicle NVH development and optimization:
- FEV-VINS: Vehicle Interior Noise Simulation
- FEV-V-VINS: Virtual Vehicle Interior Noise Simulation
- FEV-C-VINS: Chassis Vehicle Interior Noise Simulation
- FEV-VENS: Vehicle Exterior Noise Simulation
- FEV-SME: Sound Metrics for specific noise phenomena

FEV has over 40 years of experience conducting industrial and scientific NVH projects worldwide and employs more than 100 highly qualified NVH specialists in Germany and the US. We have a solid reputation as a reliable engineering partner to OEMs and suppliers.

Our scope of work includes a variety of projects such as NVH troubleshooting, low noise powertrain and driveline development, NVH support during vehicle integration up to full vehicle NVH development. We also tackle challenges outside the automotive field, such as NVH optimization of industrial machinery.

Our partnership with universities and our continuous involvement in industrial and public research projects ensures that our methodologies are always up to date and thorough. The high quality standard of our work is guaranteed by modern testing equipment and facilities combined with cutting-edge NVH simulation tools and methods.
Chassis engineering

Chassis layout and tuning plays an important role in vehicle development as the chassis represents the interface between vehicle and road. FEV’s engineering services cover all activities in chassis development starting with concept layout and definition of component technical specifications up to final fine-tuning and release prior SOP. The component development incorporates design and functionality with respect to active safety, ride and handling performance and continuous-travel comfort. The achievement of all development targets relies on up-to-date R&H simulation tools as well as in-house test and validation procedures complying with the international standards. The development process is supported by an extensive R&H parameter data base as well as by unique tools as e.g. FEV’s Chassis VINS for rolling noise optimization.

FEV’s highly skilled R&H team feels at home on all R&H proving grounds and takes also benefit from FEV’s Racing Team. It is accustomed to manage system suppliers “at eye level” assuring system and component quality, cost and performance targets. Our customer oriented work is characterized by open partnership utilizing our customer’s methods and procedure if requested. R&H workshops and trainings together with our customers bring up FEV’s chassis services to a round figure.

Concept tuning

- Chassis development from concept to SOP using up-to date simulation tools and qualified testing by highly skilled R&H specialists
- Benchmark and Target Setting based upon FEV’s unique R&H scatterbands
- Chassis tuning
- Adaptation and calibration of active safety devices (e.g. ABS, ESP …)
- Development and calibration of active chassis systems (e.g. active damper, steering system …)
- Chassis induced NVH optimization based upon FEV’s Chassis Vehicle Interior Noise Simulation
The true potential of advanced powertrain technologies can only be exploited with powerful control strategies in combination with modern electronic control units ensuring maximum reliability and functional safety. FEV’s tremendous competence covers the full development range from rapid prototype solutions up to mass production and includes almost all of the controller platforms used in automotive industry. Our scope of work includes E/E hard-/software engineering and integration for combustion engine powered, hybrid and battery electric vehicles. Our development methodology is supported by highly effective HIL testing and up-to-date project management tools certified according to CMMI.

FEV is one of the world’s leading development partners for hybrid and electric vehicles with the battery as one of the key components. The entire battery development process is covered starting with requirement specification to benchmarking, concept layout, design and vehicle integration. The design process includes passive and active safety measures, thermal and battery management systems.
FEV has been performing vehicle testing for many years, with focus on performance, fuel consumption, emission, durability, NVH and Ride & Handling as an essential part of a successful vehicle development program. FEV’s vehicle engineering and testing services in Germany are concentrated in Alsdorf, near FEV’s Headquarters in Aachen. Besides offices, laboratories and workshops the Engineering Center features also specific vehicle testing facilities, as e.g. climatic chassis dyno, semi-anechoic vehicle dyno, Pass-By noise track etc.

In 2013 a new vehicle test track area (3km distance to FEV Vehicle Engineering Center) has been completed including mid speed oval circuit, vehicle dynamics area, brake tracks, bad road area, ride and handling course, uphill grade etc. Specific vehicle testing activities (high-speed, Off-Road etc.) are performed on worldwide test tracks. The Nürburgring race circuit is 90 km located from Aachen.

Durability / Fleet Testing
FEV employs a specially trained and experienced driver pool that has performed more than 40 million kilometers of durability runs with the highest level of safety. The examination program, which is conducted by a fleet management group and driven on specific worldwide test routes or proving grounds, offers statistically confirmed test results. The test routes can lead our team through the cold temperatures of Scandinavia, the high altitudes of the Sierra Nevada Mountains, the heat of South Africa or Australia, and the demanding roads and low quality fuels of China, Brazil, Russia or India.

Vehicle testing

Test Facilities

Durability / Fleet Testing

- Worldwide fleet testing
- Access and driving experiences on a variety of proving grounds
- Professional and highly-skilled drivers
- Robust program control in close co-operation with our clients
- Calibration and durability experience within one team
FEV offers comprehensive and unique vehicle benchmarking covering worldwide technology and market trends. Our extensive benchmark data base comprises all up-to-date powertrain technologies including driving strategies, e.g. energy management for HEV and electric vehicles. Benchmark projects can be performed according to FEV’s standard procedures or customer specific.
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