automotion

Excellence in Automotive Research & Development · IAV Customer Newsletter · 2-2011

IAV Automotive Engineering is proud to be a winner of the SAE 2011 Tech Award!

IAV is actively exploring innovative technologies to help extend understanding and increase capabilities. By applying a supercharger to manage EGR there are benefits to both transient performance and emissions reduction. Such developments within IAV help not only to hone our engineers' creativity and design skills, but also to enhance testing and data analysis to bring forward leading edge engineering approaches for clients. To honor this performance, IAV has received this SAE 2011 Tech Award.

Exhaust gas recirculation (EGR) is a proven method for emissions reduction in diesel engines; the higher the quantity of exhaust gas in combustion air, the more the oxides of nitrogen are reduced.

To increase levels of EGR,, IAV has developed a forced induction concept, where a Lysholm twin-screw compressor with a rotary-slide control is placed between the exhaust-gas turbocharger and the engine intake. The compressor draws cooled exhaust gas downstream of oxidation catalyst and mixes it in a controlled manner with the fresh charge air to provide the optimum blend for best emissions and performance.

IAV's system uses an engine-driven, but electrically-assisted, compressor to keep the EGR ratio at an optimum level even at changing engine speeds. The assistance of the electric motor/generator comes through a planetary gear element. About two thirds of the compressor power is produced by the engine and one third by the electric motor/generator. The compressor always runs at least at engine speed, but can be boosted when required (for example, when overtaking) through the planetary by the electric motor. The generator function may used to charge the battery system when its positive motor-assist is not required.

The EGR ratio is controlled actively by two rotary valves which define the valve timing for the fresh air and the exhaust gas. The mixing pressures are kept in balanced control, even under load changes, which gives a major advantage when compared to a plain exhaust gas feeder pump.

In contrast to other charging devices, the twin screws are insensitive to hydraulic pounding. Also, when the cooled EGR falls below dew point, the compressor may be used to clean the system with condensation. However, care must be taken in the system layout to ensure that condensation will not puddle.The studies show that the IAV High-EGR concept is successful in reducing the emissions of a diesel engine. The flexibility in the EGR mixing and the cylinder filling, held independent of each other, offer new possibilities in engine calibration for future developments. The next stage will be validating the engine dyno concept in an on-road vehicle.

Contact:
ursula.torp@iav-usa.com

News from Our President

Customers and Employees,

As we complete our 2nd quarter together, I am excited about IAV's continuing growth and about the diversity of projects we are addressing.

There is an increasing need among our customers for engineering services and the expertise IAV has to offer. I am surrounded in this company by motivated, innovative thinkers who bring enthusiasm and passion into their jobs. We met an astounding number of friends in the industry at SAE World Congress, where we showcased the technical value of the BMW/PSA Prince engine, together with our SlideCam technologies.

We were fortunate to have many colleagues from IAV GmbH present to meet our customers and to share their insights. A press interview with Joe Lemieux, our new Business Unit Director of Energy Management, was conducted and is posted online at http://americajr.com/news/saeworldcongress0418.html. IAV was very active in the two recent CTI symposia which dealt with transmissions and with emissions. Timm Kellermann, VP for Consulting4Drive, the strategic global consulting arm of IAV GmbH, gave a keynote address at the transmission CTI, where Dr. Burghard Voss and Erik Schneider also presented papers. At the Emissions CTI conference, Dr. Michael Traver spoke about emerging innovations and the latest developments in heavy duty emissions control.

IAV is also proud to be among the 10 winners in 2011 of the SAE Tech Award for the development of the charged EGR concept! In this issue, you may also read about our new technologies in the areas of efficiency calculation, diesel and electric vehicles and automotive applications.

Andy Ridgway
President of
IAV Inc.

IAV Automotive Engineering Continues Growth with the appointment of Joseph Lemieux

The Experienced Automotive Leader Is Now Responsible for IAV's Energy Management Sector.

Joseph (Joe) Lemieux is the new Business Unit Director of Energy Management at IAV's North American subsidiary, IAV Automotive Engineering in Northville, MI.

Lemieux is well-known in the automotive industry. He has over 30 years of experience in the international automotive industry in technologies including Engine Control, Transmission Control (AT, DCT, CVT), Braking Systems (ABS, TC, Stability), Vehicle Electronics, Telematics, and Vehicle Interiors.

Andy Ridgway, president of IAV Automotive Engineering, appointed Lemieux in this new role and is very pleased to have Joe on our team. "The new technological area of Energy Management within a vehicle, and between a vehicle and the outside world, offers us many opportunities and challenges. I look forward to working with Joe to solve these challenges with our clients," states Ridgway.

Previous Executive Positions at GETRAG, EDS and Ricardo

Previously, Lemieux held the position of Senior Manager, Controls, Electronics and Calibration at Getrag Transmissions Corporation North America. His primary responsibilities were the design, development, and launch of various DCTs in the areas of controls, software, and calibration. Lemieux's engineering consulting background with global customers includes the position of Chief Technologist at EDS Engineering and Manufacturing Services, and then Chief Engineer at Ricardo. In these positions, he was responsible for the design and development of multiple Hybrid systems and supporting components.

Joe Lemieux holds a Bachelor of Science degree from General Motors Institute (now Kettering University) and Masters of Science and Masters in Business Administration degrees from the University of Michigan. He is currently working on his PhD in Automotive Systems with a focus on Electric, Hybrid, and Fuel Cell propulsion systems. His memberships in SAE, the SAE Embedded Software Standards Committee and IEEE have been valuable to his career.

"I am excited to be joining a recognized leader in engineering consulting at IAV. As both a customer of, and competitor to, IAV globally over the last 11 years, I have gained a great respect for the company, and most importantly, for the excellence of the staff here. It is an exciting time as the automotive industry rises from the ashes of the last 3 years and begins moving transportation from petroleum based fuels to new technologies to sustain both our individual mobility and our environment," states Lemieux.

Contact: ursula.torp@iav-usa.com

Knock- the (Un)Known Phenomenon

140 Experts From All Over the World Meet in Berlin to Discuss Knock in the Gasoline-Engine

Although downsizing makes engines more economical, it leads to higher mean pressures in the cylinder and gives rise to new knocking phenomena that limit advances toward still lower levels of fuel consumption. IAV's third conference on "Gasoline-Engine Knock – Irregular Combustion" put the spotlight on thermodynamic analyses as well as innovative simulation methods.

Recent years have seen carbon dioxide become the focus of work on developing gasoline-engines for reduced fuel consumption. A clear trend is currently emerging toward downsizing. "Reducing swept volumes while significantly increasing mean pressures opens up considerable potential for cutting CO_2," explains Matthias Kratzsch, Senior Vice-President for gasoline engines at IAV.

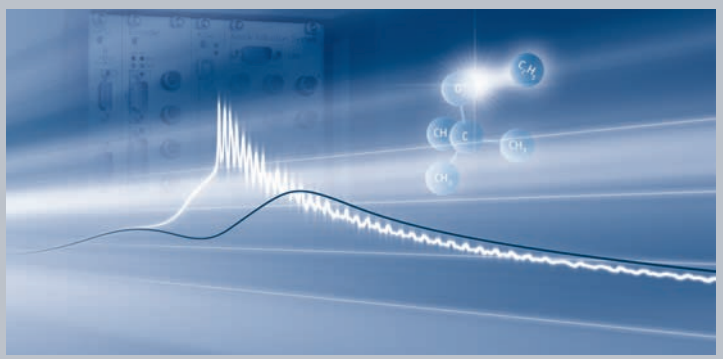
Knock is Preventing Further Progress in Downsizing

The high mean pressures in the combustion chamber have increased to over 20 bar, which leads to a new development focus. "Knock in particular is preventing a further rise in mean pressures. Highly supercharged engines show a more pronounced tendency toward irregular combustion," Kratzsch says. "Higher mean pressures result in knock events with extremely high peak pressures. These can be initiated, for example, by the mixture igniting before the firing point. Peak pressures in excess of 250 bar can lead to irreparable damage to the engine." Although knock is not a new phenomenon – it is as old as the gasoline engine itself – the immense intensity of "irregular combustion" is relatively new. Such events are currently preventing further progress in downsizing the gasoline-engine, because this would demand mean pressures of 25 to 30 bar. "More than ever, we need a better understanding of the causes along with concepts for avoiding knocking combustion, and we were driven to reexamine the subject in depth and from all angles at IAV's third knock conference," Kratzsch reports. "Doing so, we hit the bull's eye: 140 participants came to Berlin from all over the world."

IAV Explains Irregular Combustion Events Using an Enthalpy-Based Approach

Twenty-two papers spread over five sessions examined the subject of knock on November 25 and 26, 2010. As part of the first session on thermodynamics directed by Prof. Bargende (Stuttgart University), IAV presented its approach to explaining the new knock events. "We determine charge enthalpy in the cylinder and compare it with an engine-specific limit enthalpy," explains Kratzsch. "As soon as actual enthalpy exceeds this limit, irregular combustion occurs." By analyzing the parameters influencing charge enthalpy and the limit enthalpy at the particular operating point, IAV is in a position to optimize all influencing variables in a way that reduces the risk of irregular combustion events.

Prof. Spicher (KIT) facilitated the second session on optical methods for measuring combustion processes. Discussion covered new developments and methods of analysis in applying indication technology, high speed cameras, fiber-optic investigation methods and ionization-current measurements. Knock simulation was covered by the third session conducted by Prof. Mauss (Cottbus University of Technology). This compared both zero, one and three-dimensional simulation methods and analyzed different knock criteria for designing gasoline engines. In this context, IAV presented a development system that uses laser-vibrometer measurement and FEM simulation for determining the transmission of structure-borne sound from knock signals.



New Approaches in Knock Sensor Systems

The detection of conventional knock is also moving forward, and was the subject matter of the fourth session. Discussion points included alternatives to today's knock sensor for detecting knock. Approaches were presented to detecting knock by evaluating engine-speed fluctuations as well as measuring cylinder pressure. The influence that different fuel qualities have on knock was examined in the fifth session moderated by Prof. Schwarz (BMW). "A higher share of ethanol in fuel is a very current issue at the moment," Kratzsch says. Ethanol has a significant influence on knock in gasoline engines, and the extent to which it affects the tendency of highly supercharged engines to pre-ignite was discussed in various presentations. During the conference, IAV, Kistler and AVL showed their knock measuring systems.

Contact:
matthias.kratzsch@iav.de
kody.klindt@iav-usa.com

App and Away!

In a Few Years' Time, Automotive Apps Could Be Extending the Scope of Car Functions

Vehicle networking will bring numerous benefits to consumers and manufacturers: cars with functions that can be upgraded later on by software update, and enhanced replacement-parts logistics. Consumer electronics are showing how existing hardware can add flexibility in meeting new user needs.

Do you want a bit more „vroom" over the weekend?

Not a problem: just download an update from the Internet for the engine management system and get ready to take off for a couple of days! What's already reality in the field of consumer electronics could also be finding its way into the car over the next few years: "automotive apps" that extend the vehicle's scope of functions, bring it in line with the latest requirements, give it more power or teach it to use less fuel as prices rise. Wireless data services can provide the key to such capabilities, regardless of time or place.

"Interconnecting the vehicle is a major trend that manufacturers need to address," explains Timm Kellermann from IAV's Consulting4Drive subsidiary. But there are two worlds clashing: the fast-moving domain of consumer electronics with updating cycles at less than a year; and the automotive industry that thinks in cycles more likely to extend over a decade." If the vehicle is to be readily upgradeable for years to come after it is purchased, ways must be provided to download additional functions using software updates; the hardware should not require any adjustments. "Apple could show us how it's done," says Christof Kleinhenz, Senior Consultant at Consulting4Drive. "There are hundreds of thousands of apps that are easy to use and don't overtax the user with complicated technology."

Selling Automotive Apps as the Basis for New Business Models

Networking the vehicle will open up new business models for car manufacturers. It is becoming more possible to activate additional functions after a vehicle is purchased. "This will also make it possible to match a car to changing customer needs once it's ordered and produced, such as adding new driver assistance or entertainment systems," Kellermann says. "Not only could the OEM boost aftersales turnover, it could also sell hardware packages to be updated with software later on."

The residual value of leased vehicles could also be increased relatively easily for new users by upgrading the equipment lineup with software updates at minimal cost. But will consumers be prepared to pay for the software? "Things will change," Kleinhenz believes. "A lot will be free at first, and some will likely spark impulse purchases, perhaps $30 or $40." Prices of $250 for such apps may become acceptable in a few years' time.

Consumer Loyalty Boosted by "OEM Cloud"

Networking also means giving consumers the capability of bringing in other technologies to their vehicles. Mobile access to information and services from the Internet will become commonplace, and must also be addressed by car manufacturers. They must integrate data and functions into the vehicle so consumers can use them wherever they are. This could be achieved using a "cloud": an OEM would not only use the "computer cloud" to document the user's personal data but also to access information and cost-option features that can be used in the vehicle. "If consumers decide to change models within the same brand, they can download their chosen vehicle configuration," Kellermann explains. "This can bring an OEM extra turnover while also strengthening consumer loyalty."

Yet manufacturers also need to develop solutions for motorists to use on the road without involving distraction with familiar touch screens and user interfaces. "Taking the technology a step further will be to make driving partially autonomous, and allow drivers to operate their consumer devices without any risk to other road users and within the bounds of the law," adds Kleinhenz. "Vehicles can be parked semi-autonomously today, and it won't be long before they can find their way into the garage without the need for a driver at all." The expert even sees fully autonomous driving a reality by 2025.

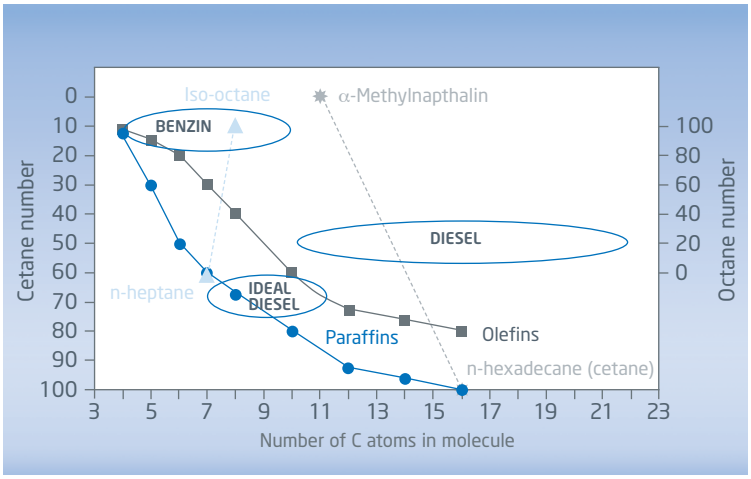
Telematic Solutions for "Zero Downtime"

The service side can also benefit from the networking trend. The vehicle might use a second SIM card to send comprehensive and detailed diagnostic information to the manufacturer, and permit early detection, for instance, of problems with a transmission operating outside its tolerance. In this case, the manufacturer would send a replacement part to the next dealership, and the repair would be taken care of in just half a day thanks to the improved logistics input. "Remote vehicle programming would also be an option," Kellermann says. "This would give the consumer the premium promise of being mobile at all times, and manufacturers would have fewer problems with recalls and goodwill expenses."

The result: much better customer satisfaction while reducing costs for the automobile manufacturer.

Contact:
c.kleinhenz@consulting4drive.com
t.kellermann@consulting4drive.com
joseph.lemieux@iav-usa.com
Jeremy.goddard@iav-usa.com

Searching for the Ideal Diesel



Cetane and octane number still a molecule matter

Diesel fuel today consists of a large number of hydrocarbons, with its specific composition heavily depending on the crude oil used. IAV experts have examined the effect of individual components on engine operation. Processes for producing alternative diesel fuels, such as BtL, GtL or CtL, could in the future provide an "ideal" diesel fuel.

What does the ideal fuel for a diesel engine look like?

This has been a rather academic question because the composition of diesel fuel is largely governed by the crude oil used and can only be altered in the refinery within tight boundaries. Although synthetic fuels – such as those made from biomass (BtL), natural gas (GtL) or coal (CtL) – are still more expensive to produce, they provide far greater flexibility in terms of their composition. Changes in the synthesis process make it possible to define the molecular structures of the different hydrocarbons and their mixture ratio across a broad spectrum.

Ignition Delay Varies Widely

"The diesel combustion process is an ingenious invention but it has a number of weak points," says Maximilian Brauer, Team Manager of Advance Development – Diesel Engines at IAV. "These include cold-starting behavior, high hydrocarbon and carbon-monoxide emissions in the cold phase, the trade-off between soot and NOx emission, combustion noise and limited combustion rate which restrict the specific output attainable." The reason for these problems is ignition delay which varies extensively in relation to engine temperature and engine load: sometimes too long; sometimes too short. The fuel cetane number and boiling characteristics become the most important diesel parameters, for both affect the length of ignition delay and speed of mixture formation during diffusion combustion, and influence engine behavior in terms of both pollution and noise. "The C/H ratio, a further important fuel parameter, determines CO_2 emission per energy unit and should be as low as possible," Brauer says. "The fuel's chemical composition is directly related to soot emission."

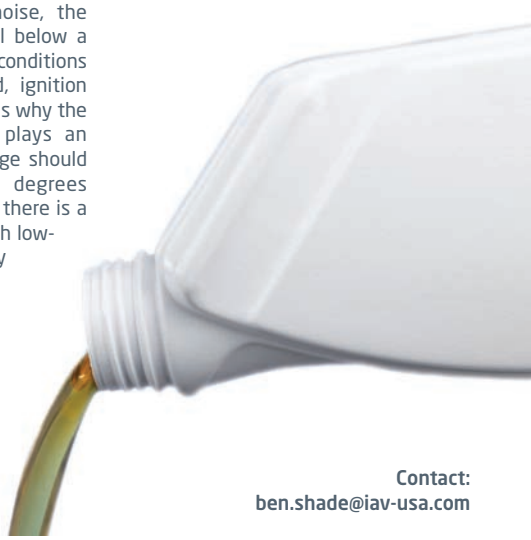
Comparison of Different Fuels

In cooperation with Berlin University of Technology, Brauer and his colleagues have conducted tests on a single-cylinder diesel engine with common-rail injection system. They used the primary reference fuels to determine octane rating (iso-octane and n-heptane) and cetane number (n-hexadecane and alpha-methylnapthalene). "At a rated output, the conditions for ignition and vaporization are so favorable that even marked variations in cetane number and boiling characteristics produce hardly any measurable differences," reports Brauer. "However, fluctuations in the cetane number and boiling characteristics have a significant effect at part load, particularly when the engine is cold." For good cold starting behavior, low HC and CO emissions and low combustion noise, the cetane number should not fall below a value of 53. Under part-load conditions and when the engine is cold, ignition delay tends to be long – which is why the fuel's vaporization behavior plays an important role: its boiling range should be between 100 and 300 degrees Celsius. With highboiling fuels, there is a risk of lube oil dilution and with low-boiling fuels, the mixture may be overly lean.

What Does the Ideal Diesel Fuel Look Like?

If Brauer could mix the fuel of his choice for today's engine concepts, he would have a composition completely different from conventional diesel. "Where today's cetane number in Europe is normally between 51 and 55, I would prefer about 70 for better cold-starting behavior," the expert says. "Its mean boiling temperature would be 150 °C, which could be achieved using n-alkanes with a relatively short chain length of approximately seven to eleven carbon atoms." To bring down soot emissions, the ideal diesel would not contain any aromatics either.

A fuel of this type could also drive forward base engine development. "The high cetane number and associated improvement in cold-starting behavior would permit a further reduction in the compression ratio. For the same peak pressure, this can increase a diesel engine's power output per liter," says Brauer. Extreme downsizing concepts like this could achieve 100 kilowatts per liter of swept volume (75 kilowatts/liter is considered high today) and, through the comparatively reduced level of engine friction, lead to further CO_2 or fuel consumption savings.



Contact:
ben.shade@iav-usa.com

Experts from Across the World Present Innovations

8th Braunschweig Symposium on Hybrid and Electric Vehicles and Exhibition

February 15 and 16 saw experts meet up for the eighth time at Braunschweig to discuss the latest solutions for hybrid, plug-in and electric vehicles while also covering the infrastructure. IAV organized test drives with various makes of hybrid and electric vehicles at the Gifhorn Development Center.

For two days in the Braunschweig Civic Hall, over 300 participants discussed the status quo and future prospects for electromobility. Those attending included representatives from prominent automakers as well as international research and development centers. Once again organized by IAV and ITS Niedersachsen, this year's symposium focused on vehicle concepts, powertrain components, energy-storage systems, energy management, infrastructure and experiences in the field. For IAV, committed to being the leading innovator in the field of electric and hybrid vehicles, the Braunschweig Symposium ranks among the most important forums in this domain. "Unlike hybrid vehicles, more and more of which are going into mass production, electric vehicles remain a niche product," says Prof. Dr. Burghard Voss, head of Transmission and Hybrid Powertrain Development at IAV and the Braunschweig Symposium's deputy conference director. "But pressure from policymakers and the public to bring out electric vehicles is growing all the time. This is also why activities are increasing on the part of developers such as IAV."

Battery technology is at the focus of electromobility development work at IAV. "Battery technology is pivotal to electrifying the private car," says Prof. Voss. "Because the performance and value for money provided by the batteries will determine whether the average wage-earner will choose to buy an electric car"

Saving in Second Gear

An Additional Transmission Ratio Helps in Electric Vehicles Too – By Saving Energy

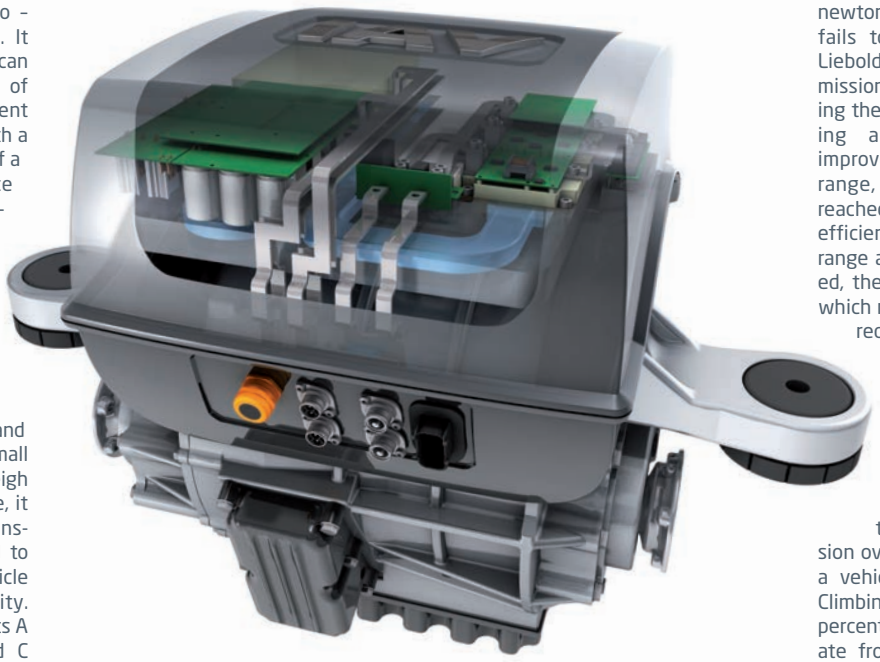
The "IAV DrivePacEV80" electric drive unit can easily be integrated into A to C-segment vehicles with a noticeable boost in efficiency and comfort. Its two-speed transmission keeps the e-machine operating at its best efficiency to improve drivability and reduce energy consumption.

Electric vehicles need a very simple transmission with just one gear ratio – this is a statement that is often heard. It is not entirely wrong an e-car really can manage with one gear, and most of today's low-volume and development vehicles do have an electric motor with a fixed-ratio transmission. Yet the use of a two-speed transmission will produce significant benefits in terms of acceleration and hill-climbing performance.

IAV has developed a highly integrated and modular-scalable drive unit for e-vehicles to be equally suitable for electric vehicles and hybrids. The aim of developing the "IAV Drive-PacEV80" was to create a compact unit comprising electric motor and transmission to take up up only a small amount of space in the vehicle and weigh as little as possible. At the same time, it was important to ensure that both transmission and motor could be adapted to meet the demands of different vehicle categories: modularity and scalability. The drive unit can be used in segments A (microcar), B (subcompact car) and C (compact category). It makes no difference if it is to be used in an axle-hybrid, range extender, battery or fuel-cell-powered vehicle. Whether the unit drives the front or rear axle is also immaterial.

A Robust Asynchronous Motor Provides Propulsion

An oil-cooled asynchronous motor driver the IAV DrivePacEV80. "Oil cooling allows us to get maximum use out of the limited design space in the vehicle," says Bernd Cebulski, Team Manager of Electric Drives at IAV in Chemnitz. "And we need it anyway as a transmission lubricant." IAV's experts deliberately decided against a permanent-magnet synchronous motor because the asynchronous drive is more robust - high temperatures at the rotor might demagnetize a permanent magnet – and can be produced less expensively in high volume.



The asynchronous motor was able to earn bonus points on the safety front as well. "If necessary, the motor can be deactivated simply by shutting down the inverter," Cebulski says. "Developed in-house at IAV, the motor delivers a continuous output of 50 kilowatts and maximum output of 80 kilowatts. It provides 150 newton meters of torque (continuous) which can peak to 300.

Efficiency and Comfort from Two-Speed Transmission

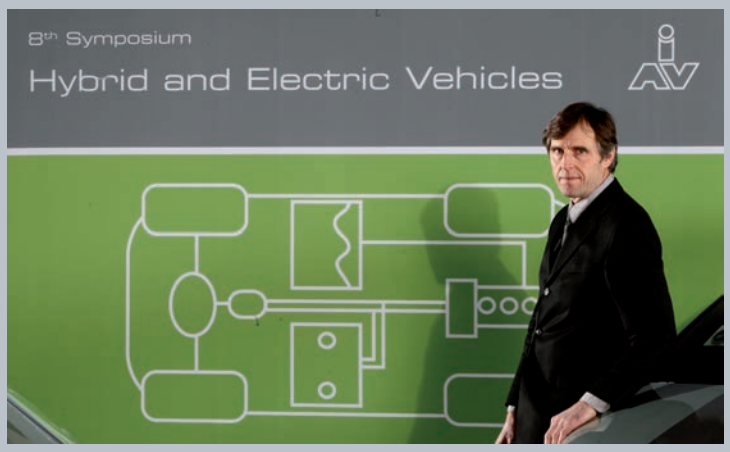
The transmission in the IAV Drive-PacEV80 has two speeds, to enhance the comfort and efficiency of an e-vehicle. "A vehicle from the compact category requires a transmission ratio of about 13 to climb a 35-percent incline," says transmission specialist Jens Liebold from IAV in Chemnitz. "To accelerate from 0 to 100 km/h, the optimum is about eight." The values are even lower for maximum road speed (four) and minimum consumption (three).

These calculations were based on a typical electric motor with a maximum speed of 8,000 rpm and torque of 150 newton meters. "A single speed ratio fails to provide sufficient flexibility," Liebold says. "And multiple speed transmissions are an obvious way of satisfying the conflicting demands." Hill-climbing and accelerating performance improves in the lower vehicle-speed range, whereas top speed can be reached at lower e-motor rpm. Better efficiency produces a greater traveling range and, because less torque is needed, the costs fall for the electric motor which may now be lighter in weight and require less space.

16 Percent Less Energy Consumed

Simulations of longitudinal dynamics show the advantages of a two-speed transmission over a single-speed transmission in a vehicle from the compact category. Climbing performance improved by 88 percent, and the time taken to accelerate from 0 to 100 km/h was cut by twelve percent – and even by 32 percent from 0 to 60 km/h. Clear differences were also revealed on the NEDC where consumption fell by 16 percent.

Contact:
bernd.cebulski@iav.de
jens.liebold@iav.de
joseph.lemieux@iav-usa.com



Exhibition

The exhibition accompanying the symposium gave manufacturers, developers and suppliers the opportunity to present their latest systems, components, software and services in the field of hybrid and electric vehicles. Contacts were also established and deepened between symposium exhibitors and participants, including students from technical colleges and Universities.

Driving Event at IAV

On the evening of the first day, many visitors took the opportunity at IAV's Gifhorn development center to gain expert insight into the latest electric and hybrid-vehicle models and take them on a spin round the test track. Among other vehicles, they were able to try out the Mitsubishi i-MIEV that has been available on the European market since January 2011 as a production vehicle and rated as a fully-fledged vehicle with sound handling performance in an ADAC (German auto club) impact test. Other highlights at the driving event were the Fiat 500 CARe and the Micro-Vett Fiorino. The event also provided visitors with the chance to try out many other electric and hybrid vehicles.

Contact: dr.burghard.voss@iav.de
joseph.lemieux@iav-usa.com

Development Environment with Every Freedom

The IAV-MPEC Modular Development Environment

Engine developers today are facing huge challenges. Stringent new standards, are demanding a further reduction in emissions and fuel consumption while consumers expect efficient and low-noise engines. These demands can only be met with modern components and processes; multi-stage supercharging combined with downsizing, piezo-injectors, variable valve trains, cylinder-pressure measurement and continuous injection-rate shaping play a crucial part.

Although all of these approaches improve the efficiency and comfort of modern engines, they also demand a complex electronic control system. For hybrid drives, powertrain management is evenly distributed over several control units. To design and test these interconnected computer architectures, the developers need a flexible tool that quickly adapts to different concepts while providing sufficient computing capacity. For a number of years, IAV has been using its own MPEC (Modular Prototyping Engine Controller) development environment. IAV-MPEC is a rapid prototyping tool that can be used to operate a vehicle without any production control unit. The in-house development guarantees high performance and achieves model cycle times down to 100 microseconds. A further advantage of IAV-MPEC lies in its ability to add virtually any number of inputs and outputs.

There are few restrictions to the number of sensors that can be connected to MPEC and, with its 100 Mbps EtherCAT bus, the values it measures are recorded in real time. The type of sensor signal is not restricted either: IAV has already developed numerous terminals (I/O devices) for the EtherCAT bus capable of measuring the frequency of FM signals or values from lambda probes.

IAV's own FI^{2RE} (Flexible Injection and Ignition for Rapid Engineering) control unit is responsible for actuating the injection systems, and recording the cylinder pressure signals in synchrony with the combustion process and thermodynamics. It is capable of operating both conventional solenoid injection valves as well as piezo injection valves, with up to five injection events being possible per cycle and cylinder.

An integral part of the FI^{2RE} is the TRA (Thermodynamic Realtime Analysis) board that measures and evaluates cylinder pressure in synchronization with the crank angle; it provides the most reliable information on combustion timing and quality, and provides the means for recording and processing up to eight signals on an angle or time basis. Modular in design, the entire system can be installed in a standard 19-inch rack. Depending on a project's specific requirements, different input and output cards can be connected, e.g. for analog and digital, as well as for PWM and FM signals. It also provides the vehicle-specific CAN and RS 232 interfaces. IAV-MPEC acts as its own EtherCAT master to allow direct communication with the connected terminals for simplifying their integration and facilitating diagnosis.

This development environment has proven its worth in a wide range of different projects at IAV. IAV-MPEC has been able to demonstrate its talents in all of these tasks.

Contact:
kody.klindt@iav-usa.com

More Comfort and Longer Cruising Range for Electric Vehicles

IAV's "Power Conditioning Unit" (PCU) comprises a combustion engine, an electric motor and an air conditioning compressor. It optimizes the use of the chemical and electric energy on board an e-car and permits the use of smaller high-voltage batteries while improving comfort.

We can quickly see how significant the differences between conventional and electric vehicles are: 37 kilograms of diesel fuel can provide power for a distance of a approximately 850 kilometers, where, despite weighing some 300 kilograms, a fully charged battery may offer a maximum cruising range of 150 kilometers.

An added concern is that vehicles need energy not only for propulsion – air-conditioning and infotainment systems also demand their share of the power source. Where the waste heat in combustion-engine vehicles can be used for heating more or less for free, this energy must also be taken from the battery in an electric car. In most cases, the limited amount of space available in the vehicle limits the battery size.

IAV engineers have developed an alternative: their "Power-Conditioning Unit" (PCU) comprises a small electric motor, a combustion engine, an air-conditioning compressor and fuel tank, a heat exchanger and the power electronics. It is a reduced range extender that not only takes care of heating but also cools . "We want electric vehicles to have a sufficient traveling range after taking into account the comfort functions," reports Holger Gentgen, designer in IAV's Powertrain Integration division in Gifhorn. "But under no circumstances is this to come with higher costs or added weight."

Same Cruising Range despite Smaller Battery

The PCU makes it possible to reduce the size of the battery because it no longer needs to guarantee a cruising range of around 150 kilometers: 50 to 100 kilometers are enough to cover everyday needs. The PCU also serves as a cushion for additional mileage. It can ensure the electric energy storage system is always maintained at its optimum working temperature of between 10 and 40 degrees Celsius. When cold-starting in winter, the PCU's combustion engine uses the heat it dissipates to bring the battery to working temperature while supplying electric power from its generator for charging it. "The combustion engine can be used for cooling and heating at the same time, for example, when the passenger compartment is cold but the battery is hot," Gentgen explains. "In this case, the motor would drive the compressor for cooling and use the waste heat to take care of heating." If the battery is almost flat, it can provide energy for charging in addition to heating and cooling.

Patented Operating Modes Optimize Use of Energy

If there is sufficient electrical energy in the battery, the PCU's electric motor can drive the compressor to cool both passenger compartment and battery. "We have developed the optimum operating modes for a wide range of different scenarios and obtained patents for them," Gentgen says. "The PCU ensures that both chemical and electric energy is always used in the best way possible."

A "Coming Home Function" ensures the vehicle has enough power to return to the starting point. It uses data from the navigation system to compute the required amount of electric energy. If the battery's charge level is not sufficient, the combustion engine starts up and recharges it while traveling. However, its modest power output of just a few kilowatts is not able to propel the vehicle on its own.

Wide Range of Different Engines Conceivable – Software Recommends Best Solution

The type of engine used in the PCU is determined on a case-by-case basis. "A small spark-ignition engine is the right choice for a standard-size car because exhaust-gas aftertreatment will be relatively simple," Gentgen argues. "For buses or other commercial vehicles, a diesel engine would probably be more suitable." Another option might be the use of Wankel-type engines or fuel cells drawing their chemical energy from ethanol.

Contact:
holger.gentgen@iav.de
joseph.lemieux@iav-usa.com

Clearest Picture Possible for Asphalt Pilots

IAV Experts Develop Optimum Human-Machine Interfaces

In a modern vehicle, it isn't easy to keep track of everything. And that is where ergonomics experts are needed: IAV's specialists in cockpit development make sure the driver does not lose sight of the overall picture despite the growing number of infotainment and assist systems.

The classic speedometer, rev counter and fuel gauge are being joined in the instrument panel by a growing quantity of information from infotainment and driver assistance systems. The multimedia display in the center console is now almost part of the standard line up and, in a way, makes the motorist feel like a pilot.

How do motorists cope with all these indicators, levers and buttons? The driver-cockpit experts are developing new cockpit systems while making sure the ergonomics do not fall short. "This subject has two aspects," says Helge Schäfer, team manager of Advance Development – Cockpit Systems at IAV. "Ergonomics in the classic sense is about providing an average driver with good external vision and ensuring all symbols meet the applicable standards." The many new assistance systems in the vehicle also make it necessary to look at the cognitive ergonomics.

Cognitive Ergonomics as a New Challenge

Can drivers understand the multimedia display symbols intuitively or are they confused by dynamically changing screen content? Electronic helpers, such as the navigation system, intelligent cruise control, lane-keeping assist or parking assist, all vie for the driver's attention. The art lies in configuring the available information in a way that ends up providing a well-balanced display concept and not merely a string of information fragments. Combining intelligent cruise control with a lane-keeping assistance system simultaneously provides information on longitudinal and transverse dynamics and, thus, a clear picture of the current driving situation. It is important, however, for the signals not to result in confusion. In IAV's human-machine interface (HMI) customer clinics, average users are required to cope with the information they are confronted with; they often sit in a simulator that reproduces a complete cockpit and generates a simulated view of the outside world. "A virtual car allows us to observe the test person's behavior very well," Schäfer reports. "It tells us a lot about the influence the HMI has on the driver's behavior and allows us to assess how long it takes to perform the various operating actions." In the next step, the systems are experienced first hand as prototype versions in test vehicles.

IAV Takes Care of Developing All Aspects of Cockpit Systems

It is crucial to make sure drivers can always perform their primary driving functions safely. They are assisted here by the instrument cluster which not only indicates traveling speed but also the state of important subsystems, such as oil and coolant level. Under no circumstances must the "secondary operating functions" – making phone calls or reading e-mails – be allowed to distract the driver's attention. "But they must be convenient to use; consumers are accustomed to straightforward operation from their smart phones and music players," says Schäfer. One of the main tasks for IAV colleagues is to write the specifications for new cockpit systems and to take care of managing suppliers in the later development process. "At the end of all this, we can also build entire prototypes and integrate them into test vehicles," Schäfer reports. "Projects covering all aspects of new driver cockpits normally involve colleagues from the Electronics Division (they specify the HMI definitions) and from the Interior division (they attend to the classic ergonomics)."

Cockpit systems are not only designed to provide the ergonomics for a specific model. They must also be recognizable. Each manufacturer has its own philosophy reflected in many models. "The cockpit is a key purchasing criterion," says Schäfer knowingly. "It must also be possible for existing customers to find their bearings quickly in new products, which is why we often take evolutionary steps in model changes but rarely change entire concepts." However, customers in new markets do expect the developers to take cultural differences into account. The user interface in Europe is always designed to be as quiet and communicative as possible, whereas the Asian markets favor colorful displays with contents that are also allowed to change with more dynamics.

Driver to Car: "Please Take a Left Turn"

In future, Schäfer expects new technologies to penetrate the cockpit-systems market from established IT companies, like Intel, ARM, Google and Microsoft. "Because manufacturers use proprietary operating systems today, we may see a certain standardization in the future." New forms of interaction between vehicle and driver are conceivable also: the automobile will perform whole driving maneuvers on the driver's behalf. In this context, it will be necessary to resolve issues of how to optimize the way in which the driving function is passed from driver to vehicle.

Besides the question of how such partially autonomous vehicle functions can be controlled by the driver, it will be necessary to determine how best to use the driver's senses for information, warnings and function feedback.

Contact:
helge.schaefer@iav.de
jeremy.goddard@iav-usa.com

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
www.iav.com

Editors:
Ursula Torp
Jeremy Goddard

Design:
ZITRUSBLAU GmbH
www.zitrusblau.de

Frequency:
three times a year

Public Appearances & Publications

June

June 07-08, 2011
"Transmissions in Vehicles"
Friedrichshafen, Germany

June 07-08, 2011
chassis.tech plus
Munich, Germany

June 08-09, 2011
Third German Electric Vehicle Congress
Bonn, Germany

September

September 21-23, 2011
SAE North American International Powertrain Conference (NAIPC)
Chicago, IL

October

October 2-5, 2011
ASME (Internal Combustion Engine Division's 2011 Fall Technical Conference)
Morgantown, WV

October 3-6, 2011
DEER (Directions in Engine-Efficiency and Emissions Research)
Detroit, MI