



auto**motion**

EDITION 3 | 2008 | IAV - AUTOMOTIVE ENGINEERING

Gaseous-Powered Vehicles

Model diversity: important factor for the spread of gaseous fuels – QVM conversion is IAV's approach

by Kody Klindt and Iraklis Avramopoulos



Limited oil supply, increasing demand and dependency on foreign oil are heating up the discussion regarding alternatives to conventional fuels. Compressed natural gas (CNG) and liquefied propane gas (LPG), in particular, are viable solutions capable of being implemented in the short term. The lack of diversity in vehicle models is demanding new approaches.

The successful spread of gaseous-powered vehicles is not strictly dependent on alternative fuels being more favorably priced. Infrastructure and model diversity are also extremely important factors in the market success of gaseous-powered vehicles. "This is why the decision to develop the vehicle concepts demanded by the market and the way they are realized are of tremendous significance," says Iraklis Avramopoulos, Head of Department, Gas Propulsion at IAV.

In principle, having a wide range of gas-powered vehicles in all vehicle classes would do most to boost their spread. This can be underpinned by the fact that, last year alone, some 70,000 vehicles across Germany were equipped with LPG retrofit systems. The situation for compressed natural gas (CNG), however, is different. Because CNG systems cannot be integrated in an existing vehicle concept without several system changes, the consumer is provided with a relatively narrow choice of vehicle models. These are offered by the OEM directly or by QVM (Qualified Vehicle Modifier) converters, such as IAV. "The CNG conversion time and expense is constantly limiting growth figures and harbors the risk of seeing the 'delicate flower' of compressed natural gas wither as a fuel because Germany's relatively well-developed CNG filling station network is not being used to capacity," Avramopoulos explains.

Various approaches are available to prevent this from happening, as referenced in the accompanying table. Iraklis Avramopoulos' upshot: "After considering the key aspects of environmental protection and cost reduction, approach no. 2, as a means of paving the way to approach no. 3, seems to be the optimum solution."

IAV is a full service provider for the development of gaseous-powered vehicles

IAV has been working on the development of gaseous-powered engines since the early 1990s. Experience and know-how has been demonstrated in developing production vehicles and devising QVM conversion solutions. In addition to converting vehicles, IAV also takes care of all after-sales activities; such as servicing, workshop training and spare parts supply. The benefits of IAV's concept using the master/slave
▶ [continued on page 6](#)

Editorial

Dear Readers,

With market analysts portraying the current financial crisis as a 'once-in-a-century' economic event, the next couple of months will have a decisive impact on commerce as a whole, the North American automotive industry included. Development budgets will undoubtedly be constrained, investments discouraged and funding cut in the hope that some resurgence looms in the near future.



Despite these hurdles, several truths remain. Among them, the need for fuel efficiency and refined powertrains has never been greater. To confront this reality, while simultaneously strengthening the automotive industry and meeting the challenge of ever-increasing development costs, it's clear that the responsibility for corrective action rests with those who lead the automotive sector. By coming together and focusing on core strengths, the leaders of today's industry can shape what is to come. The importance of forming strategic partnerships and alliances with suppliers, as well as other OEMs, cannot be stressed enough. IAV remains prepared to bolster these efforts in support of our customers by forming long term relationships and speeding up the development of next generation powertrains while minimizing costs. Having IAV serve as an interface between the vehicle manufacturer and the engine or transmission supplier is one example of how we can enable new alliances.

I invite you to read on; you will find interesting reports throughout this most recent edition of IAV's **auto**motion newsletter on how we have accomplished this successful partnership in the past (e.g. VW Lavidia development) and how we are prepared to support your efforts in the future (gaseous-powered vehicles, plug-in hybrid simulation etc.). And, with IAV's "big move" to Northville, we are now further equipped with the tools to do so.

Utz-Jens Beister
President of IAV Inc.

IAV at Convergence 2008

Vehicle-electronics capabilities for controlling powertrain, chassis and other features

By Jeremy Goddard

The first formal coming-together of the North American automotive-electronics community at Convergence was in 1974 in Dearborn, MI. At that time, the aim of the program was relatively simple: to share and showcase new ideas and technologies among electronics engineers and their companies, all of them eager to develop improved controls, audio systems, telematics and more, and to bring together the automotive and consumer-electronics industries. 241 people attended.

Since then, the annual Convergence Show has maintained its focus and grown steadily, such that in 2000 the show was relocated from Dearborn to Detroit's Cobo Hall – with its broader range of facilities to handle the growing number of Converging visitors from around the nation and abroad – where it has remained ever since.

It may not be universally recognized that a significant portion of the monies raised by the Convergence event is dedicated by SAE to developing programs and providing funding to assist teachers and education administrators in improving the education of students in mathematics, science and engineering.

Today, Convergence hosts around 7,000 attendees over its three action-packed days and consumes 140,000 sq.ft. of the Cobo arena. Attendees can meet fellow electronics engineers on the bustling stands of exhibiting companies or learn of emerging technologies and significant issues in greater depth from experts presenting their papers on a variety of technical specialties.

Given the focus of the show, IAV exhibited its vehicle-electronics capabilities for controlling powertrain, chassis and other feature products in a well-located 900 sq.ft. booth. The foundation of the IAV booth was the glass car, which allowed several technologies to be showcased: controllers for CNG engines, transmissions

and vehicle dynamics; adaptive forward lighting; high-voltage battery and inverter; and the latest generation of drive recorders. Apart from the car, IAV displayed model-based testing, open-loop test systems, ECU-validation and thermo-electrics for discussion with development-engineering visitors to the booth. IAV had several experts on hand to support the glass car exhibits and to confer with visitors about model-based testing and ECU validation. "Although IAV Inc. is currently focused on Powertrain Engineering," commented Utz-Jens Beister, president of IAV Inc., "we are pleased to have such support from our parent company for the electronic controls for vehicle-dynamics. This offers us a strong potential for new growth in North America."

For the past twelve months, Azad Moorad from IAV Marketing has been charged with coordinating with several departments and drawing together the exhibits chosen for display at Convergence. "We put a lot of time into the planning, and my colleagues worked very hard to develop the exhibits, their accompanying presentations and the associated logistics," Azad observes. "Very few changes were needed, and the final set-up of the exhibit was exactly what we anticipated."

Convergence attendees are typically 61% from the Automotive Sector, 18% from Truck and Off-Road companies and 11% from Aerospace.

Company Executives and Senior Managers comprise 17%; Engineering Product Design, R&D and Manufacturing, 34%; and Quality, Purchasing and Sales/Marketing, together with 1% Academics, making up the balance. IAV ended the Show with numerous new-business leads for development into new projects for the company. "The show was quieter than it has been in previous years," concluded Utz Beister. "However, we are very encouraged by the interest shown in IAV and in our capabilities, and are looking forward to developing solid business with the new opportunities we have found here."

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GM Dinner Drive

Driving advanced powertrains in upcoming GM models

By Jeremy Goddard

During this year's SAE World Congress in April, General Motors and FISITA invited selected participants to visit GM Headquarters in Detroit for their "Advanced Technology Ride and Drive Dinner". The event was backed by ATZ Autotechnology and IAV.

years. Dan Hancock, vice-president GM Powertrain Engineering, provided the drivers and diners with a detailed and comprehensive presentation on all the new technologies GM has been developing for the North American and global marketplaces.

Participants had the exclusive opportunity to test-drive the latest hybrid models and other alternative-powertrain concepts which have occupied GM development engineers over the past couple of

Gerhard Buschmann, executive vice president Diesel Engines – IAV Powertrain Mechatronics, with Dan Hancock, vice president GM Powertrain Engineering



IAV's Big Move

New facilities with four state-of-the-art dyno cells

by Kathleen Rafalko and Craig Assenmacher



IAV Inc. has a new home in Northville

After a year of planning and another nine months of construction, IAV's entire staff found themselves in a new home on the morning of November 3, 2008. Not surprisingly, anticipation of the move had been building just as quickly as the facility itself. Given the aggressive schedule for the "Big Move" of IAV's North American operations, it was imperative that IAV staff were at the top of their game, especially those responsible for the successful completion of the project. There were many hurdles to overcome throughout the duration of the project.

From on-the-spot decision-making to long drawn out meetings, IAV's team worked together to solve problems and assist the general contractor in meeting milestones. "The entire project was a success and it is so gratifying to see the employees enjoying a facility that was so well-deserved," said IAV's new Test Facility Manager, Craig Assenmacher. "The employees here at IAV really care about the quality of work they perform for their customers. The new technical center will make it that much easier to continue to deliver such high quality services,

reinforced by the expanded capabilities that IAV will acquire upon the commissioning of four dynamometers in early 2009."

The new facility consists of a two-story office building, a workshop that far exceeds the size of IAV's previous shop in Ann Arbor and an area which houses four state-of-the-art dynamometer test cells. The building also encompasses many "Green Building" features, all of which Utz-Jens Beister, president of IAV Inc., insisted upon to demonstrate that IAV's energy-conscious mind applies not

only to the automotive industry, but also to the building industry. These features include, among others, argon gas between window panes to reduce heat loss in the winter, while helping to keep the heat out in the summer, making use of energy efficient light fixtures, and using power generated by dynos to supply the HVAC units and other utilities in the facility.

IAV employees are certainly enjoying the new facility and all that it has to offer. It has been acknowledged that many people are to thank for the Technical Center and the seemingly smooth transition from Ann Arbor to Northville. In addition to the move, some personnel changes took place in recent months at IAV. Three hardworking employees were promoted from within, as new roles were created to accommodate growth within the organization. Cheryl Boland was appointed to Vice President of Business Administration, Craig Assenmacher took on the role of Test Facility Manager and Kody Klindt stepped up to be the Manager of the Gasoline Team, which is part of the Calibration & Testing group. Congratulations to these deserving IAV employees!

As IAV employees settle into the Technical Center during the final quarter of 2008, the new capabilities of this growing company hold exciting promises for 2009.

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In honor of our valued customers, IAV has made a donation to a local food bank this holiday season.

We look forward to continuing to serve you and the community in 2009.

Simulation of Plug-In Hybrid Electric Vehicles

Component selection and control strategy development

by Jason McConnell

As vehicle manufactures begin to offer their respective versions of Hybrid Electric Vehicles (HEV) in the marketplace, significant effort has begun to push the envelope, further increasing efficiencies, reducing dependence on oil supplies and improving tailpipe emissions. Plug-in hybrid vehicles (PHEV) have captured much of the attention of this research, as the technology and vehicle architecture offer additional degrees of freedom by which to meet these objectives. This additional complexity requires the development and use of advanced simulation methods to evaluate and design robust vehicle architectures.

Simulation activities play a particularly important role in the development of such a highly complex system. IAV has developed a framework to support PHEV development using simulation by creating component models for analysis of advanced vehicle architectures. The models allow the development team to study, analyze and even optimize the component size and performance within various drive cycles and operating environments. As early as the concept phase, simulation makes it possible to estimate – for differing technical configurations – many key vehicle-performance properties, such as fuel economy or drivability.

From a component and vehicle architecture perspective, predicting the charge-depletion range of the vehicle is critical to the sizing of the energy storage elements and electric machines. Through the use of vehicle simulation, coupled with optimization approaches such as Design of Experiments, IAV has proven that components can be pre-selected to meet perfectly the constraints of physics, driving behavior and vehicle performance requirements.

Once the vehicle architecture has been identified, operating strategies and energy management methodology are developed within the simulation framework. Initially, the PHEV's energy management objective is simple: deplete the battery's energy during electric operation. When the lower operating boundary of the battery state of charge (SOC) is reached, the vehicle switches from its pure EV mode to one of standard HEV, either parallel, series or both. Such a range extending approach can have a significant impact on the vehicle's fuel consumption, drivability and emissions output.

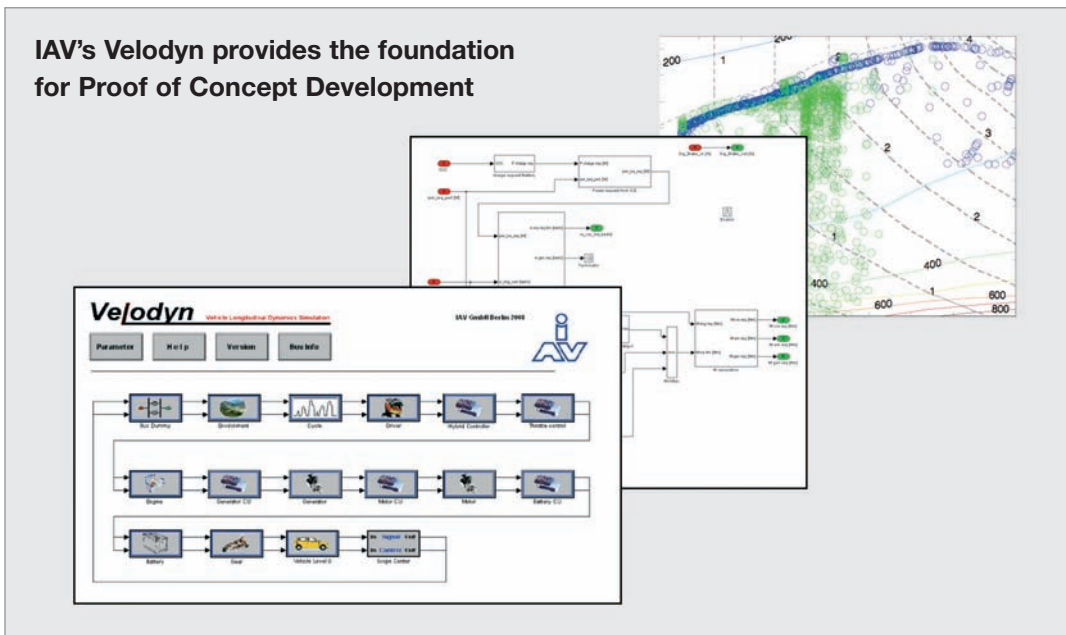


For PHEVs, IAV has developed energy management strategies to match desired vehicle performance while the vehicle is operated in the range extended operating mode. The ability to manage the battery's SOC during this mode allows the development teams to design robust control strategies and minimize fuel consumption in various, and often unknown, driving cycles.

The simulation and modeling approach developed by IAV provides an environment where advanced numerical methods can be employed early in the development process, resulting in much improved real world fuel economy.

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IAV's Velodyn provides the foundation for Proof of Concept Development



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Design:
ZITRUSBLAU · www.zitrusblau.de

Frequency:
three times a year

The VW Lavida: A Sino-German Success Story

IAV Ltd. Shanghai as a development partner to Shanghai Volkswagen

by Jeremy Goddard and Frank Strueber

The Chinese car market is unusual among the world car-markets: over 50 car brands - domestic, Japanese, Korean, American and European automobile groups - are on sale to the consumer. Volkswagen, which has been building and selling cars in China for many years, has shaken up the competition again with the launch of an exciting new model.

At the Beijing Motor Show in April 2008, Volkswagen presented the new mid-range Lavida sedan, an A-class vehicle carefully tailored to the needs and wants of the Chinese market. The Lavida brings a breath of fresh air to VW's vehicle line-up in the country with its focus on addressing Chinese consumer tastes while benefiting from German engineering foundations. The entire vehicle was developed by Shanghai Volkswagen – a joint venture between VW AG and SAIC – with little actual involvement from VW Europe. However, IAV was involved in the project from the outset as a development partner through its IAV Ltd. Shanghai subsidiary.

From the development perspective, the Lavida offers an all-new vehicle body based on an existing VW global platform. The complete body-development program was conducted in China from the initial concept and advanced engineering phases through design, computation, prototyping, body and safety testing and on to the vehicle's mass production.

Communication is everything

Several evolutionary adaptations were needed during the course of the project, and all the development departments cooperated intensively to complete the program successfully, on time and within budget. Some of the challenges and constraints which had to be accommodated while developing the Lavida included:

- ▶ Taking into account a second new vehicle to be developed on the same platform and using a high percentage of shared components;
- ▶ Maximizing the use for both vehicles of standard components or modules already available within the VW Group to minimize costs to the project;
- ▶ Reconciling the quality of local-supplier development expertise and their technical capabilities and capacities with European expectations;
- ▶ Working with VW AG in Wolfsburg, which remained responsible for releasing all platform and safety-related developments;
- ▶ Working with Volkswagen Group China to manage all the VW-program aspects specific to China.

"This project involved a large number of development partners which made communication, coordination as well as data management among them particularly demanding," recalls IAV project manager Frank Strüber. "This huge challenge had to be overcome in addition to the actual development work needed."

"Best in class" in the vehicle-safety score

During the course of the project, overall vehicle requirements increased as a result of changes in safety standards, driven by the rising expectations observed in Chinese consumer testing. As in all VW vehicle programs, the target for safety performance was to be "Best in Class." The team worked effectively and, given the outstanding level of safety expertise available in the group, achieved the objective.

To meet tooling lead timing, the prototype bodies were carefully checked and managed so that the development testing would give conclusive results. Individual parts, sub-assemblies and the entire vehicle were examined after body and crash testing, endurance testing and all vehicle safety eva-



The Lavida is 4.61 meters long, 1.74 meters wide, has a 2.61-meter wheelbase and a 472-liter trunk capacity. Coupled with its choice of engines (1.6 l 77 kW as well as 2.0 l 88 kW), this produces a truly Chinese Volkswagen

luations. "As the project progressed, it was important to assess and track pre-production and pilot production vehicles and testing very precisely," says Frank Strüber. "And we spent much time working with and coordinating all of the component suppliers to ensure the design could be assembled correctly and effectively during the production process."

In this project phase, the quality assurance team constantly validated component and assembly quality on the complete vehicle. In addition to surface quality, controlling the dimensional accuracy of components is a core prerequisite for a high-quality end product.

The finishing touch

As the team neared production launch, they addressed the finishing touches for the Lavida: fine component quality, joint optimization and a precision fit all made sure that the overall impression of the car was one of superb quality. The electronics were also rigorously tested. Here as well, IAV's significant expertise and experience played a key role in ensuring that all of the vehicle's functionality was fully optimized. State-of-the-art analyzers, such as data logger and reference test stations for validating assemblies, were used to locate fault sources and to define appropriate counteractions. While one team applied optimization measures in the pre-production phase, elsewhere, another group was fine tuning the ride comfort. Based on subjective test drives and objective component measurements, further significant improvements to in-vehicle NVH were incorporated. Effective insulation and damping changes provided a noticeable

improvement to general ride comfort. To ensure the top level of production-quality assembly and then to maintain quality levels as production volumes increased demanded that IAV conduct regular and intensive training of personnel at the assembly stations in the production plant.

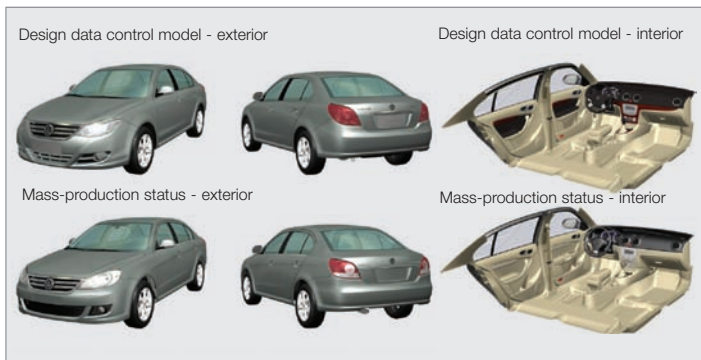
Win-win situation for all of the partners involved

"In developing the Lavida, Shanghai Volkswagen has scored a great hit. Working together within a highly motivated team and contributing the necessary expertise, IAV did much to help secure this success," Frank Strüber feels. "It was the bringing together of German and Chinese know-how that drove this turn-key project forward, and which resulted in this Sino-German success story."

Initial responses from press and customers were extremely positive. The late-June launch was a great success, and the volume of advanced orders for the car is very encouraging for the model's future.

Even while work was progressing in developing the Lavida, IAV Ltd. Shanghai expanded also. IAV staff there are working on a new series of projects which have directly supported the decision to move to new and expanded premises. IAV's operations in China have now become a significant element in IAV's continuing, globe-spanning growth strategy.

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The re-vamping work carried out during the course of the project was implemented efficiently and punctually because of intensive coordination between all parties involved

► continued from page 1

	Approach 1	Approach 2	Approach 3
Solution	Offer a small range of after-market conversions for gaseous-powered vehicles in specific vehicle classes (current situation)	A mix of low-volume OEM vehicles and further QVM conversions	Offer a broad range of OEM gaseous-powered vehicles
Benefits	Low overall development costs	Higher development costs compared with approach 1, fewer additional costs from the development of QVM concepts, wide range of vehicle models, small financial development risk	Optimum way of serving clientele
Draw-backs	Lack of choice, insufficient range of models and poor spread of gaseous-powered vehicles, results in potential deteriorating infrastructure (fewer filling stations)	Concept is limited in production capacity	High development costs for vehicle manufacturers and risk of poor profitability

Under the aspects of environmental protection and cost, approach 2 is recommended as a means of paving the way to approach 3

engine management approach at a glance:

- Calibration input well under 20 % of the normal development to mass-production level;
- Comparatively-low overall development costs;
- Use of proven parts from OEM suppliers;
- Modeling and design of the fastening systems by IAV;
- Layout and design of the CNG vehicle electrical system to OEM standards;
- In-house algorithm development and implementation of various new functionalities in the engine management system;
- Comprehensive experience in the field from 15 years of converting vehicles.

IAV is in a position to design an appropriate concept for any engine/vehicle combination and to put a QVM solution

on the market today, working together with the manufacturer. "Our experience with various production-development projects of gaseous-powered vehicles and over 5,000 IAV-QVM conversions in the field can be applied to every new project." Avramopoulos points out.

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IAV concepts

- VW T5 2.0 | LPG and CNG
- VW Caddy 1.6 | LPG
- Skoda Octavia 1.6 | CNG
- Audi A3 1.6 | CNG
- VW Jetta/Golf 1.6 | CNG

Public Appearances & Publications

Congresses

with accompanying trade exhibitions

February 09 – 12, 2009
EUROFORUM "Automotive Electronic Systems"
Munich, Germany

February 11 – 12, 2009
Hybrid Vehicle Technology Symposium
San Diego, CA

March 24 – 25, 2009
HDT-Symposium "Electrical Drives for Hybrid and Electric Vehicles in Practice"
Munich, Germany

March 26 – 27, 2009
6th Dessau Conference on Gaseous-Fuel Engines
Dessau, Germany

April 20 – 23, 2009
SAE World Congress
Detroit, MI

May 07 – 08, 2009
30th International Vienna Engine Symposium
Vienna, Austria

June 16 – 18, 2009
Testing Expo
Stuttgart, Germany

June 30 – July 01, 2009
VDI-Congress "Vehicle Transmissions"
Friedrichshafen, Germany

October 05 – 07, 2009
18th Aachen Colloquium "Automobile and Engine Technology 2009"
Aachen, Germany

October 07 – 08, 2009
14th VDI-Conference "Electronic Systems for Vehicles"
Baden-Baden, Germany

IAV Conferences

IAV will be organizing conferences on the following topics:

February 18 – 19, 2009
6th Symposium "Hybrid Vehicles and Energy Management"
Braunschweig, Germany

April 28 – 29, 2009
4th Conference on "On-Board Diagnosis (OBD)"
Braunschweig, Germany

May 12 – 13, 2009
3rd Conference on "Oil Circulation in Combustion Engines"
Zwickau, Germany

June 18 – 19, 2009
7th Symposium "Powertrain Control Systems for Motor Vehicles"
Berlin, Germany

June 29 – 30, 2009
5th Conference "Design of Experiments (DoE) in Engine Development"
Berlin, Germany

Technical Publications

IAV regularly publishes professional articles on current automotive topics.

MTZ 12/2008
"Emission-Based Engine Management for Heavy-Duty Applications"
eckhard.stoelting@iav.de,
joern.seebode@iav.de,
raif.gratzke@iav.de,
kai.behnk@iav.de

MTZ 01/2009

"Effective Methods of Optimization in the Process of Laying out Chain Drives"
uwe.parsche@iav.de,
steffen.kux@iav.de

ATZ/MTZ Engineering Partners 05/2009
"Test-Engineering for Engine Controllers - IAV as Test Facility for OEMs"
andreas.greff@iav.de,
dr.heiko.hepp@iav.de,
thorsten.roehrs@iav.de,
carsten.kulkwitz@iav.de

ATZ 05/2009
"Hybrid Powertrain Simulation"
thiess-magnus.wolter@iav.de,
dr.burghard.voss@iav.de

Automobile Construction 2/2009
"Rapid Calibration of DPF-Regeneration"
benjamin.felchner@iav.de,
juergen.rohr@iav.de,
michael.frambourg@iav.de

MTZ 09/2009
"Model-based Approach for the Calibration Process of Engine Controllers"
michael.guenther@iav.de,
nick.elsner@iav.de,
steffen.zwahr@iav.de

ATZ 09/2009
"Holistic Function Development – Automated from Model to Production Controller"
sven.potrykus@iav.de,
[Dr. A. Arenz \(VV\)](mailto:Dr. A. Arenz (VV)@iav.de)

MTZ 11/2009
"KatSim – a Tool for Numeric Simulation of Exhaust Catalysts"
kay-jochen.langeheinecke@iav.de