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AVL

THE AVL MAGAZINE FOR
POWERTRAIN DEVELOPMENT,
TESTING AND SIMULATION

powertrain & drive focus

» WE BELIEVE IN RIGHTSIZING. «

KIYOSHI FUJIWARA, MANAGING EXECUTIVE OFFICER
IN CHARGE OF BUSINESS STRATEGY;
PRODUCT, DESIGN AND COST INNOVATION AT MAZDA

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Tractor-Implement Systems
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a Single Source
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new Formula One





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AVL's new Powertrain World app for the first time provides engineers across the auto industry with insight and information into the latest innovation, wherever they are. Powertrain World is a content-based app for smartphones and tablet devices like the iPad that delivers exactly what it promises – comprehensive information on everything to do with the very latest on powertrains. The content is a combination of different types of articles, images and videos, as well as information on events and products, intelligently categorized and tagged so that the app is easily navigable.

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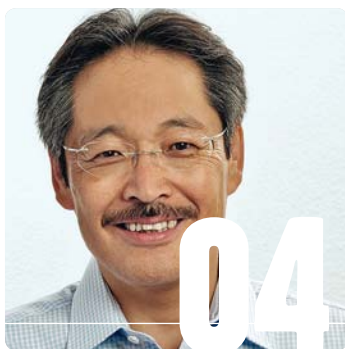
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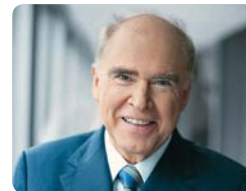


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Prof.
Helmut List
Chairman
and
CEO AVL



The automotive industry is increasingly faced with the challenge of having to reduce development costs and time, despite the growing complexity of drive systems and the rising number of variants. Here, model-based development methods can make a valuable contribution: Already at a very early stage, optimizations are performed in a purely virtual – and thus more cost-efficient – test environment based on models of the internal combustion engine and the entire powertrain. Particularly where complex, electrified drive systems are being developed, and fuel consumption and emission limits need to be met in real driving operation, model-based development helps significantly to enhance efficiency in the development process.

Its wide-ranging capabilities and many years of experience in the development, testing and simulation of modern drive systems have made AVL one of the world's leading companies in the field of model-based development. Our engineers are already utilizing this new methodology intensively to achieve efficient vehicle drive optimization. For our customers, virtual test systems are a forward-looking addition to their development and testing capacities.

It is essential for us to reach one goal together: to develop environmentally sound drive systems that are as appealing as they are affordable to buyers.

Helmut List

Interview with Kiyoshi Fujiwara, Managing Executive Officer in charge of
Business Strategy; Product, Design and Cost Innovation at Mazda.

» WE BELIEVE IN RIGHTSIZING «



► **«F»:** With its SKYACTIV diesel and gasoline engines, Mazda has some very advanced engines with a lot of high-tech elements. Could you give us an overview of the new technology used in these engines?

«Fujiwara»: There may be a trend toward engine downsizing, but Mazda is different. We believe in what we call rightsizing. This means that we primarily want to improve the internal combustion engine, the combustion chamber per se. With our SKYACTIV engines, we have managed very well to accomplish this. The engines have an outstanding compression ratio of 14:1, which is very high for the gasoline engine and very low for the diesel. This means we are optimizing performance and torque curve while, at the same time, reducing fuel consumption and, of course, emissions by as much as 20 percent. Mazda solves any issues resulting from the 14:1 compression ratio by using technical tricks. For example: The high compression ratio in the gasoline engine increases the probability of knocking – an issue we can get under control with the 4-2-1 exhaust system. With the diesel engine, on the other hand, the low compression ratio could cause trouble at low temperatures. We handle this by raising the exhaust gas temperature inside the combustion chamber.

«F»: The SKYACTIV diesel engine complies with EURO 6 without having an expensive NO_x after-treatment system. Will that fact contribute to an even greater number of cars sold with diesel engines in Europe? And are you planning to sell cars with diesel engines in Japan and the U.S. too, where Mazda even runs a diesel racecar?



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The Mazda Skyactiv Diesel engine with its unusually low 14:1 compression ratio enhances the efficiency while reducing harmful emissions, especially of nitrogen oxides (NO_x).

«Fujiwara»: The demand has already risen – especially in Japan. Apart from that, we added the U.S. and Canada as new diesel markets for Mazda in 2013. The fact that we managed to win the title in the American Grand-Am GX Championship this year with our SKYACTIV diesel is the best advertisement ever. Right now, we are considering whether there might be worthwhile potential for the SKYACTIV diesel in Russia or various other Asian countries. We have certainly already exceeded our original production capacity. In view of gasoline and diesel engines put together, we are now raising the annual quantity from 800,000 to one

million. In addition, we are making production more flexible, improving our ability to respond to peaks in demand at short notice.

«F»: What is your opinion on using new technologies, like energy regeneration systems or sub-component electrification (e.g. water and oil pump), to further reduce CO₂ emissions of the internal combustion engine?

«Fujiwara»: To Mazda, both of these options are fundamental to paving the way to lower emissions – providing you have the right basis. After all, the internal combustion engine still remains the prevailing propulsion system. With regard to its



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In the American Grand-Am GX Championship, Mazda successfully runs a racecar with the SKYACTIV 2.2-litre diesel engine.

» DUE TO THE HUGE DEMAND,
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FROM 800,000 UNITS TO
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SKYACTIV engines, Mazda first laid the basic foundations; in other words, it made the engines cleaner and more economical. Electrical components, like the start-stop technology and the brake energy regeneration system, were the next step. i-Stop and i-ELOOP combined are able to lower fuel consumption by another 5 to 10 percent. Not least

with the help of its electrical components, Mazda is on the right track to reach the sustainability target – i.e. to lower fleet fuel consumption by 30 percent and fleet emissions by 23 percent from 2008 to 2015.

«F»: Mazda has a rich tradition in the field of rotary engines. Are you

planning to offer cars with rotary engines again anytime soon? Is it likely that the rotary engine will celebrate its comeback as a hydrogen-fueled engine?

«Fujiwara»: Mazda won the Le Mans race with a Wankel-type rotary engine. At least since then it has been clear to us that we are never going



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The Mazda5 Hydrogen RE Hybrid with a hydrogen rotary engine



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The Mazda3 CNG was presented at the Tokyo Motor Show



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The Mazda2 EV is available in a small 'for lease' series, especially for urban use.

to give up. Even if there is currently no series production, Mazda is still putting rotary engines to use in its test vehicles. In Japan there is a leasing fleet of Mazda5 Hydrogen RE Hybrid vehicles. In these, the rotary engine is powered by hydrogen to produce electricity for the electric drivetrain.

◀F: In some of the world markets, hybrid vehicles are a great success. Are you planning to sell hybrid vehicles in the near future?

◀Fujiwara: At the 2013 Tokyo Motor Show, we'll be unveiling our all-new Mazda3 with hybrid drive that pairs a 2-l SKYACTIV gasoline engine with an electric motor. Its sale will start in Japan because we expect the country to have the highest demand for this type of vehicle. We are indeed thinking about launching it in other countries.

◀F: With the Mazda2 EV you already have an all-electric vehicle in your portfolio. How do you rate the prospects of the all-electric drive concept?

◀Fujiwara: Well, our Electric Mazda2, which has a range of 200 km, is at least on the road and used for urban commuting. It is available in a small 'for lease' series, especially for urban use. We are certainly technologically capable of delivering an electric car ready for serial production – if there is a market for it.

◀F: What factor do you think is most important for selling more EVs to customers? Is it a technical element like, say, batteries with higher capacity or improvements



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The world's most successful sportscar: the Mazda MX-5.

to the availability of charging systems?

«Fujiwara»: Greater ranges, uniform plugs and charging standards or lower acquisition costs in general – these are all factors that help electric cars catch on on a wider scale.

«F»: Do you think that alternative fuels or CNG will play a significant role in certain markets?

«Fujiwara»: One thing's for certain: there is definitely a market for gas-powered vehicles. In addition to the hybrid version, the Mazda3 CNG made its premiere at the 2013 Tokyo Motor Show too, which we would like to offer customers as an attractive alternative. Mazda alone is unable to say from what sources the fuel is derived. In the case of biofuel, for example, it is, not least, also an ethical question.

«F»: Advanced in-car electronics, like car-to-smartphone connections for using social networks, are becoming more and more important, especially with young people. What features do you think will be most important for future car buyers?

«Fujiwara»: The Connect system in the new Mazda3 demonstrates our strategy. The concept places the highest priority on making access to web content as safe and as intuitive as it can be. Our solution is a heads-up display and a large central display sitting atop the dashboard, along with a command controller based on a turn-and-push button concept within comfortable reach in the center floor console. With regard to web content, we try to satisfy a variety of customer demands: private drivers get internet radio or Facebook and Twitter features while business

customers, for example, get location-based services like live weather reports or restaurant tips while they navigate.

«F»: Mazda has the world's most successful sportscar – the MX-5 – in its lineup. Do you think a car's emotional component will remain an important factor in the future?

«Fujiwara»: The MX-5 would never have sold a million times without its emotional component. Mazda is a relatively small manufacturer which owes its existence to always being slightly different from the mainstream. The philosophy we live and work by is to defy conventions – whether it is with the MX-5, the Wankel-type rotary engine or SKYACTIV rightsizing instead of downsizing. And the emotional component of a car and a brand is more likely to become more important in the future. ←

► AVL AST has been successfully collaborating with leading universities from all over the world for several years. With the introduction of the University Partnership Program (UPP) in 2008, AVL has further intensified its co-operations with academic institutions. Within the context of the UPP, AVL provides universities and technical academies with free licenses of the AST Software Tools AVL BOOST, AVL CRUISE, AVL EXCITE and AVL FIRE. It means that universities have the opportunity to use the latest simulation technology of the world's largest independent company for the development, simulation and testing of powertrain systems for scientific research and teaching activities. AVL's state of the art products enable universities to educate their students at the highest possible standards and use the best possible simulation tools for their research activities.

AVL has more than 200 active UPP partners spread all over the world – mainly in Europe and the United States. But AVL is also well connected with universities in Japan, India and South East Asia. The first contacts between AVL AST and international universities are usually established at academic conferences and fairs but the personal recommendations of professors, lecturers and other university officials are also an important trigger for future co-operations. "Based on the results achieved with AVL AST Software Tools, AVL is mentioned in more than 400 academic publications so far. And more and more professors recommend their colleagues to collaborate with AVL on a profession-



CONNECTED WITH UNIVERSITIES ALL OVER THE WORLD

"With the University Partnership Program, AVL Advanced Simulation Technologies (AST) has established a worldwide network of long-term co-operations with universities and technical academies," explains Reinhard Tatschl, Research and Technology Manager at AVL.

al basis. Our University Partnership Program and its benefits for universities are already well known to the community by now; indeed it has become a great success for us", says Tatschl.

Thanks to the UPP partners' intensive use of AVL's simulation technology all over the world, AVL AST receives valuable feedback on the software tools' functional range

and applicability, as well as essential input on future demands on its software. In addition, numerous successful co-operations and projects have already emerged from these collaborations, explains Reinhard Tatschl: "The intensive collaboration with universities and technical academies is an important source of latest scientific results and hence serves as a sound basis for future innovations in our software products." ←

INNOVATIVE SOLUTIONS FOR INTEGRATED TRACTOR- IMPLEMENT SYSTEMS

AVL has been successfully involved in powertrain development for agricultural machinery for quite some time. By establishing its new Commercial Driveline & Tractor Engineering business unit, AVL has substantially expanded its scope of agricultural engineering products and services, which now ranges from market analysis and product management through to integrated tractor-implement system development.

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At AVL, the role of model-based development is gaining significance in the field of agricultural engineering.



► “It is our clear intention to win over customers with AVL’s overall system capability in the field of agricultural engineering. By ‘overall system’ we mean the tractor, but also the combination of the tractor and the implement – because the way the two machines interact is becoming more and more important,” says Udo Kneitz, Managing Director of the newly founded AVL business unit Commercial Driveline & Tractor Engineering, based in Steyr, Upper Austria, adding “Acting as a kind of neutral link between tractor and implement, we can help both parties to optimize their systems and components, or define interfaces without giving priority to any one of the two sides.”

LEAN AGRICULTURE

Farming worldwide is undergoing radical change. It is therefore all the more important to identify global trends early on and provide suitable technological solutions. “A sharp rise is being seen in the need for agricultural commodities, for ex-



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AVL employs a tire model that simulates the interaction between tire and road surface – as well as the classical powertrain elements of combustion engine, transmission and axle – for increasingly precise integrated-vehicle models.

ample cereal. Reasons for this trend are the rise in the world population and changing eating habits, such as the increased consumption of meat in the emerging markets. The Lean Agriculture approach can help to solve this problem. Lean agriculture refers to a combination of the already familiar Precision Farming process and the right kind of technologies, in other words the right kind of mechanization in the background,” says Udo Kneitz, describing the ideal level of interaction between processes and tools, specifically between agricultural processing methods and the associated technology on the side of the tractor and the implement. “To be able to give our customers the right recommendations, it is neces-

sary to identify future agricultural trends at an early stage. Our global presence in markets all over the world allows us to pass on this kind of knowledge to our customers in the context of market and competition analyses which, in combination with our knowledge of future technology trends, result in the requirements for production specification and, consequently, for our customer’s product portfolio and product management. Against the background of increasing professionalization in farming, such information is extremely valuable, both for globally established OEMs and for new companies wishing to expand into markets they are not yet familiar with.”

AVL can also support and advise its customers worldwide on all aspects of agricultural equipment homologation. A design approval in Europe, for example, requires that hundreds of legal framework conditions be met. These include matters like whether a tractor is roadworthy or whether it satisfies the relevant requirements of the EC Machinery Directive or the respective emission limits. AVL creates all documents and either runs the tests itself or initiates and supervises any tests that are needed to be awarded the European homologation. At their customer’s request, AVL specialists can additionally ensure compliance with the latest applicable emission legislation (Tier 4 Final, Stage 4, etc.) before starting the homologation process.

AMPLE OPPORTUNITY FOR INNOVATION

With regard to the now globally established technology for meeting the stringent emission limits, Udo Kneitz sees ample opportunity for innovation for agricultural machinery manufacturers in the near future: “Over the past 10 to 15 years, most of the financial and human resources were tied to exhaust-gas issues. Now that the development work to ensure compliance with the emission limits is complete, agricultural machinery manufacturers are offered a wide scope for implementing novel technologies and solutions. Starting with improving the level of comfort at the workplace by optimizing the man-machine interface, for example, or developing new solutions or upgrading existing ones for the autonomous use of tractors, there is a tremendously wide scope of forward-looking development themes to which AVL can make an active and efficient contribution – thanks to its comprehensive system capabilities.”

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Modern automated transmissions can contribute to the optimization of the powertrain in tractors.



UDO KNEITZ,
Managing Director, Commercial Driveline &
Tractor Engineering

» ACTING AS A KIND
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Another very attractive field of development is also electrification and thus the further optimization of the tractor/implement interface. Where electrification is concerned, it is not the tractor that the expert regards as the driver, but the implement. The reason for this is that electrification on the side of the implement can unleash its full potential. “Many manufacturers of implements have already got electrified prototypes up and running. These work with much higher precision and efficiency if electric and electronic components are used effectively. A hay tedder that has electric drive motors and therefore can do without any mechanical power transfer, for example, not only achieves higher efficiency, it also offers advantages in road transport due to having space-saving and easily retractable arms,” points out Udo Kneitz.

Central to electrification is the definition of a uniform and open interface between the tractor and the implement. In this respect, AVL can play a decisive role due to its expertise and its position as a neutral link. AVL is a member of the VDMA (the German Engineering Federation) and the AEF (the Agricultural Industry Electronics Foundation) where such standards are defined. This makes us the perfect partner for either side – manufacturers of implements and tractors – and excellently capable of implementing whatever ideas you may have,” adds the agricultural engineering expert.

In future, tractors will consequently have an electric generator, which on no account will be a simple add-on. Instead, solutions have to be highly integrated: “An example for uti-

lizing the generator potential wisely would be to apply downsizing or perhaps phlegmatization of the engine, which would make it possible to replace complex and expensive charging technologies, such as twin-chargers or VGTs, with much simpler turbochargers. In addition, elements like starters or dynamos will no longer be needed if the generator is integrated into the powertrain. The general goal is to raise the efficiency of the overall system by electrification – which could ideally be done at no extra cost.“

GROWING SIGNIFICANCE OF MODEL-BASED DEVELOPMENT

Following the example of the automotive industry, the role of model-based development is also gaining significance in the field of agricultural engineering. Due to the comparatively small quantities produced, this type of development method can be employed with particular efficiency. This is because model-based development allows comparing a multitude of variants and concepts with relatively minimal effort. Based on these findings, it becomes possible to concentrate on the most promising variants in the further course of the development.

For the increasingly precise integrated-vehicle models, AVL not only uses the classical powertrain elements combustion engine, transmission and axle. It also employs a tire model that simulates the interaction between tire and road surface. This kind of interaction – friction, slip, interlocking, etc. – is of crucial significance in off-road

applications, as it can cause up to 10 percent deviation in efficiency. Another special feature of AVL's integrated vehicle model is its real-time capability, which enables its use in test bed and hardware-in-the-loop testing too. To begin with, it is important to model as many sub-elements as possible virtually and then test the way they interact within the overall system. In the course of the development process, virtual functions can successively be replaced by hardware components – ranging from individual control units to complete powertrain components.

PARTIAL SOLUTIONS WITH A SYSTEM VIEW

“With our broad scope of agricultural engineering products and services, which encompass all of AVL's global capabilities, we are able to provide support both to established players in the agricultural engineering sector at a superior technical level and to newcomers. Our capability to design an overall vehicle also makes us the ideal partner for the development of individual components. Given today's ever-increasing complexity and interaction, even



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On the test bed the results of the virtual development are verified. The values measured on the test bed are additionally fed back into the virtual model to improve it further.

Virtual models also play an important role in the final tests on the vehicle test bed, where the vehicles go through exactly the same cycle as they did previously at the virtual development stations, ensuring good comparability. The values measured on the vehicle test bed are additionally fed back into the virtual model to improve it further.

the development of individual elements requires in-depth knowledge of the overall system – and that is exactly what we can offer our customers all over the world,” says the Managing Director of the AVL business unit Commercial Driveline & Tractor Engineering. ←



OVERALL POWERTRAIN CALIBRATION FROM A SINGLE SOURCE

AVL offers its customers a comprehensive scope of calibration services ranging from gasoline and diesel engines through to transmission and all elements belonging to the electrified powertrain. By combining great expertise, innovative methods and state-of-the-art tools, AVL is also the perfect partner for overall drivetrain system calibration.

► AVL not only calibrates entire powertrains – it also takes care of the individual powertrain elements, both in passenger cars and commercial vehicles. “Having AVL calibrate their entire system gives customers loads of benefits. There is no need for them to communicate with different engineering partners or coordinate activities with several teams. Apart from that, fewer prototypes are needed and for a much shorter time. The multitude of synergies that AVL can provide general-

ly allows you to reduce development time and cost very considerably,” Gerhard Kokalj, Head of Transmission, Hybrid and e-Vehicle Calibration at AVL, tells *Focus*. Besides supplying comprehensive calibration solutions from a single source, AVL also performs calibrations of individual powertrain elements – from gasoline and diesel engines to the transmission and all electrification elements, including the operating strategy for the entire system. These

calibration services are offered for both light-duty and on- and off-road heavy-duty applications.

Where internal combustion engine calibration is concerned, AVL has been an established engineering partner all over the world for quite some time. By employing new and model-based development methods, diesel and gasoline engine calibrations are now conducted with much higher precision and efficiency than they were before (read more about this on the following double-page spread). According to Gerhard Kokalj, automatic-transmission calibration is assuming increasing importance in the optimization of the classic powertrain: “The trend in the automotive industry is towards trying to keep the drive hardware the same within the context of the platform strategy. The vehicle characteristics are increasingly being defined by adjusting or calibrating the software. In this respect, the automatic transmission, which is increasingly being employed in passenger cars, is becoming more and more important. Furthermore, reduced fuel consumption and CO₂ emissions can only be achieved by optimizing the overall system – in other words engine and transmission combined.”

HYBRID AND ELECTRIC VEHICLE CALIBRATION

As for the hybrid drive, the central focus is on the harmonious interaction of all powertrain elements. Calibration here is even more critical – both where the individual components are concerned and the overall system. And this, says the expert, is exactly where AVL can play out its strengths: “The more complex a



» THE COMBINATION OF OUR EXPERTISE AND AVL'S INNOVATIVE METHODS AND TOOLS ARE OUR REAL STRENGTHS IN POWERTRAIN CALIBRATION. «

GERHARD KOKALJ

drive is, the more important it is to have overall knowledge at the level of the powertrain and the vehicle. AVL has this knowledge. We calibrate both, the entire hybrid system – in other words the hybrid control unit (HCU) – and all the other individual components too, ranging from the internal combustion engine through to the transmission, the electric motor and the decoupler. A further major area is variant calibration for hybrid vehicles, which AVL carries out for OEMs.”

Besides hybrid calibration, AVL also calibrates vehicles powered purely by electricity. Here, the main priorities are extending the battery range

by pursuing an intelligent operating strategy and diagnostics calibration which ensures safety and reliability in electric cars. Drivability tuning is also central, which is applied to give the electric vehicle a very comfortable or perhaps a decidedly sporty driving behavior. As the brand-specific character should be maintained, also in electric vehicles, this aspect of calibration is assuming an increasingly important role.

INNOVATIVE METHODS AND STATE-OF-THE-ART TOOLS

At AVL, only the most advanced calibration methods and tools are used. Kokalj: “The virtual world is becoming more and more important in calibration. With AVL’s MoBEO tool, model-based engine optimization has already found its way into the engine world. And there are now some very promising approaches in this direction in transmission calibration, which are increasingly being incorporated into our projects.” Another AVL innovation is a methodology for the objective assessment of the gear shifting strategy. “The challenge we faced here was to assess the gear shift points based on physical measuring quantities ensuring the greatest objectivity possible. The result are various criteria at which the gear shift should ideally take place according to the driver’s wishes. This kind of objectified gear shift point assessment is currently only possible here at AVL. Apart from that, an AVL tool has now made it possible to optimize the driving strategy offline – a task which previously exclusively took place on the proving ground. The concluding validation stage takes place in the vehicle.”

For hybrid calibration, AVL applies its internally developed HyHab methodology which has a number of advantages. “A large part of the base calibration of the operating strategy, which is then incorporated into the hybrid control unit (HCU), is a result of simulation with AVL CRUISE. In future, the share of simulation in the operating strategy is expected to grow even further,” stresses Kokalj. After that, the powertrain and – in case it is already finished – the entire hybrid vehicle is tested on the powertrain or chassis dynamometer. Using the driver simulation system AVL DriCon, an event is automatically initiated from an extensive test application. The effects the event has on drivability are measured using the AVL DRIVE tool. After the test runs are complete, AVL CAMEO is used to perform the calibration on the Office desktop, saving both time and cost. The HyHab methodology is also employed for drivability coordination in electric vehicles.

A STRONG COMBINATION

“The combination of our calibration engineers’ extensive breadth of expertise and AVL’s innovative methods and tools are our real strengths in powertrain calibration. Added to this is the advantage of our global presence: in our 32 Tech Centers around the globe we can meet the specific local requirements on site and cater to our customers’ special wishes very effectively – and always with the support of our headquarters and competence center in Graz, whenever we need it,” says Gerhard Kokalj, summing up the advantages of having AVL as your established engineering partner for all areas of Powertrain Calibration. ←

MODEL-BASED ENGINE CALIBRATION ON THE VIRTUAL TEST BED

AVL's MoBEO method (model-based engine optimization) enables you to optimize gasoline and diesel engines, including exhaust gas aftertreatment systems, on the virtual test bed at a very early stage of the development process under (simulated) real world conditions.



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The virtual test bed for model-based engine optimization AVL XIL.STATION.

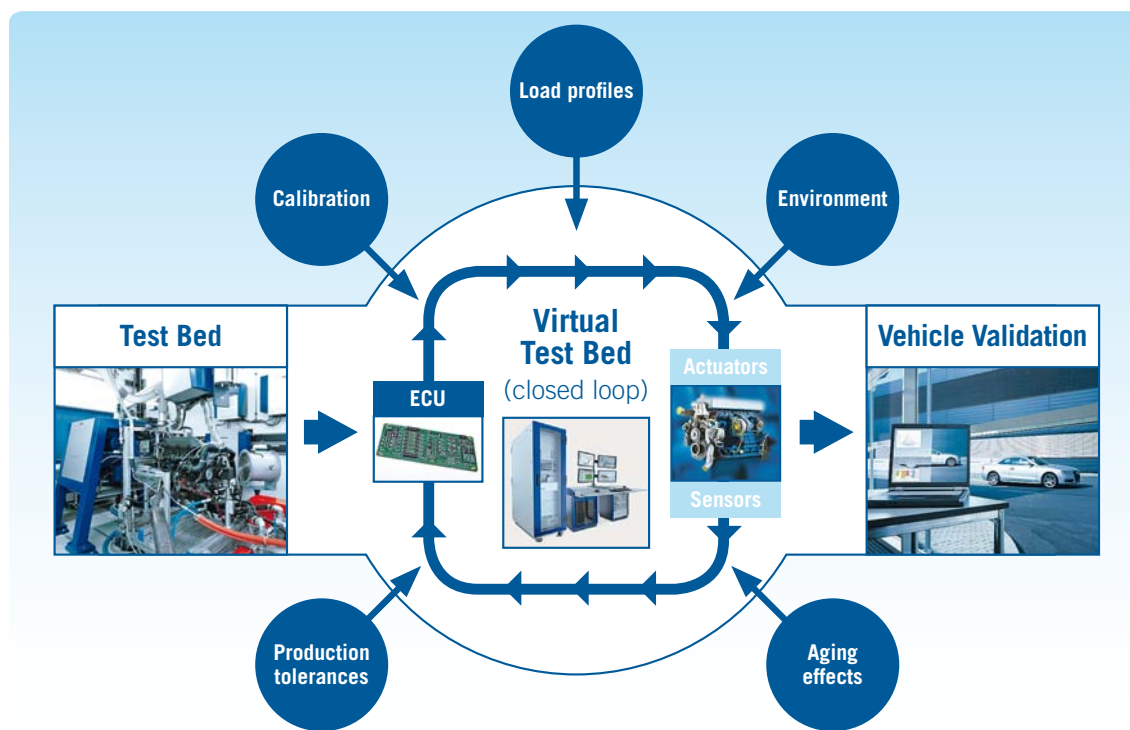
► The main goal of AVL MoBEO (model-based engine optimization) is to shift major parts of engine development from the real to the virtual test bed. According to Michael Kordon, Manager Methodology for Development, Calibration and Testing, high-precision engine models are fundamental to the process: "Our engine models are a combination of physical and empirical models. This helps us take advantage of both approaches and satisfy the high model standards which calibration requires – both in view of quality and calculation speed."

The empirical part of the models is based on the AVL engineers' many years of experience and the evaluation of huge volumes of measuring

data. The empirical parts of the combustion models are based on around 10 000 operating points from nine different engines (with a displacement of 0.5 to 2.5 liters per cylinder). "What is so special about our empirical models is that the coefficients are constant. This makes it very easy to make adaptations to a certain engine. Only a few parameters need to be set. Very roughly speaking, the physical models are used first, but if the calculation time has a limiting effect, the highly complex parts are substituted by empirical models, so that the engine model is real-time capable and can be used on the virtual test bed," Michael Kordon explains.

EXHAUST GAS AFTERTREATMENT MODELS PLAY AN IMPORTANT ROLE

According to Martin Schüssler, Manager Development Aftertreatment Systems, not only engine models, but also exhaust gas aftertreatment models play an important role in calibration on the virtual XIL.STATION test bed (see also page 29): "Compared to the engine, significant phenomena inside a catalytic converter are on a slower time scale. Yet the reaction equations typically are highly complex. Similar to the engine model, semi-empirical approaches are used to keep parameterization workload and calculation time within a reasonable range. To provide exhaust gas systems in time with project schedules, AVL



→ By using high-quality real-time simulation models, MoBEO enables calibration engineers to carry out major development steps, such as function pre-calibration, function tests and OBD calibration tasks, at a very early stage in a virtual development environment.

has developed an integrated methodology that includes measurement (on the synthesis gas and engine test bed), evaluation and even parameter identification.”

TRANSIENT TESTING ALREADY IN THE CONCEPT PHASE

Based on simulation models, transient engine testing can already start in the concept phase. In parallel to basic development, the virtual test bed can be used, for example, to simulate the engine’s emission behavior under real driving conditions, which is not only a huge advantage with regard to assessing and calibrating the powertrain in view of its compliance with new emission legislation – key word “Real Driving

Emissions” (RDE) – it also proves worthwhile when it comes to specification of the exhaust gas after-treatment components. It additionally leads to significantly enhanced efficiency in the calibration of engine protection functions: The virtual test bed also allows data records to be reviewed under extreme ambient conditions (temperature, sea level, etc.) and with different component tolerances in varying operating states. As a result, the limits of vehicle operating conditions can be taken into account at a very early stage in development under cost-optimized conditions.

By using high-quality real-time simulation models, MoBEO enables calibration engineers to carry out

major development steps, such as function pre-calibration, function tests and OBD calibration tasks, at a very early stage in a virtual development environment. This leads to tremendous reductions in development time and costs while improving quality at the same time. “One can basically say that the higher the system’s complexity and number of engine variants, the more savings potential can be achieved – ideally, no more than the final validation of data will be necessary in the real vehicle. The outstanding ease of use is another major factor: Due to the huge experience the AVL engineers have who have developed this methodology, the MoBEO method satisfies the exact requirements of the developers who use it,” says Michael Kordon. ←

Interview about the future of powertrain development

» ENABLING AGILE AND INTEGRATED POWERTRAIN DEVELOPMENT «

Kai Uwe Voigt, Executive Vice President Instrumentation & Test Systems, and Mario Walenta, Vice President Sales Instrumentation & Test Systems, on new trends in simulation and test systems for powertrain development, and the way in which AVL is taking on these challenges.

► **«F»: Vehicle drivetrains are becoming progressively more complex. At the same time, they have to be developed efficiently and to the highest quality. How does AVL, as a manufacturer of highly advanced simulation and test solutions, respond to these new challenges?**

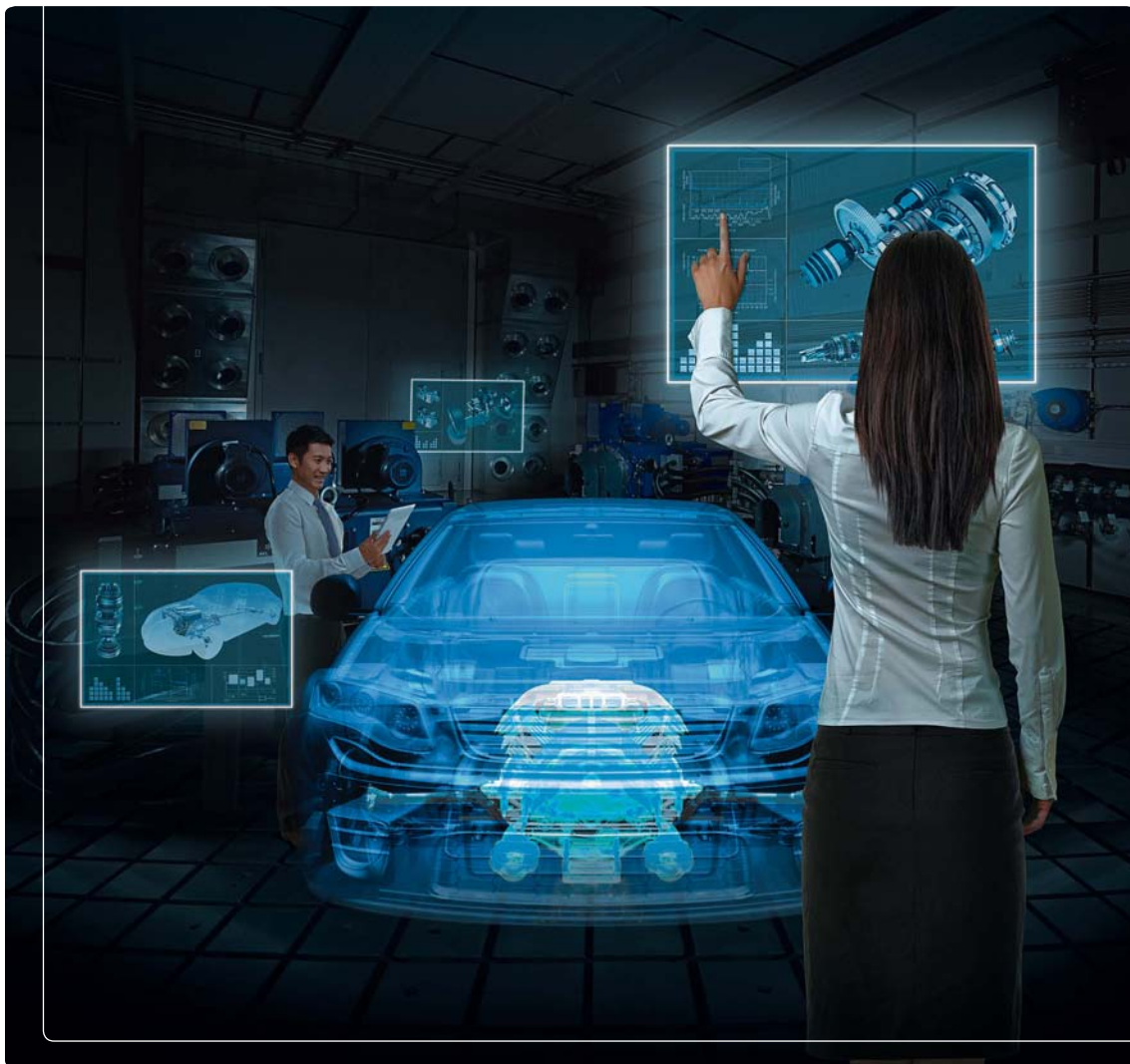
«Voigt»: To satisfy these diverging requirements, development tasks need to be shifted to earlier phases of the development process. It is crucial that the different powertrain components are continuously integrated into the overall system. This means that virtual prototypes need to be combined with real, existing com-

ponents and tested within the integrated system, so that their functionalities and performance can be evaluated. Based on the strategy of its Integrated Open Development Platform (IODP), AVL provides its customers with a platform that combines different development environments in a manner which is perfect to enable agile and parallel development activities.

One very central aspect of system integration is collaboration. On the one hand, this refers to the way designer teams working at different locations cooperate, but, much more importantly, this concerns the way

specialists interact across different disciplines. In this respect, it is crucial for these people to network, to make knowledge accessible and comprehensible and to piece it all together in a meaningful way.

«Walenta»: Distributed development requires uniform processes that achieve comparable results. The tools of the IODP deliver the infrastructure for different kinds of users to collaborate productively at different locations along a defined process. We at AVL make intensive use of methods, processes and tools at our own Tech Centers around the globe. No matter in which AVL



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Intuitive operation of software tools, as well as faster and easier access to information, will shape the powertrain development for the future.

Tech Center the tests are run, our high standards demand that the results must always have the same superior quality and be reproducible everywhere.

«F»: How can the AVL tool chain be expanded or redesigned to even further optimize collaboration in

powertrain development across different locations and cultures?

«Walenta»: For us, the next step is to significantly simplify the access to our tools and enable a more intuitive use. The main focus is on solving a specific development task – the tool itself must offer engineers

optimal support in doing so. This is why software tools have to get smarter and smarter and integrate an ever increasing level of application knowledge. This gives users information – and not just a mere view of data that first requires a lot of hard work before they can be interpreted. An intuitive approach

will bring on a sharp rise in development efficiency.

◀F: What role does intuitive operation have in the high-tech environment in which AVL is active?

◀Walenta: Usability improved this way plays a huge role, and particularly so for the new generation of designers who have only just left university. These young engineers use novel tools at a very advanced level and are very quick to achieve results with them. These users, however, give very little thought to the deeper processes behind applications. This, of course, raises demands on the manufacturers of development tools: the specialized knowledge made available by such tools has to be validated in the best possible way, because engineers no longer have the wish or even the time to question the underlying methodology or calculations. All the tool is required to do is be stable and deliver the required results quickly.

◀F: How, specifically, does AVL adopt this intuitive approach in its products?

◀Voigt: We consider it essential to give our products a uniform look & feel, because an individual user usually has to operate an entire set of integrated tools at once. We also attach great importance to ensuring ease of use in our products: In special usability labs, we run thorough tests – both with experienced and inexperienced users – to see just how usable our products really are. One of the latest examples is the new version of AVL CAMEO, our established all-in-one calibration tool, which has a remarkably advanced and clearly structured graphical user interface that helps



KAI UWE VOIGT,
EXECUTIVE VICE PRESIDENT INSTRUMENTATION & TEST SYSTEMS

» IT IS CRUCIAL FOR PEOPLE
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AND TO PIECE IT ALL TOGETHER
IN A MEANINGFUL WAY. «

users perform their work in a very effective way.

But now we are taking usability one big step further: 'User experience' today is an essential feature of products and systems. So our ambition now is to make sure that users of our solutions truly experience the consistency of our tools. This requires that the same functions are implemented in a consistently identical way in all of our products. To be able to master the resulting complex interdependen-

cies, we employ advanced system engineering approaches to develop our products. To model our systems, for example, we use SysML.

◀F: How can these new products help to make knowledge available in one organization accessible to others in a fast and convenient way?

◀Walenta: The focus here must be on integration. The system integrates and concentrates data from a broad variety of sources. In a



MARIO WALENTA,
VICE PRESIDENT SALES INSTRUMENTATION & TEST SYSTEMS

» A DECENT PORTION OF
PIONEERING SPIRIT AND OUR
INTENSE RESEARCH IN THE AREA
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US TO CONTINUOUSLY DEVELOP OUR
SOLUTIONS FURTHER. «

second step, these data need to be consolidated – i.e. the data relevant for the specific application are sought and any other are no longer needed. In a third step, the accumulated information must be turned into aggregated information, which is eventually presented to the user. The goal is now to use this selected and simplified information to derive conclusions or make decisions on possible directions the development is to take.

«Voigt»: The buzzword here is Big

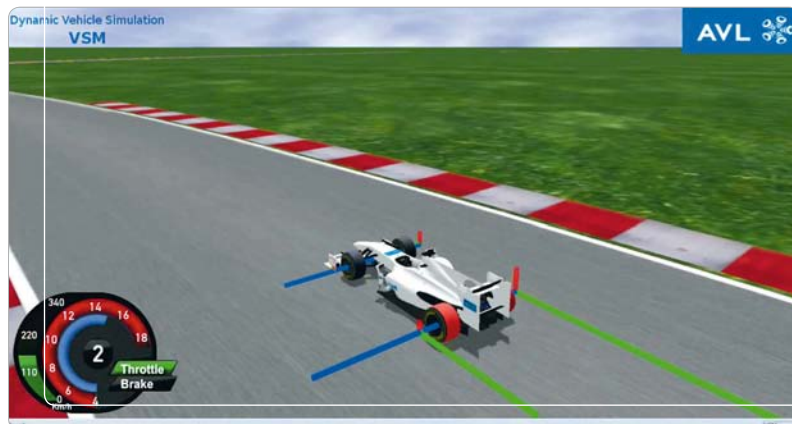
Data – it is all about extracting information from a tremendous variety of data. For example, you can generate very valuable information from the data collected in our calibration database AVL CRETA, which were obtained from a large number of calibration projects. Based on this, you can apply statistical methods to create preliminary calibrations or decide at an early stage which parameters need to be manipulated or changed if any.

A second major field involves making processes visible and measurable. This includes, for example, determining and displaying performance indicators based on an analysis of usage behavior in the powertrain test field. This is then used to derive measures for continuous efficiency enhancement.

«F»: AVL has assumed worldwide leadership where this kind of development is concerned. What is the motivation behind this commitment?

«Voigt»: AVL has extensive powertrain development expertise and is just as competent when it comes to integrating development tools into our customers' processes. By combining the comprehensive capabilities we have in the area of simulation and test systems with our wide-ranging application knowledge in powertrain engineering, our 6,200 employees all over the world – the majority of these are engineers – constantly strive to develop efficiency-enhancing methodologies and make them available to our customers in our products. It is this globally unique combination that continues to drive our methodology and product development forward.

«Walenta»: AVL sees itself as a powerful innovator in this area. It is AVL's vision to ensure mobility that is both clean and affordable. Our claim to never stop questioning the status quo, a decent portion of pioneering spirit and our intense research in the area of technology and trends enable us to continuously develop our solutions further, thus ensuring their long-term feasibility. ←



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Peter Schögggl, Head of Business Field Racing, Powertrain Engineering

THE ACTUAL RACE STARTS VIRTUALLY

The 2014 racing season sees electrification in Formula One becoming more relevant than ever before. This means that simulation is increasingly important for making the most of the new powertrain.

► Simulation is getting more and more important in international motorsports. In Formula One racing preparations, it is nowadays just as much standard practice to cover as many as 50,000 virtual laps on a PC as it is to run tests on test beds, where different kinds of simulations provide for realistic testing conditions. For more than ten years, it has not been possible to imagine global motorsports without the AVL Vehicle Simulation Model (VSM), a tool that was designed specifically

for these testing tasks. “We introduced VSM to the Formula One back in 2001, together with Ferrari, in an effort to tune the then-new traction control technology on the test bed at an early stage in development,” Peter Schögggl, Head of Business Field Racing, Powertrain Engineering, told *Focus*. “Today, with our VSM, we are market leaders in a large number of international racing series. VSM is developed further on a continual basis, with new

functions and models regularly being added to fit the changing rules and regulations. For quite some time now, this has empowered us – and our customers – to test and optimize the new electrified F1 powertrain both purely virtually and on a highly dynamic engine, transmission and powertrain test bed.” (*Read more about this in our double-page feature.*)

HIGH-PRECISION MODELS

For racecars to be optimized virtually, multiple different simulation models are required. The scope ranges from “driver models”, which are capable of moving the vehicle realistically at its limits, and models of the individual elements of the powertrain (engine, electrical machines, battery) through to highly accurate digital representations of racing circuits from all over the world. More than 70 of these tracks can be found in AVL’s comprehensive virtual library. Among myriad other features, these include the exact properties of the asphalt surface, any occurring bumps and even

the infrastructure along the track, giving drivers in the driving simulator an idea of their braking points.

To enable simulation, the chassis, the racecar's aerodynamics and its suspension have to be represented as models too. "The data relating to the spring suspension and damping system are supplied by other simulation models or special test beds, and are imported directly into the VSM. The principle of using measured data for the models is applied very frequently – for creating the model in the first place and also for refining it later. Where this is concerned, values which our engineers measured on site at the racing circuit also play a key role," points out Peter Schöggel. The important thing is always to make sure that the processes are executed fast.

One of AVL's outstanding developments is its high-precision tire model. "The high aerodynamic downforce helps to push the racecar's hot tires deep into the pores of the asphalt. Using the asphalt-surface micro-roughness data for the respective racing circuit, we are able to simulate the way the tire rubber reacts with the racing track and incorporate such data into the overall vehicle model, which increases its quality very significantly," Schöggel explains.

1.6-L-TURBO ENGINE AND NEW ELECTRIFICATION COMPONENTS

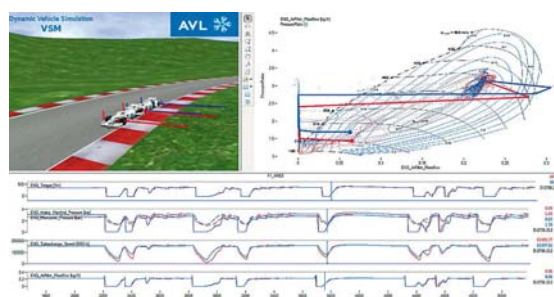
An essential new feature of the 2014 F1 regulations is the 1.6-liter, six-cylinder, turbocharged engine, for which AVL has developed an engine model. Despite being extremely powerful, the model is also real-time capable. "Using our many years of experience with

direct-injection turbocharged engines," says the expert, "we managed to develop an extremely high-performing transient model of the new F1 engine, including a combustion model. Particular attention was also given to fuel consumption, which, according to the 2014 F1 specifications, will now be restricted both in view of the total amount of fuel allowed in a race (100 kg) and fuel flow rate per hour (100 kg/h)."

One of the really tough challenges the AVL simulation experts had to deal with was posed by the new

be to power the turbocharger electrically, which would firstly remove lag and, eventually, lead on to the development of a new generation of turbochargers with an even better level of efficiency." According to the expert, this Formula 1 innovation might soon even be applied in series-production sports cars, taking the form of new and electrically powered turbochargers.

Especially the increased level of electrification has caused a sharp rise in the number of parameters available for fine-tuning a Formu-



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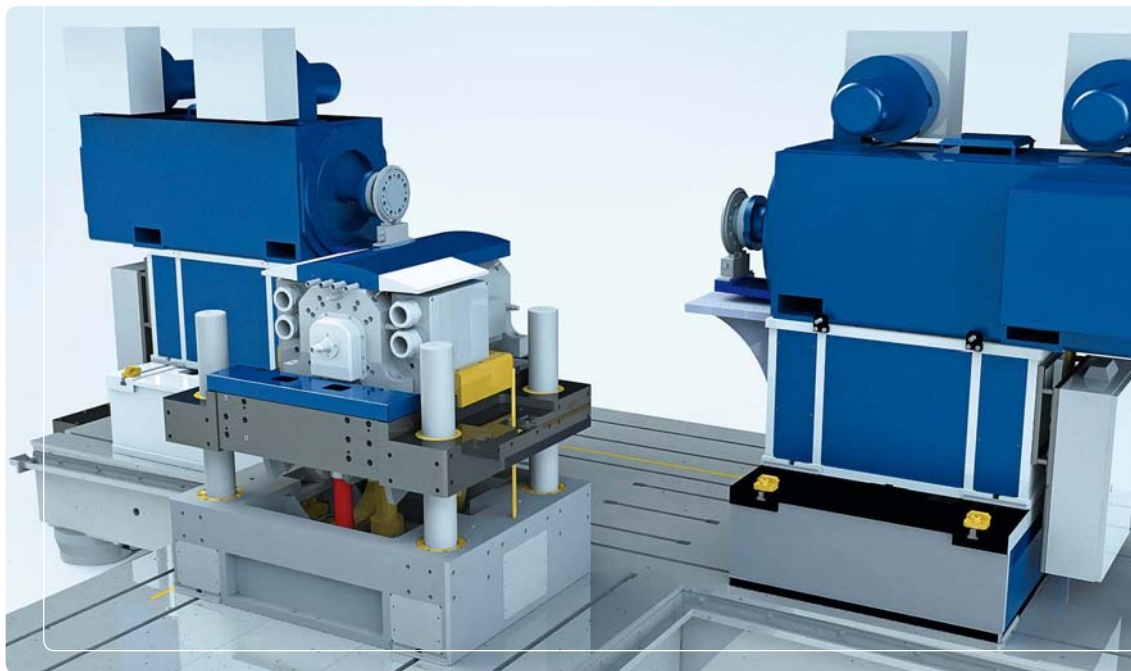
Simulation of the turbo charger map with the AVL Vehicle Simulation Model (VSM).

F1 electrification components: the electrical machine MGU-H (Motor Generator Unit – Heat) coupled with the turbocharger – its rotational speed must not exceed 125,000 rpm – and the MGU-K (Motor Generator Unit – Kinetic) which is deployed as a means of propulsion and energy recovery.

Peter Schöggel: "The MGU-H, in particular, opens up a vast number of novel ways to develop the operating strategy. The energy, for example, can be fed straight into the MGU-K and used for propulsion, which, according to the regulations, is possible without limitation. Or you can store the generated electricity in the battery to use it later as an extra boost. Another option would

be to power the turbocharger electrically, which would firstly remove lag and, eventually, lead on to the development of a new generation of turbochargers with an even better level of efficiency." According to the expert, this Formula 1 innovation might soon even be applied in series-production sports cars, taking the form of new and electrically powered turbochargers.

Especially the increased level of electrification has caused a sharp rise in the number of parameters available for fine-tuning a Formula 1 powertrain. "Particularly in view of optimizing the interaction between the 1.6-liter turbo engine and the new electrification components, we at AVL have clear technological edge over our competitors. This is down to the fact that our engine model is also capable of representing the feedback effects which the electrification technique has on the combustion engine. But even where performance optimization of the overall vehicle is concerned, the Vehicle Simulation Model is a superior tool, a fact clearly reflected in the AVL VSM's great success in international motorsports. In 2013 VSM customers won as many as ten national and international championships," adds Peter Schöggel. ←



ELECTRIFIED FORMULA ONE ON THE TEST BED

AVL test systems allow you to test the entire powertrain of F1 racecars – including all of the new electrification components.

► 2014 sees the introduction of new rules and regulations, where electrification takes on a whole new level of significance: The power of the electric drive motor (MGU-K for Motor Generator Unit – Kinetic) increases from 60 to 120 kW, and, at the same time, the additional electrical energy may be used for more than 30 seconds each lap (previously 6.6 seconds). The amount of energy stored in

the battery is ten times that allowed previously. There is also a totally new electrification component in the 2014 Formula One season, as Volker Niemeyer, Director of Electrification & Racing Test Systems, points out, “The second electrical machine, which is referred to as MGU-H (Motor Generator Unit – Heat), is mechanically directly coupled to the

compressor side of the turbocharger. The MGU-H has two functions: firstly, it is used as a generator to produce electricity, and, secondly, it can electrically power the turbo at low engine speeds, improving the engine’s torque behavior at low speed levels. In short, the engine management system in a F1 racecar gets lots of additional degrees of freedom that need to be controlled.”

For these degrees of freedom to be managed, extensive testing is required – both in the context of simulation during the concept phase and by running tests on special AVL test beds, where simulations also play a major role.

TWIN E-MOTOR TEST BED

Testing and calibrating all electrification components – MGU-K and MGU-H, battery, inverter and the ECU – of a Formula One powertrain requires the use of the AVL twin electric motor test bed. “As the MGU-H reaches 120,000 rpm and the MGU-K reaches up to 50,000 rpm, the electrical machines are coupled to the dynos using a transmission. Especially where the MGU-H is concerned, torque measurement is necessary, which is not an easy matter to deal with. The entire high-speed drive has to be precisely aligned to the engine mount, down to a hundredth of a millimeter,” says Volker Niemeyer, describing the tough challenge in testing. In addition, the test bed is designed to allow you to connect the two electrical machines on the test bed to the inverter using exactly the same cable harness that is used in the racecar. Having the possibility to install the identical cable harness from the vehicle offers customers the advantage of being able to transfer the entire power unit straight from the car to the test system. This can be useful later on, for example, for troubleshooting. Both for cooling the electric motors and the inverter, the test bed has special conditioning systems that are able to reproduce thermal loads like those in the vehicle.

The energy supply for the two electrical machines is ensured by the AVL E-Storage System with Battery Emulation, which reproduces the exact behavior of a Formula One battery. “We have three kinds of battery emulation: The most simplistic model simply involves reproducing the battery’s internal resistance. The second variant is a closed AVL battery model that offers our customers parameterization options. The third and most sophisticated model is a Matlab/Simulink environment, where customers can replace the battery model supplied by AVL with one of their own.

The other elements of the powertrain can be represented by models, too, giving actually existing, real components – like the MGU-K and the MGU-H – the ‘feeling’ as if they were already inside the vehicle and on the track,” explains the expert. “This way, even powertrain vibration can be emulated, which allows designers to develop and tune the strategy for damping the powertrain vibration with the existing electric motor early on in the frontloading procedure on the test bed.”

OPTIMIZATION ON THE POWERTRAIN TEST BED

Once all elements of the F1 powertrain are available as hardware, the tests are continued on the powertrain test bed. The real internal combustion engine, however, is not absolutely necessary for these tests. It can be replaced by the AVL F1 Prime Mover dyno, which can reproduce the main orders of the real engine. “With the AVL F1 Prime



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The MGU-H and MGU-K can be tested with the AVL Twin E-Motor Testbed.

Mover, designer teams can test the MGU-K or the transmission with the complete powertrain without the need for the real engine, which frequently isn’t available to all teams for testing purposes. Even the operating strategy can be optimized on the powertrain test bed, using high-precision tire and track models,” says Volker Niemeyer. As well as for Formula One, this test and optimization method is also employed for the electrified racecars of the WEC series, and even for road vehicles.

“We offer our customers an integrated tool chain for testing the electrified powertrain – from virtual frontloading to test beds for individual components and test systems for the complete powertrain. At the same time, we combine highly dynamic test engineering with state-of-the-art simulation technologies, creating testing environments which are as close as possible to real driving on the racing track. This empowers our customers to get maximum performance from their racecars in this brand new era of motorsports,” says Volker Niemeyer, summing up the advantages of AVL RACING. ←

THE MINIATURE WORLD OF AVL

Opening ceremony of the AVL Crèche/AVL Kindergarten in the AVL headquarters in Graz.



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At the successful opening, CEO Helmut List and Provincial Governor Franz Voves presented a framed logo of the AVL Crèche/AVL Kindergarten to the children.

► “There’s no nicer way to start a day.” These were the words of CEO Helmut List when he congratulated the children on their

welcoming performance at the official opening ceremony of the AVL Crèche/AVL Kindergarten in the AVL headquarters in Graz.

Around 50 children from ten different nations, along with their parents, will benefit from the loving care provided by the childcare facility close to their workplace. The AVL facility for child education and care operates according to a well-thought-out pedagogical concept which encourages children to explore, sparks their curiosity and promotes intercultural understanding. ←



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Kathryn List, founder and chairwoman of the AVL Cultural Foundation, and Michael Ksela, CEO of SCOOP & SPOON, at the awards ceremony.



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Helmut and Kathryn List were delighted by the Lovie Award for the Helmut List Halle app. The Lovie Awards are known as the highest award for digital projects made by European organizations and institutions.

LOVIE-AWARD FOR HELMUT LIST HALLE APP

The prestigious award for digital projects was presented in London.

► Art and creativity is an essential part of AVL’s corporate culture. Impressive art-and-culture achievements at AVL include the founding of the AVL Cultural Foundation and the establishment of the Helmut List Halle with its internationally acclaimed acoustic system and much more. And here’s the latest highlight of the company’s

intensive cultural commitment: the app for the Helmut List Halle has won the Lovie Award and the People’s Lovie Award in the category Mobile and Applications – Entertainment!

The app, which was created and designed by SCOOP & SPOON, proved successful against close to 70 competitors in the same category. ←

The Trend Conference in Graz

26th International AVL Conference "Engine & Environment"

ENGINE 2020 – SPARK VERSUS COMPRESSION IGNITION IN A NEW ENVIRONMENT

The 26th International AVL Conference "Engine & Environment" will take place in the Helmut List Halle in Graz, Austria, on the 11th and 12th of September, 2014.

► Further optimization of the combustion engine is an essential key for achieving the CO₂ ambitions. During this conference the potentials of diesel and spark ignition engines will be compared and discussed. The impact of hybridization and connectivity on the design and configuration of combustion engines is another focal topic.

How shall the combustion engine, within the increasingly sophisticated powertrain systems, be designed to meet the future market require-



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Scan QR code and access the app.

ments efficiently? How does the engine change in an environment of increasing electrification? In which markets and vehicle segments will the spark ignition or the diesel engine win or lose? Which role will alternative fuels take on in the future?

These and many more questions will be examined by international experts at the AVL conference. Information, registration and app-download at: www.avl.com/engine-environment-2014; event@avl.com ←

6TH AVL LARGE ENGINES TECHDAYS

"Gas & Dual Fuel" will be the main topic of the international AVL conference on 6th – 7th May 2014 in the Helmut List Halle in Graz, Austria.



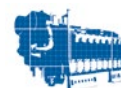
► AVL has selected "Gas & Dual Fuel" as the main theme of the 2014 AVL Large Engines TechDays due to the increasing relevance of gas to the Large Engine Industry.

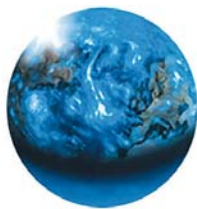
Large engine OEMs are, more and more, challenged by end users to introduce large gas and dual fuel engines to the marketplace as versatile, efficient fuel-to-mechanical energy convertors. The task is complex and challenging, driven by new gas and dual fuel gas engine applications in areas such as locomotive, mining and oil fields. There is also a need for speedy delivery of the introduction of new products and new technologies that allow diesel and gas operation in

the same engine at low future exhaust emission regulation levels.

The conference will open with keynotes of leaders and opinion-makers from the large engines industry who will share their views on future trends and upcoming challenges around gas and dual fuel. To complement these perspectives and to help us see the bigger picture on the conference topic, the program will also include "impulse speeches" by renowned personalities from outside the industry.

For more information see: avl.com/large-engines-techdays2014; email: event@avl.com ←





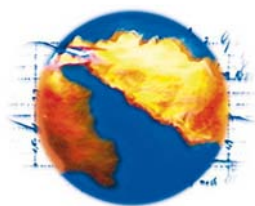
8TH INTERNATIONAL EXHAUST GAS AND PARTICULATE EMISSIONS FORUM

1st and 2nd of April 2014, Forum am Schlosspark, Ludwigsburg, Germany

► In previous years, development trends and strategies have been affected by the exaggeration of actual and perceived possibilities for electrification in the automotive and component industries, but the picture of what is feasible and what is affordable has recently begun to sharpen. Consequently, a meaningful and realistic coexistence, free of contradictions, between combustion engines and electric motors has emerged. Thus, hybrid solutions now have greater potential to offer new possibilities of meeting existing

and future challenges in the reduction of CO₂ emissions and pollutants. The variety of different technological approaches will increase accordingly, depending on whether customers demand mobility in urban areas or cross-country handling. In addition to the existing dynamometer test cycles, plans are in place to include legislative requirements for real road drive cycles with continuous emissions monitoring, which will present a whole new challenge for which convincing solutions must be supplied.

The focus of the 8th International Exhaust Gas and Particulate Emissions Forum is on issues related to the development of petrol and diesel combustion including hybrid solutions and the use of conventional and alternative fuels. Requirements of „Real Driving Emission“ and the increase of efficiency and robustness of exhaust after-treatment systems also play a role, as does the technology of recording even the lowest emissions at transient operation. Information and registration: www.forum-emissions.com ←



11TH INTERNATIONAL SYMPOSIUM ON COMBUSTION DIAGNOSTICS

Combustion Analysis – Visualisation – Simulation,
1st and 2nd of July 2014, Baden-Baden Kurhaus, Germany

► The number of electric vehicles introduced to the market in recent times has increased significantly, and there are no longer ‘rebuilt of an existing solution’. As such, a shift to greener transport solutions are actively supported, though there still remain applications where a combustion engine cannot be replaced or where both drive systems complement each other perfectly.

Out of this fact, the efficiency of electric energy conversion will receive greater focus in research and

development. The results of these measurements and measurement techniques, which we in this Symposium will again devote ourselves to, will be presented and discussed. The complement of indicated results with visual data, together with the link to simulated results, will remain the focus of these lectures.

To satisfy the high investments in modern drive systems that couple combustion engines with electric

mobility, the utilisation of economies of scale is necessary. Here the same combustion engine, even when used in different applications, will share a high proportion of identical parts. To control this development effort effectively, the simultaneous measurement of combustion characteristics and control variables becomes necessary, which demands an expansion of the classical approach.

Information and registration:
www.combustion-diagnostics.com ←

VIRTUAL TEST BED FOR MODEL-BASED DEVELOPMENT AND CALIBRATION

Based on simulation models of the combustion engine and the exhaust gas aftertreatment system, the AVL XIL.STATION enables to perform key development steps in a virtual testing environment. Ensuring ease of use and a high level of acceptance, the test system's user interface and calibration tools are identical to those on the real engine test bed.

► The AVL XIL.STATION is a virtual test system where all elements of the test bed are simulated. Based on real-time models of the internal combustion engine and the exhaust gas aftertreatment system (see page 16), the system allows you to develop or calibrate control devices, even under extreme ambient conditions such as heat or cold – conditions which real engine test beds frequently cannot represent at all, or can do so only with extreme effort. Besides reducing time and cost of development, this approach also leads to a significant gain in calibration quality. This is because, right from the start, the system works with a high level of data quality. Under ideal circumstances, the concluding validation in the vehicle will merely require minor changes to the data status.

To make work with the new system as convenient as possible, developers will discover that the operator interface on the XIL.STATION is exactly the same as they find it on their engine test bed. The applications used are identical too: for calibration purposes, AVL CAMEO is deployed; test run automation takes place with PUMA Open. Where required it



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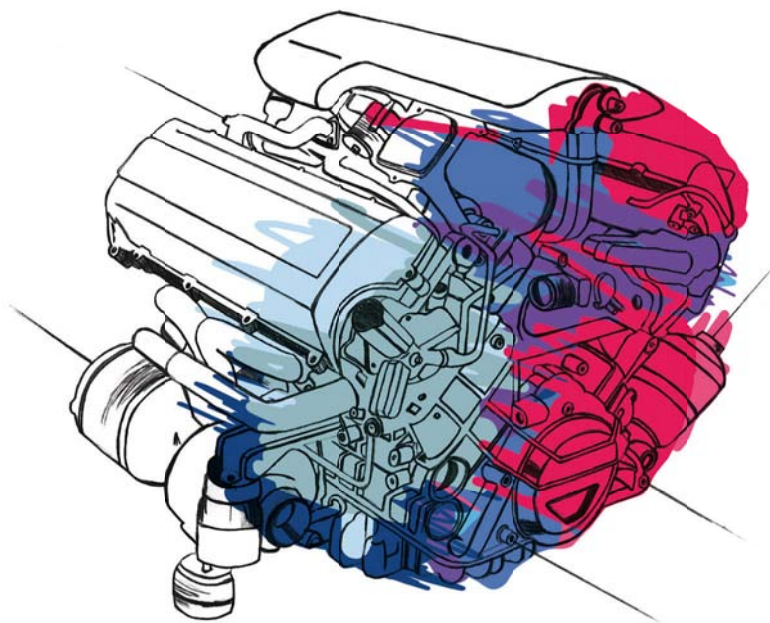
The AVL XIL.STATION for model-based development and calibration.

is possible to simulate the overall vehicle using AVL CRUISE. Maneuver simulations can be integrated with AVL InMotion. Calibration data management and result post-processing on XIL.STATION are performed with the proven AVL tools CRETA or CONCERTO, respectively.

Adding the engine control unit (ECU) to the integrated HiL system is accomplished quickly and easily via a load-unit drawers and a standard cable harness. The

system's open architecture also enables the integration of HiL systems from various makers. In addition simulation models created by the customer or other suppliers can be integrated on XIL.STATION.

Gerald Hochmann, Application Manager Engine Testing, Instrumentation & Test Systems, sums up the key advantages of XIL.STATION: "Unlike conventional HiL systems which very often can only be operated by specialists XIL.STATION is extremely easy to work with due to the smart way an in-the-loop front-end, models, calibration tools and test automation system are integrated into an overall system. Added to this is the fact that developers can operate in their usual working environment with tools they are already familiar with. This reduces training requirements for the test facility operators considerably. Integrating XIL.STATION into an existing test environment is possible without any difficulty with regard to data management, data usage, parameters and results and is a fundamental requirement for reaching development goals faster at higher quality." ←



AVL CAMEO: ALL-IN-ONE POWERTRAIN CALIBRATION

To meet strict emission legislation and increased market expectations, AVL CAMEO has become even faster and even better – from measurement data to the optimized map.

► With the growing challenge of increasing development efficiency, powertrain calibration is becoming more and more important. For more than 15 years AVL CAMEO delivered sophisticated methodologies in a practical tool, enabling engineers to deliver real-world improvements in calibration quality. Calibrators all over the world use CAMEO as their tool of choice, which is shown by the large number of sold licenses.

As calibration is becoming increasingly complex and the expectations of the marketplace greater and greater, AVL decided to meet these various challenges – such as the trend towards greater diversity of variants – which has made calibration such a tough job.

THE NEW CAMEO 2013 R2

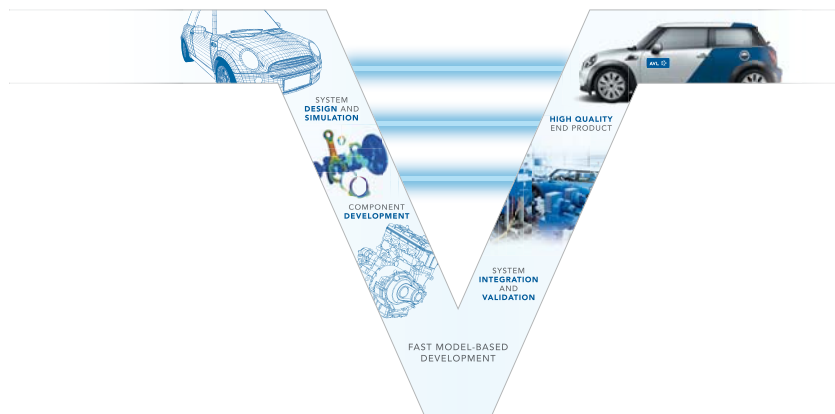
Intense discussions with calibration engineers at major OEMs all over

the world, inspired AVL to design the new CAMEO 2013 R2. “Our well established all-in-one powertrain calibration tool has now a much fresher, cleaner and more focused user interface. Engineers can focus on the task and still have all relevant information available without distraction. This philosophy of CAMEO helps to dramatically reduce ramp-up time from weeks to single days – and to save valuable time every day of use”, says Alexander Heindl, product manager for AVL CAMEO.

NEW ONLINE INTERFACES

CAMEO addresses both the needs of the calibrator as well as the engineer who operates at a test bed. Wherever engineers want to work, they can do so with the same familiar tool. To supercharge the development cycle, CAMEO has been designed with new online interfaces into the virtual world of IPG CarMaker software – an industry first. AVL’s leading advanced simulation tools like BOOST, EXCITE, FIRE and CRUISE are closely integrated as well – facilitating the use of advanced design-of-experiment and modeling methods within frontloaded development applications, as well as system design.

Starting with the raw data the whole workflow process of the calibration task has been optimized in the new CAMEO – quick analysis of this data, with respect to the modeling task, is an essential component in an efficient process. Poor quality data means low quality models unsuitable for optimization and map generation. With advanced statisti-



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CAMEO can operate in several stages of the V-process and increases efficiency in calibration by using standardized workflows, in combination with excellent usability.

cal methods and built-in powertrain knowledge, CAMEO automatically checks the quality and plausibility of measurement data in a minimum of time.

INNOVATIVE MODELING TYPE

INN2 is an innovative modeling type that is pushing the boundaries of DoE even further. “We are proud that our INN2 has been proven to be the best in class model by independent DoE experts. The patent protected algorithm is capable of representing the most complex of surfaces and design spaces”, says Alexander Heindl.

CAMEO offers a number of advanced modeling methods to suit applications like base calibration, emission calibration, transmission calibration and others – understanding that there is no single algorithm that is optimal for all use cases. What makes it unique is the fact that CAMEO can automatically determine the most suitable model algorithm and intelligently tune

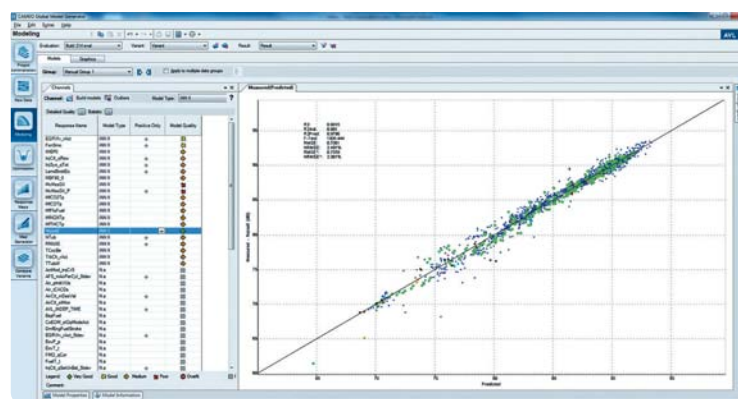
model type parameters to help engineers to quickly get first results.

“Emissions Legislation is one of the most challenging parts of modern powertrain calibration”, states Alexander Heindl: “That’s why spe-

car emission cycles. This enables the engineer to optimise on its familiar cycle based g/km target in a simple and easy way, benefiting from CAMEO’s proven processing speed.” Another feature that supports the calibration engineer is the new combined optimisation algorithm which ensures reliable and consistent results. Engineers can concentrate working on the results without hassling with algorithm selection. In this spirit, all optimization results are automatically displayed in the familiar map view.

New map data can be downloaded online to the control units, stored directly in calibration data management systems (e. g. AVL CRETA) or exported as DCM-files.

Finally, it is the collectivity of the advancements in functionality and usability that make AVL CAMEO



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Verification data proof best result of the automatic model selection.

cial attention has been put to the optimisation module. CAMEO now understands all relevant passenger

the tool of choice for boosting real world productivity in powertrain calibration – from measurement data to the optimized map. ←

AVL ARTS & SCIENCE — PROCESS AND RESULT AS A SOURCE OF INSPIRATION

With its Arts & Science communication platform, the AVL Cultural Foundation encourages creativity and innovation, placing its main focus on the interface between science and the arts.



► The process leading up to the implementation of projects, the central theme of which is the bridge between the arts, culture and technology, is an essential part of the way creative development is perceived. To help observers and participants relate to this process, the AVL Cultural Foundation has set up the Arts & Science platform. The projects in their entirety – and not just their final result – become a source of inspiration. The purpose of the Arts & Science platform is to enable cre-

ative and innovative processes and to help people develop their potential to be passionate inventors, explorers or thinkers.

Artists and scientists are offered the opportunity to address all sorts of different project themes, commissioned by the AVL Cultural Foundation. These may range from setting up art projects inspired by scientific or technical problems or technology to collaboration be-

tween artists and scientists on joint initiatives. The principle of cooperation and networking is the foundation upon which the AVL Cultural Foundation builds the contents of its Arts & Science focus.

ART IN SCIENCE, SCIENCE IN ART

Creativity is not confined to artistic activities; it also leads to forward-looking developments and innovative solutions in science and tech-

nology. Decisive in Arts & Science projects is not the strict categorization of the disciplines – Art, Culture, Science and Technology – it is rather more the demonstration of the effects they have on each other by interaction and the development of parallels and contrasts. Step by step,

ects as is the unrestrained play with visions. By dealing with each project, creators and spectators alike can draw conclusions and gain insights and perspectives for their own work.

To launch the Arts & Science platform, the AVL Cultural Founda-

Arts & Science, Peter Oswald, cultural theorist who specializes in New Music and is an Austrian cultural and music manager, focuses on the subject “From Chaos Theory to Beethoven: Complexity in Art and Science.” Cellist Friedrich Kleinhapl explores the topic of “The Miracle of the Ear.” Thanks to the multimedia content available on the Arts & Science platform, anyone interested can gain fascinating insights into each of the projects.

DIGITAL REFLECTION

These outstanding projects are central to the Arts & Science app. Updates on the process steps allow users to keep track of the development on their mobile devices. The Arts & Science app and the website are linked to each other, so that the log-in function can add a bookmark to an article in the app, which you can later read on your laptop.

The design of both digital communication tools reflects the Cultural Foundation’s rich diversity of activities in a subtle and very contemporary way. The AVL Cultural Foundation’s new website (www.avlcf.com) is very clearly laid out and offers its visitors profound insights into its projects and cooperation initiatives, past and present.

To further deepen the understanding of the AVL Cultural Foundation’s work, which primarily seeks to bridge the gap between art and science, multimedia contents have been included, such as event recordings, detailed project descriptions and interviews with artists. ←



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Mobile insights into complex projects: The AVL Cultural Foundation Arts & Science app.

the Arts & Science platform seeks to outline the project process throughout the different development phases. The object is to create a dynamic and open dialog between the arts and science, because reflection as a critical process within the scope of creative work and theoretical discourse is just as much a part of these proj-

tion explores the topics of Sound and Complexity and discusses how far these central buzzwords reach into different areas of society, as well as arts and science disciplines. Within the context of

LARGE GAS AND DUAL FUEL ENGINES

As the cost of gas comes down, especially in the United States, there is more and more demand for gas and dual fuel engines in a variety of existing and new applications. Andrei Ludu, Deputy Vice President of Large Engines at AVL, spoke to *Focus* about how AVL is working closely with customers to develop innovative new engines at high speed.

► The background to recent high demand for large gas and dual fuel engines is the increased availability of gas in North America and the consequent reduction in price. But as well as cost there are also a number of other benefits.

“Gas creates far fewer emissions,” says Ludu, “and almost no particulate emissions. And the technology needed to have low emission gas engines is less complex than that needed for Diesel engines.”

Gas engines have historically been used at gas power plants. Then, in the past decade, gas became a more common form of power generation. And Liquid Natural Gas (LNG) is being used more and more for marine applications, especially by LNG carriers.

But Ludu says that there is a revolution taking place in large gas and dual fuel engines. “The end users are requesting our customers (engine OEMs) to create gas or dual fuel solutions in applications that would not have been thought of before e.g. locomotives, driving pumps

in an oilfields or large mining trucks. This is a game changer!”

And according to Ludu, AVL is well placed to deliver exactly the kind of solutions that both OEMs and end users are after.

“The gas engine is a very specific animal. You can be a very good Diesel development engineer and still in some aspects be a beginner in gas engine development. You need dedicated expertise. AVL has that.

The company started working intensively on large gas engines in the 1990s, making it one of the most experienced companies in the world in the technology.

“We are one of the pioneers for some elements of the gas engine,” says Ludu, “like Diesel-Fuel-Ignited gas combustion, laser ignition systems, Dual-Fuel engine design, increased efficiency and emission control.”

“And we invested our R&D money wisely to understand the specifics of gas combustion in order to



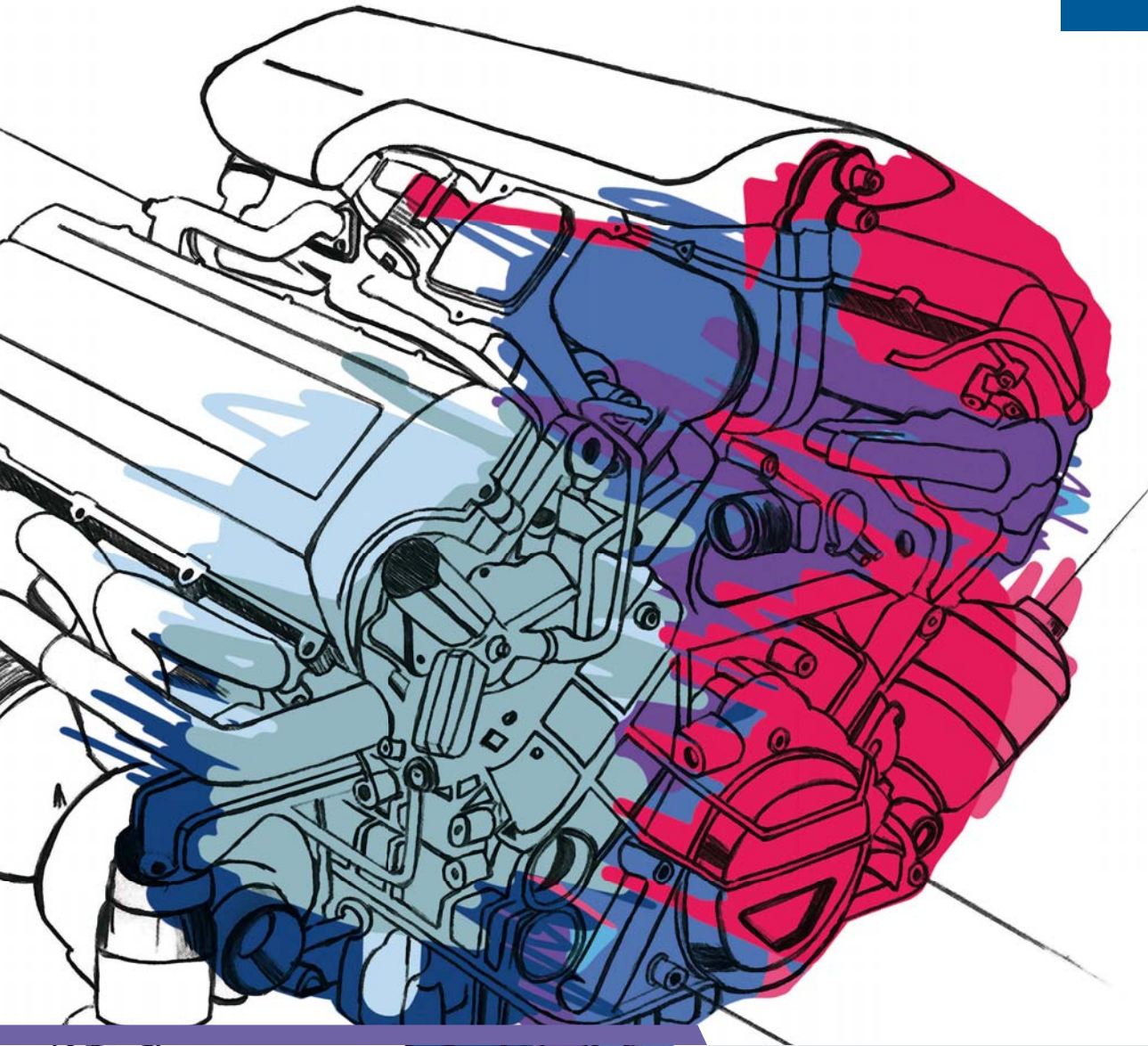
Andrei Ludu, Deputy Vice President of Large Engines at AVL

have the gas and Dual-Fuel engine performance as close as possible to Diesel engine performance. What our customer ideally wants is to convert from Diesel to gas or Dual-Fuel without any handicap from making that choice.”

As the world moves towards more gas engines, the winners will be the people who have the best existing expertise, create new technology fast, e.g. Tier4 emissions solutions for Dual-Fuel engines and are able to materialize all of this into industry projects.

According to Andrei Ludu, AVL are well-equipped in all departments, having years of experience, dedicated in-house R&D programs and industry projects know-how and references.

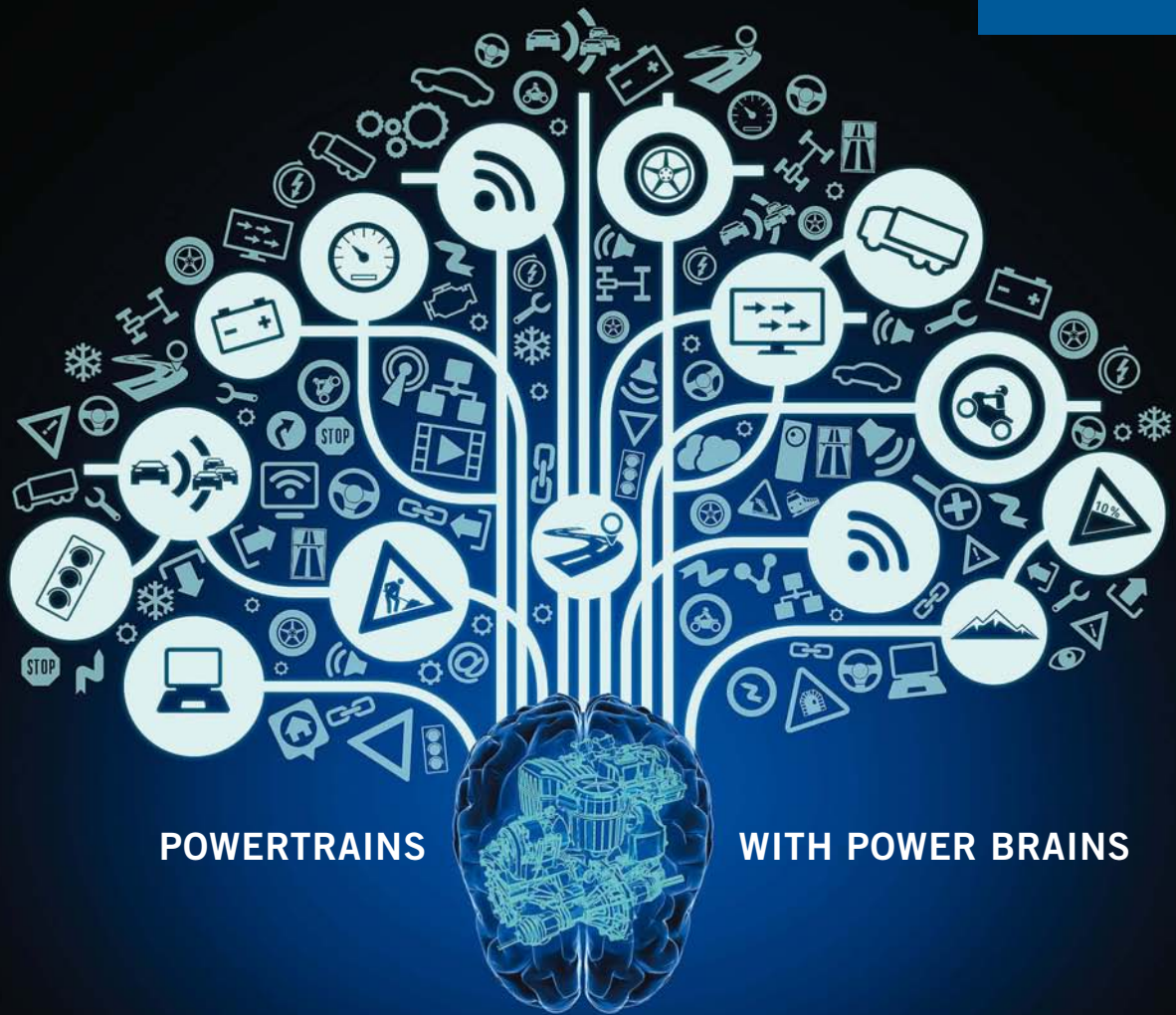
“We feel comfortable and strong in that we understand holistically what needs to be changed on a diesel engine in order to make it a gas or a Dual-Fuel engine. We now need to continue to market our expertise and services fast because the opportunity is now.” ←



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