



## IAV Inc.'s Inaugural DoE Conference

Design of experiments in engine development with modern development methods

By Jeremy Goddard



Dr. Karsten Roepke (left) and Tony Gullitti (center) of IAV and Professor Zoran Filipi (right) of the University of Michigan were delighted with the conference turnout and the quality and breadth of the presentations.

For the past several years, IAV has hosted a biennial conference in Berlin to provide a forum for vehicle manufacturers and Tier I suppliers to discuss developments and new applications in Design of Experiments (DoE). Dr. Karsten Roepke, head of Department Development Methods, and his colleagues at IAV have brought forth a number of innovations in the DoE field to the benefit of all involved in vehicle and powertrain calibration.

Due to the recognized contribution of the European conferences, IAV, together

with the University of Michigan, elected to host a similar gathering in the United States in 2010. The response to the announcement was very positive and, on June 24<sup>th</sup>, speakers and conference attendees gathered at the Inn at St. John's in Plymouth, MI, to share their ideas and to learn more of the state of the art in DoE approaches.

Conference chairs Tony Gullitti, IAV Inc., and Dr. Filipi, UoM, introduced the program to the 40 attendees, including speakers from John Deere Power Systems, Ford Motor Company, Navistar

Engine Group, IAV, Chrysler Group LLC and more. The schedule for presentations was packed tightly and there was a powerful exchange of information throughout the day.

Topics discussed were, among others, steady state and dynamic approaches; advanced experiment design techniques; DoE tools; statistical analysis; the integration of physical and empirical methods; advanced model fitting techniques and analysis; and test cell automation and applications.

Several companies also exhibited their technologies at the gathering. Experts from exhibiting companies, including A&D Technology, Inc., ETAS, Square One Network and IAV GmbH were available in the morning and for the remainder of the day to answer questions. Chrysler Group LLC and A&D Technology, Inc. also sponsored lunch and refreshment breaks, respectively.

The group gathered after the conference to tour IAV's new Technical Center North America, where the response to the information shared was overwhelmingly positive.

IAV now plans to alternate the DoE conference annually between Berlin and Northville in the coming years.  
[jeremy.goddard@iav-usa.com](mailto:jeremy.goddard@iav-usa.com)

### Editorial

Dear Readers,

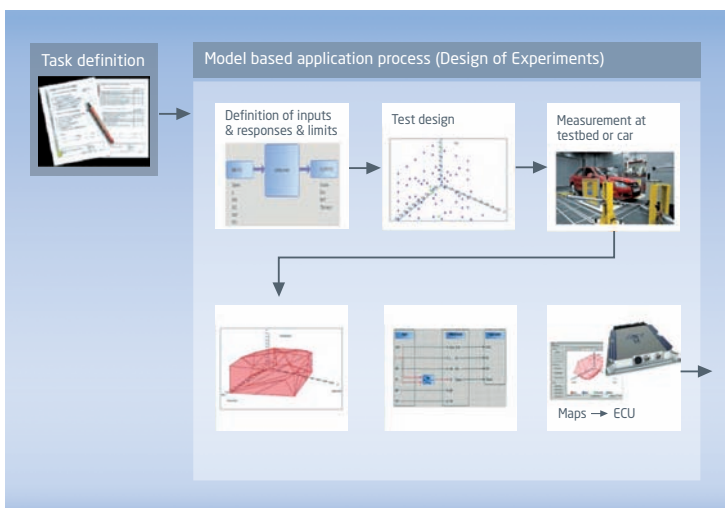
IAV as a company is better known in Europe than in North America. In fact, as an engineering force, the company is larger globally than its recognized competition and broader in its engineering scope. The breadth and depth of IAV's engineering core supports significant advanced development investigations, and the company has emerged as a leader in several key technologies: powertrain calibration, DoE, thermoelectrics and more. One of the objectives of automotion is to raise awareness among IAV customers of the pioneering work being accomplished by the company in several automotive engineering fields.



The recent North American Design of Experiments (DoE) conference hosted jointly by IAV and the University of Michigan in Plymouth, MI, and reported on elsewhere in this publication, brought together a diverse group of people from several companies to compare notes and measure their own advancements against the state of the art in DoE. The conference came together quickly and was not widely publicized, but awareness grew powerfully through word of mouth, and registrations followed as the date approached. IAV's leadership in DoE was key to driving forward both the interest and benefit of the gathering.

The technology-leadership model has proven effective elsewhere within the IAV Group, with regularly scheduled conferences in thermoelectrics, hybrid engineering, powertrain controls, OBD, NO<sub>x</sub> emissions and more. The result is that the benchmark is raised for all participants, and IAV can learn as well as share at such gatherings. With increasing pressure on vehicle emissions and efficiency improvements, such open dialog between service providers and manufacturers is a fine way of driving technical progress for the benefit of all.

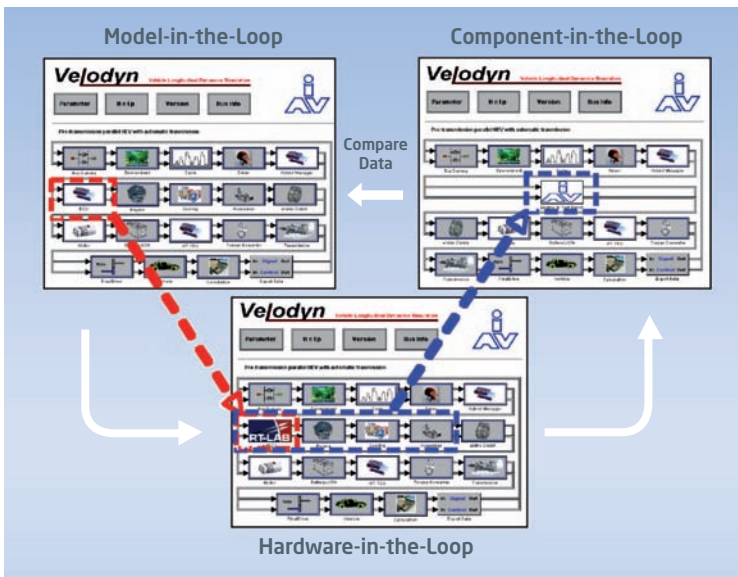
Jeremy Goddard  
Vice President Sales & Marketing IAV Inc.



# Shrinking Powertrain Development Time

Using VeLoDyn for component-in-the-loop development

By Andrew Shabashevich



The application of VeLoDyn in multiple phases of powertrain development.

The continuously growing need to reduce vehicle fuel consumption and emissions has resulted in increased powertrain complexity at a time when vehicle development cycles are shrinking and budgets are constantly being stretched. This has placed tremendous pressure on OEMs and their suppliers to develop cost effective products quickly, while with meeting customer expectations and reducing the environmental impact.

## Shrinking Development Time

In order to facilitate the development of advanced powertrains, such as those of hybrid and electric vehicles, IAV has developed a vehicle simulation tool called Vehicle Longitudinal Dynamics, or VeLoDyn. IAV uses VeLoDyn to assist customers in developing a single vehicle model that can be used in multiple stages of powertrain development. In a typical

new powertrain development program, a vehicle and its components must be modeled and simulated, the control software written, and new hardware and software tested rigorously for durability and quality. Using VeLoDyn, a single tool can be applied to aid in all facets of powertrain development, even when the physical components, or the vehicle itself, have yet to be developed.

## Initial Powertrain Simulation

Often, VeLoDyn is initially used for fundamental powertrain analysis to quantify how a particular powertrain configuration, select components, and powertrain control strategy will perform together over various drive cycles. This allows for the components to be properly sized and preliminary controls to be developed and simulated within a single development environment.

## Hardware-in-the-Loop on a Test Bench Simulator

Once the powertrain and key components have been determined, the VeLoDyn vehicle model can then be integrated into a HiL test bench for further software and controls development, and for controller hardware testing. The specific controller under development or testing is removed from the VeLoDyn model and replaced

with an I/O block that can communicate with the physical controller connected to the HiL test bench simulator.

## Component-in-the-Loop on a Dynamometer

In a vehicle development program, many of the selected powertrain components are often available before the actual development vehicles. In order to continue with the development of the powertrain, the same VeLoDyn vehicle model used for off-line simulation can be integrated into a dynamometer for Component-in-the-Loop development. This allows for the vehicle and driver to be simulated over a chosen drive cycle with the physical powertrain components' set-up in the dynamometer, responding as if they were in the actual vehicle. In this case, the blocks representing the physical components in the VeLoDyn model are replaced with I/O blocks that communicate with the physical hardware in the dynamometer.

The use of VeLoDyn throughout the powertrain development process minimizes possible errors and lost time from utilizing different software and constantly transferring data and models from one source to another at different stages of development.

Contact:

[andrew.shabashevich@iav-usa.com](mailto:andrew.shabashevich@iav-usa.com)

# Model in the Loop on Your Desktop

IAV's new MiL-Desk software helps to reduce control unit development costs

By Ralf Gratzke and Andre Ley

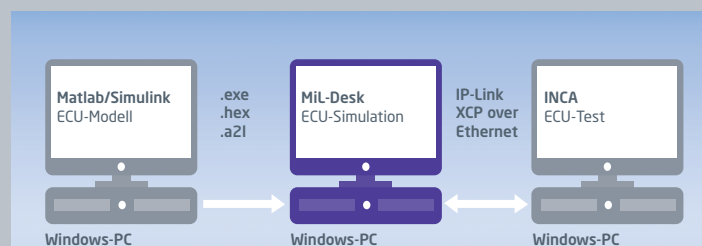
IAV's MiL-Desk simulation software simulates control unit functions in real time on a regular Windows PC or notebook. MiL-Desk can be used for testing control unit algorithms at a low cost and without additional hardware. Using a special Simulink® block set, the software generates and compiles a model of the control unit function which behaves in much the same way as the actual control unit.

ETAS' calibration tool, INCA, can access MiL-Desk through the XCP over an ethernet interface and permits parameterization much like a conventional control unit. INCA and MiL-Desk can run on the same or separate computers, and MiL-Desk also supports communication via

CAN for access to the MiL model through a conventional CAN card. With such a flexible approach, IAV's new simulation software extends the possibilities in modern-day control unit development.

"Two objectives were particularly important in developing MiL-Desk: simplifying the process from the initial design through to hardware production and cutting control unit development

costs. We have achieved both objectives," retorts Ralf Gratzke, head of IAV's Powertrain Management department. "Use of the new software obviates the need for any parallel development work, and expensive simulation hardware is no longer necessary. No major effort is needed later in the development process in the transition from the simulation to the real target hardware."



MiL-Desk functions as an efficient control unit simulation tool.

Contact:

[andre.ley@iav-usa.com](mailto:andre.ley@iav-usa.com)  
[ralf.gratzke@iav.de](mailto:ralf.gratzke@iav.de)



## Everything under Control

New universal prototype control unit, IAVcon, can be used to develop virtually all automatic transmissions

By Roland Serway and Kody Klindt

The IAVcon transmission control unit can be used from the start of development work to pilot production.

Featuring new function software, IAVcon is a universal prototype control unit capable of actuating nearly all automatic transmissions - including those of hybrid vehicles. It is utilized from the start of the development process through to the control of prototypes.

The modern transmission is a key contributor to a vehicle's driving comfort and efficiency. High-performance electronics now control the system, replacing the once complex mechanical and hydraulic systems used in the past. Several years ago, IAV developed the IAVcon rapid-prototyping control unit as a development tool, and has been working towards its improvement ever since. Today, the highly efficient 32-bit controller manages the hardware, which is equipped with numerous inputs and outputs for digital and analog signals to ensure that no connection request is left unanswered.

"IAVcon is remarkably versatile; not only is it capable of controlling a transmission, it can also run an entire powertrain, including a four-cylinder engine and an automated manual transmission," says Roland Serway, head of Software and Algorithms for Transmission and Hybrid Systems at IAV. "Thanks to the conception of this new software, we've advanced another step forward: IAVcon is now capable of controlling automatic transmissions." An optimally managed automatic transmission is vital because it can effect a noticeable improvement in ride comfort and fuel economy enhancement. The latest IAVcon is also equipped to control complex transmissions for hybrid vehicles.

### IAVcon's New Control Process for Enhanced Shift Comfort

IAVcon is in a position to actuate and control most transmission types, thereby speeding up the development process. "The control unit can be used from the start of our development work right through to the pilot-production run," Serway explains. "This is when the new software is of great help to us; supplemented by a range of functions compatible with manufacturers' latest transmission software, it has been extended by new control processes to provide greater shift comfort." IAV has never maintained a development environment as complete as this.

The developers were particularly keen to make IAVcon easily adaptable to as wide a range of transmissions as possible - for example, to the mechanical structure and number of gears, as well as the different sensors and actuators. This is now all very easy and convenient to do: the software provides a library of function modules. Only those components specific to the mechanical topology of the transmission are customized.

### IAVcon Software Based on Matlab/Simulink

The new IAVcon software was developed using Matlab/Simulink and dSPACE TargetLink. "The latest software allows us to develop transmissions using a model-based approach," Serway explains. "One no longer has to write a single line of code; we can simply modify the underlying model and, with the click of a button,

obtain new software for the transmission we are in the process of developing."

At the beginning of the transmission development process, IAV's tried and tested "VeLoDyn" software is used for simulating the forward longitudinal dynamics of the powertrain, including the transmission hardware. IAV engineers have the option to take the transmission and control software on "virtual test drives" in the early phases of development. Later, IAVcon may be used in a hardware-in-the-loop environment (HiL); the transmission software runs on IAVcon, while the transmission inputs are simulated by VeLoDyn. IAV's developers use a HiL system developed in-house using National Instruments components (PCI eXtensions for Instrumentation, PXI).

Toward the end of the development process, IAVcon may also be used on the test bench for controlling a transmission. With its robust hardware, including a production casing from Bosch, the unit is additionally well suited for use in the vehicle. IAVcon is used in the automotive temperature range from minus 40 to plus 257 degrees Fahrenheit.

The controller and the new software are already being applied in customer projects. To exhibit the development tool's performance and efficiency, IAV is planning to construct a demonstrator vehicle. Initially, IAVcon will be used to control a transmission on a test bench. Later on, IAVcon will be used to control a vehicle. In this instance, the transmission used will either be a production unit or a hybrid transmission developed by IAV.

Contacts: [roland.serway@iav.de](mailto:roland.serway@iav.de),  
[kody.klindt@iav-usa.com](mailto:kody.klindt@iav-usa.com)

## Employee Spotlight: 10 Years at IAV

Commemorating IAV employees' commitment to excellence

By Kathleen Rafalko

In May 2010, Wilfried Brunssen, Algorithm Development Team Manager, celebrated 10 years of service at IAV Inc. Wilfried is a German expatriate who joined the IAV Inc. team in May 2000. He has been employed by IAV Group since 1994. During a luncheon held in his honor on July 17<sup>th</sup>, Wilfried commented on the company's growth over the last 10 years and his satisfaction in spending this time working on a variety of interesting programs in the US. Wilfried was presented with a certificate to mark his achievement.



The IAV team would like to thank Wilfried for his hard work and dedication over the past several years.

## Publisher

automotion  
customer newsletter

IAV Automotive Engineering Inc.  
15620 Technology Drive  
Northville, MI 48168, USA  
Phone +1 734 233-3300  
Fax +1 734 233-3320  
[info@iav.com](mailto:info@iav.com)  
[www.iav.com](http://www.iav.com)

Editors:  
Kathleen Rafalko  
Jeremy Goddard

Design:  
ZITRUSBLAU GmbH  
[www.zitrusblau.de](http://www.zitrusblau.de)

Frequency:  
three times a year

## IAV Inc. Addresses Military Technology Programs in the US

New competency center established effective August 1

By Tom Reedy

IAV Inc. has opted to significantly increase the company's portfolio of engineering technology and consulting services by establishing a new competency center intended to deliver high technology solutions to the US military systems sector. By design, all customer programs are entirely firewalled, thus maintaining strict confidentiality and secure internal processes. With respect to military programs, additional ITAR controls are necessary for the handling of information, data and materials; the pre-qualification of engineering staff; and the restriction of non-qualified staff and visitors within the technical facility.

IAV Inc.'s military technology portfolio is a natural extension of its well-established capabilities in automotive, powertrain and vehicle systems engineering for on- and off-highway applications. With the company's recent expansion to include a state-of-the-art powertrain and vehicle development facility, IAV Inc. provides value-added approaches to engineering and new technologies for US military systems manufacturers. Driven by ever-tightening regulations, IAV is a global technical expert in the design and development of powertrains for high efficiency and first-rate fuel economy.

The new portfolio includes advanced new diesel engines/fuel systems; the next generation of ultra-compact broad ratio spread automatic transmissions; series and parallel hybrid-electric systems; electric drives; high and low voltage power and signal distribution systems; HVAC systems; and chassis, drivetrain, body and interior systems. IAV Inc.'s engineering experience is directly relevant to solving the US military's fuel economy, electrical power, controls, motive power, mobility, weight, package-density and thermal rejection challenges for tactical wheeled, tracked, autonomous and unmanned equipment.

For further information concerning IAV military systems technology and military program capability, please contact Tom Reedy at (734) 233-3510 or via email at [tom.reedy@iav-usa.com](mailto:tom.reedy@iav-usa.com).

# Thermoelectrics Capable of Ten Percent Efficiency over the Next Few Years

Thermoelectrics expert Dr. Harald Böttner of the Fraunhofer Institute talks to Wilfried Nietschke, IAV's Executive Vice President of Technology Monitoring

By Wilfried Nietschke and Andrew Shabashevich

Thermo-Electric Generators (TEG), in their recovery of waste heat, harbor huge potential for both business and the environment. Last year, over 550 experts in science and industry from approximately 40 countries met in Freiburg, Germany at the 28th International and 7<sup>th</sup> European Conference on Thermoelectrics; event discussions centered around current research activities and the progress being made in recycling waste heat. At the conference, IAV presented a paper entitled "Thermoelectrics Goes Automotive," which discusses the potential of thermoelectrics in future vehicles. During the exhibition, IAV also showcased a TEG demonstration vehicle that has been in development for several years.

At the end of the conference, Wilfried Nietschke, IAV's Executive Vice President of Technology Monitoring, spoke with Dr. Harald Böttner, head of the Thermoelectric Systems department at Freiburg's Fraunhofer Institute for Physical Measurement Engineering (IPM), about the future of thermoelectricity and how it might be leveraged by the automotive industry.

**Nietschke: Dr. Böttner, thank you for allowing me the opportunity to talk with you. What conclusions, if any, have you drawn from the conference?**

**Dr. Böttner:** This conference looked at thermoelectrics in a new dimension. There has been a sizeable leap for-

ward since last year, and there were many additional exhibits on display. A lot of testing is being done. Companies such as BSST have shown developments by BMW that will go into low-volume production over the next few years, thus demonstrating what is possible in technological terms. The thermoelectric presentations were extremely well attended, and IAV's plenary paper, delivered by Gerhard Buschmann, was particularly informative. He is clearly someone who speaks from practical experience.

High science not only addressed the materials, but also the practical applications. Special attention was paid to high temperature thermo-generators. Science was also called upon to address the potential for thermoelectrics in mass production.

**Nietschke: Are thermoelectric generators now fit for the automobile?**

**Dr. Böttner:** The scramble for thermoelectric use in vehicles has already begun. To date, the automotive industry has managed to reach an efficiency level of five percent, with seven percent having been achieved in aerospace applications. Ten percent efficiency will be possible in the next few years, and many test systems are now showing that thermoelectric generators are, in the mid-term, ready for use in the automobile.

**Nietschke: What related applications do you foresee?**

**Dr. Böttner:** For the automobile, I envision exhaust-gas energy being cap-

tured to provide energy for cooling batteries and powering autonomous sensor systems.

**Nietschke: What role do you think a company like IAV might play in advancing thermoelectrics?**

**Dr. Böttner:** IAV is a neutral developer that works with many different automobile manufacturers, making the company a possible link between science and practical application. For instance, IAV could construct a demonstrator in cooperation with the Fraunhofer Society. With IAV's considerable experience, joint brainstorming sessions would be both possible and productive.

**Nietschke: This seems to be quite conceivable. In what manner might we cooperate?**

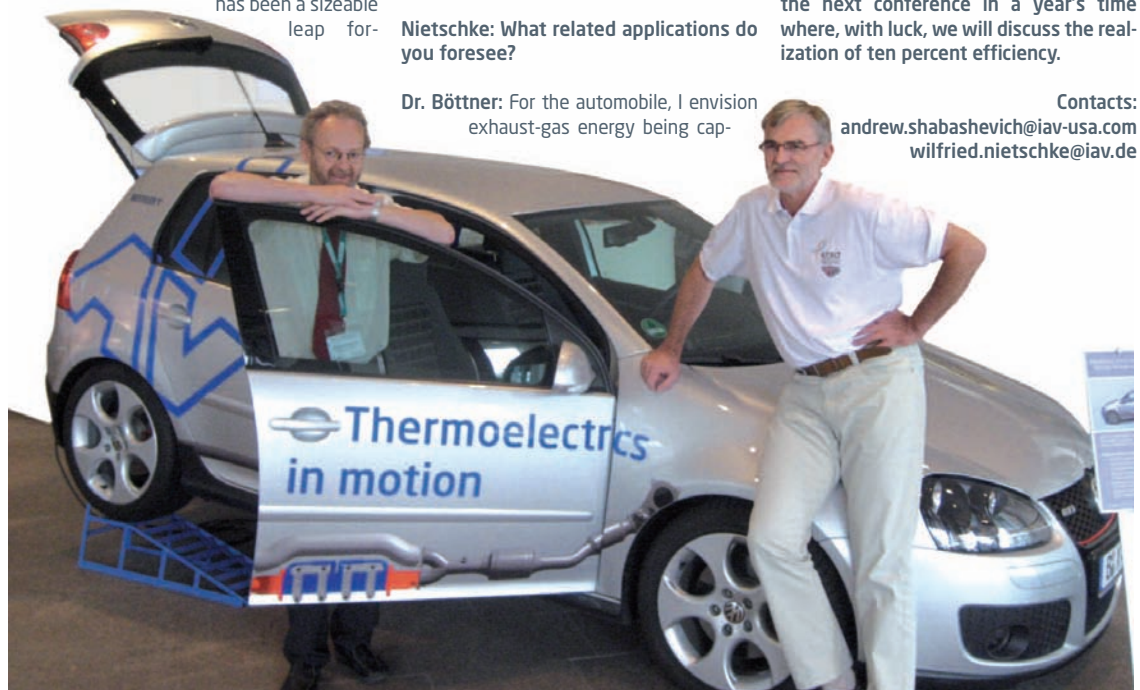
**Dr. Böttner:** I am thinking here of a partnership with the Fraunhofer Society, but also with companies like BSST.

**Nietschke: How do you propose that IAV progresses in this discipline?**

**Dr. Böttner:** IAV should continue the work being done in this field, and look toward getting involved in test benches.

**Nietschke: Dr. Böttner, thank you for giving me this interview. I look forward to the next conference in a year's time where, with luck, we will discuss the realization of ten percent efficiency.**

**Contacts:**  
[andrew.shabashevich@iav-usa.com](mailto:andrew.shabashevich@iav-usa.com)  
[wilfried.nietschke@iav.de](mailto:wilfried.nietschke@iav.de)



Wilfried Nietschke, Executive Vice President of Technology Monitoring, and Dr. Harald Böttner, Thermoelectric Systems department head at Freiburg's Fraunhofer Institute, stand beside IAV's TEG demonstration vehicle.

# Modern Transmissions Improve Emissions and Fuel Economy

Intelligent transmissions will remain at the heart of future vehicle concepts

By Dr. Gerhard Maas, Dr. Burghard Voss and Tom Reedy

**Dr. Gerhard Maas, formerly Executive Vice President and head of Powertrain Development, is now serving as Executive Vice President of International Operations at IAV. Dr. Burghard Voss, Senior Vice President, is responsible for hybrid powertrain systems development. Both experts feel that well-executed, high technology transmissions will remain at the heart of future vehicle concepts. However, new powertrain concepts are placing high demands on system developers.**

**Transmissions have been around for many decades - do they provide any scope at all for fundamental improvement?**

**Dr. Maas:** It's true that transmissions are a very old subject in automotive construction. But they're also a very important one: no matter what the powertrain looks like - a transmission is always requisite. This applies not only to vehicles powered by internal combustion engines, but also to electric and hybrid vehicles. In all cases, transmissions are at the heart of the powertrain. Over time, the attributes have also undergone drastic changes: whereas most vehicles in the past had four speed manual or automatic transmissions, automatic transmissions today come with as many as eight speeds.

**Dr. Voss:** Automatic transmissions can have as many as eight speeds, and even that doesn't seem to be the end of the development. Because the combustion engine can be kept in the most favorable fuel map range (although handicapped by relatively poor efficiency), continuously variable transmissions are also being further enhanced; they may still be the right choice for specific applications. New technologies, such as electric and hybrid vehicles, are demanding entirely new transmission concepts. Thus, development in this field still has a long way to go.

**Fuel consumption and CO<sub>2</sub> emissions are a key issue in automotive development. What contribution can modern transmissions make on this front?**

**Dr. Maas:** The trend toward broader ratio spreads has indeed brought about an

improvement in efficiency. A modern six or seven speed dual-clutch transmission is capable of reducing fuel consumption by about three percent over a manual gearshift. However, further potential will be reached not so much by increasing the number of gears, but by reducing the gear shift elements, thereby structuring a transmission to achieve greater efficiency.

**Dr. Voss:** Ultimately, though, the efficiency of future drives will be determined by intelligently connecting all of the assemblies involved in the powertrain. The electronic management system, on an event-controlled basis, always selects the gear that provides the right amount of torque to meet the driver's demand, while keeping the combustion engine operating in the most favorable map range for the lowest consumption and emissions. For automobile manufacturers, this is extremely important, because it provides the means for reducing fleet consumption and, in turn, carbon dioxide emissions.

**Does shifting six or more gears by hand make sense?**

**Dr. Maas:** Manual gear shifting is pushed to its limits at six speeds because, to cut fuel consumption, it is necessary to change gears at exactly the right moment.

Modern electronics are far better at doing this than human beings.

All the same, the manual transmission will not disappear completely from the market - after all, it is far less expensive than its automatic counterpart. Still, vehicle electronics can help drivers by showing them when to change gears.



Despite the hype surrounding electric motors, Dr. Gerhard Maas, Executive Vice President of International Operations (left), and Dr. Burghard Voss, Senior Vice President of Transmission Development (right), look to the future of transmission development.

**Dr. Voss:** And intelligent clutch actuators are not only making it easier for the inexperienced motorist. We are currently in the process of carrying out development work in this area under the heading "a nod from the passenger seat doesn't always mean approval."

**What demands do hybrid drives place on the transmission?**

**Dr. Maas:** Hybrid drives can be more complex than powertrains with a combustion engine only. This depends on the type of hybrid drive. It is always a matter of coupling torque from an electric motor and combustion engine intelligently. One way of doing this is to integrate the electric motor directly into the transmission. At IAV, we have developed an innovative hybrid-electric solution with eight speeds that's lightweight, compact and low in price. Driveline simulations have been a tremendous help to us; we have combined the components in a way that allows us to achieve more with fewer parts.

**Some experts believe that transmissions for electric motors will become less complex. What do you think?**

**Dr. Voss:** This will definitely be the case because an electric motor's torque delivery curve is broader than that of a combustion engine. A starting element such as a torque converter or clutch can be dispensed with because sufficient torque is provided from the zero motor speed, and favorable efficiency levels also extend across a wide operating range. Coupled with a vehicle speed range that's more limited than a conventional vehicle's, transmissions with one or at most two trans-

mission steps can work well. However, these transmissions must be designed to fit into small vehicles where there is inherently less space. Since small cars are likely to be the principal segment for electric drives, compact units are absolutely necessary. From the aspect of transmission development, however, we are unruffled by the euphoria that's currently linked with electric vehicles. Given their drawbacks in terms of battery costs, traveling range and performance, electric vehicles are set to be a niche solution for some time to come.

**A moment ago, you spoke about the significance of simulation in transmission development work. What are IAV's strengths in this field?**

**Dr. Maas:** One of our strengths is our ability to simulate the entire powertrain. With these tools, we can define the optimum transmission steps at an early stage. How many speeds are necessary? What's the best ratio spacing? In the future, the number of speeds is more likely to rise than fall. In addition, it all needs to be integrated into the limited package that's available. However, modern transmissions also help to save fuel. This is why IAV has been working for over ten years in the field of simulation and control-system development, and has been focusing for several years now on new hardware concepts which offer a large number of transmission steps while being compact and applicable to hybrid vehicles.

**Contacts:**  
[tom.reedy@iav-usa.com](mailto:tom.reedy@iav-usa.com),  
[gerhard.maas@iav.de](mailto:gerhard.maas@iav.de),  
[dr.burghard.voss@iav.de](mailto:dr.burghard.voss@iav.de)

# Public Appearances & Publications

September		October	November
<p>Sept. 1, 2010 <b>IEEE MSC Joint Conference 2010</b> Yokohama, Japan</p> <p><b>Presentation:</b> "Advantages of Combining Physical and Experimental Modeling" <i>philipp.schmiechen@iav.de, vasco.schirmacher@iav.de, mirko.knaak@iav.jp, S. Kaneko, A. Ohata (TMC)</i></p> <p>Sept. 13-15, 2010 <b>5<sup>th</sup> IFAC Symposium on Mechatronic Systems</b> Cambridge, USA</p> <p><b>Presentation:</b> "A Sensor Management Scheme and its Application to Internal Combustion Engines" <i>matthias.schultalbers@iav.de, nick.weinhold@iav.de</i></p>	<p>Sept. 15-17, 2010 <b>SAE North American International Powertrain Conference</b> Chicago, IL</p> <p>Sept. 21-30, 2010 <b>IAA Commercial Vehicles 2010</b> Hanover, Germany</p> <p>Sept 27 - 30, 2010 <b>DEER Conference</b> Detroit, MI</p> <p><b>ATZ 9/2010</b> "Inductive Charging" <i>wilfried.nietschke@iav.de</i></p> <p><b>ATZoffhighway 2/2010</b> "Modern Industrial Engines - Challenges to Emission Calibration and Engine Management" <i>frank.stadtaus@iav.de, christian.weiskirch@iav.de, thorsten.schmidt@iav.de, VW Salzgitter Industriemotoren</i></p>	<p>Oct. 4-6, 2010 <b>Aachener Colloquium "Automobile and Engine Technology"</b> Aachen, Germany</p> <p>Oct. 5-6, 2010 <b>SAE Commercial Vehicle Congress</b> Rosemont, IL</p> <p>Oct. 6-8, 2010 <b>International Suppliers' Fair (IZB)</b> Wolfsburg, Germany</p> <p>Oct. 12 - 14, 2010 <b>The Business of Plugging In</b> Detroit, MI</p>	<p>Nov. 17 - 18, 2010 <b>GACCOM eMobility Forum</b> Detroit, MI</p> <p>Nov. 23-24, 2010 <b>Heavy Duty-, On-/Off-Highway Engines 2010</b> Mannheim, Germany</p> <p>Nov. 25-26, 2010 <b>3<sup>rd</sup> IAV Conference "Knock Control for Gasoline Engines - Trends for Production-Vehicle Developers"</b> Berlin, Germany</p> <p>Nov. 30 - Dec. 1, 2010 <b>Virtual Powertrain Creation</b> Munich, Germany</p> <p><b>MTZ 11/2010</b> "Reducing the Particle Number in DI Gasoline Engines in the Light &lt;of Possible Euro 6 Exhaust-Emission Legislation" <i>matthias.kratzsch@iav.de, olaf.kannapin@iav.de</i></p> <p><b>MTZ 11/2010</b> "Thermodynamic Criteria for Optimizing the Calibration of Ignition Timing in Modern Gasoline Engines" <i>Bernd Naumann, Prof. Dr. Helmut Tschöke (University of Magdeburg), wolfram.gottschalk@iav.de, eva-maria.huthoefer@iav.de, andreas.jordan@iav.de, matthias.schultalbers@iav.de</i></p>

