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June 2015

**INTERVIEW:**  
GETTING INTO  
GEAR WITH  
GRAZIANO

**FOCUS ON:**  
SAFETY SYSTEMS  
VIENNA ENGINE  
SYMPOSIUM REVIEW



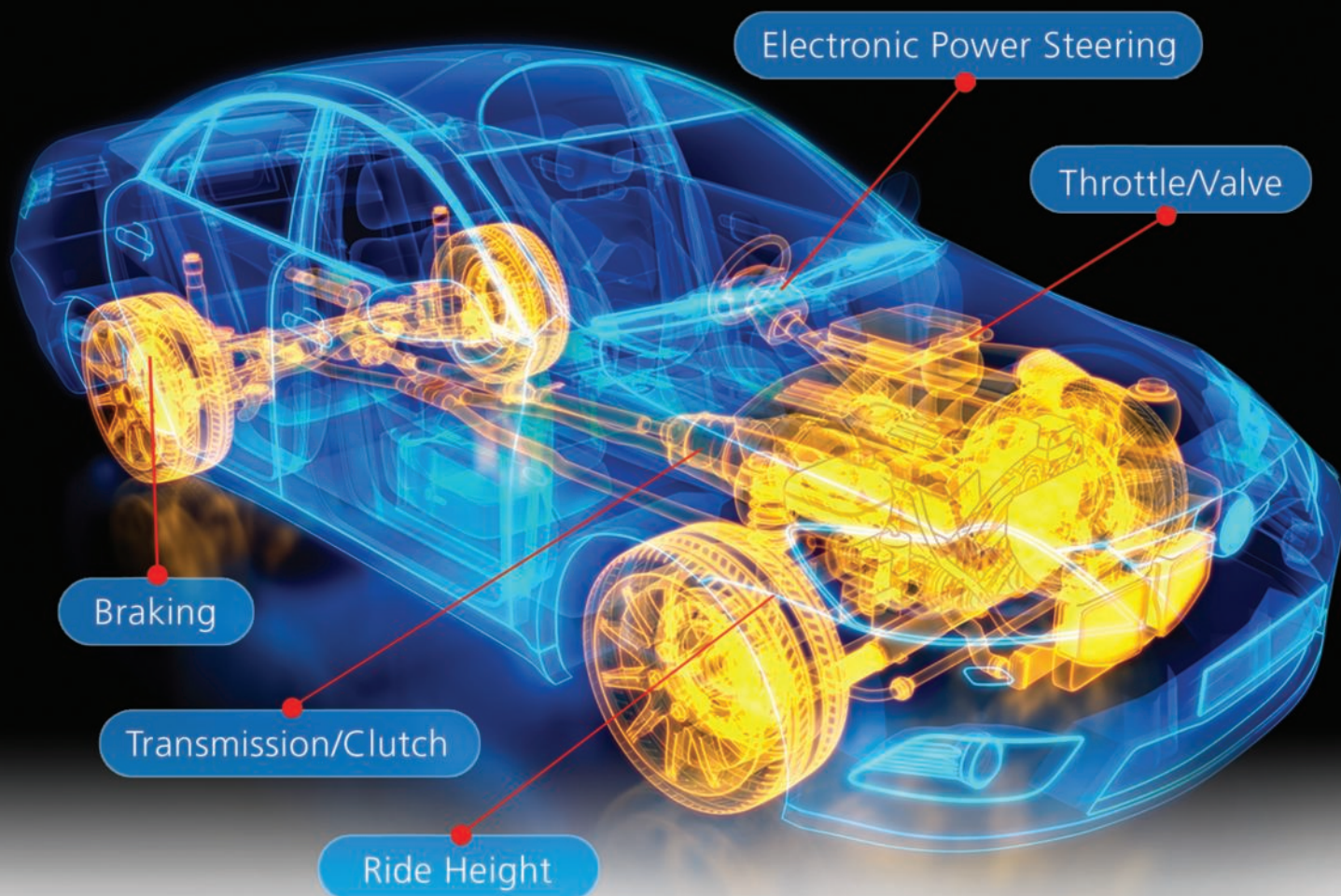
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# Contents

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14



## 14 *Automotive Design* Interview

### **Transmission: on a mission**

Ian Adcock speaks with Oerlikon Graziano's head of performance, automotive, Paolo Mantelli, about the revolution ahead for transmission systems

## 18 Cover story

### **Inside The Proving Factory**

Ian Adcock reports on a new business model designed to bridge the skills gap between engineering start-ups and the motor industry

## 24 Focus on Restraints and Airbags

### **Sensing danger, maximum response**

*Automotive Design* looks into passenger safety systems

## 26 Focus on vehicle electrification

### **48-V systems: all set to dominate?**

Special report by Kevin Jost, SAE International Editorial Director

## 28 Focus on batteries and hybrid electric motors

### **Powering ahead!**

Electrification of road vehicles is an unstoppable force, according to one expert. *Automotive Design* has been finding out the full story

## 30 Vienna International Motor Symposium

### **Trains of thought**

We bring you the latest thinking behind powertrain trends unveiled at the symposium

## 32 Question time

### **Keeping up to the marque**

Ian Adcock catches up with Ford of Europe's vehicle line director on the engineering challenges that lie ahead

## 5 Comment

- To drive... or be driven?

## 7 News

- Triple boost from Bosch
- The right blend and values from JLR
- Tenneco leverages particulate filter expertise
- Driver assistance takes wider view

## 23 The Columnist

### **Multi-material extremes**

Kevin Jost, SAE International Editorial Director

## 34 60 second interview

Dan Walmsley, Strakka Racing team principal

18



Cover photo: Donald MacLellan

28



30





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# TO DRIVE... OR BE DRIVEN?



I shared an interesting conversation recently with Jaguar Land Rover's director of vehicle engineering Mark Stanton (see page 8) on the launch of the impressive XE. Despite the brand's success with aluminium, he is open about how future products will employ the right materials in the right places, depending on the location and function, and he certainly

doesn't rule out the use of carbon fibre and steel in the future.

But what struck a note with me in particular was his concern that manufacturers will be driven down a technological road map by legislation that doesn't necessarily fit the bill for either the OEMs or their customers.

"It frustrates me that electrification is seen as this wonder solution by governments around the world," he states.

Yet, barely a few weeks later at Bosch's technical presentation, electrification seemed to take centre stage, with Dr Rolf Bulander, member of the board of management of Robert Bosch GmbH and chairman of the Mobility Solutions business sector telling everyone that "Electrification ... will give a further boost to gasoline and diesel engines".

No doubt Jaguar will play its role in electrification not because it wants, but will be forced to do so.

The Proving Factory, as you will read on page 18, shows that innovation is truly alive and well in UKPIc, but should we be surprised by that? Not really. There's always been a hot bed of innovative thinking here – we're just not very good at exploiting it. All that might change with this new venture.

Meanwhile Italian transmission specialists Graziano (page 14) has ambitious plans for its future, as well as some groundbreaking ideas that could see a reduction in ratios, rather than the current trend towards an ever-increasing number of cogs – ironically aided by electric motors.

**Ian Adcock, Editor in Chief**



## FOR THE HOT, THE HARSH AND THE TURBOCHARGED: **ELASTOMERS WITH EXTREME HIGH-TEMPERATURE RESISTANCE**

Drivers want small-engine fuel economy, but they're addicted to big-engine power. And government regulators are adding to the complexity with aggressive fuel-efficiency targets. So what's an engine designer to do? Turbocharge it!

Adding a turbocharger can help you design a fuel-efficient V6 with the acceleration and towing power of a brawny V8. And innovative fluorosilicone rubber (FSR) elastomer technology from Dow Corning can help ensure that your turbocharger hose design will perform reliably in an underhood environment that is hotter and harsher than ever before. In that same challenging environment, FSRs also increase durability for fuel, oil and transmission seals; O-rings and gaskets; diaphragms; membranes; and flexible

valves. As an added bonus, you can meet ever-expanding design and performance expectations while also enjoying the benefit of easy processing.

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## Triple boost from Bosch

Bosch technology is making cars more efficient, more convenient and more fun to drive – that is the contention of Dr Rolf Bulander, member of the board of management of Robert Bosch GmbH and chairman of the Mobility Solutions business sector. All three aspects come together in the Bosch boost recuperation system. In the New European Driving Cycle, the 48-volt hybrid can cut CO<sub>2</sub> emissions by 7% (based on a compact class model) and can deliver up to 150 Nm more torque on demand.

“Electrification and connectivity will give a further boost to gasoline and diesel engines,” predicted Bulander. “Bits and bytes are making cars more efficient.”

This future technology will supply essential traffic information about construction sites, traffic jams, and accidents in real time. From this basis, it will be possible to further improve existing functions such as start-stop and coasting. At the same time, plug-in hybrids can use the system to implement a predictive operating strategy (see picture caption). Such technologies can cut CO<sub>2</sub> emissions by at least 10%.

CO<sub>2</sub> emissions for a gasoline engine in the subcompact class can be reduced to 85g/kms and, for a diesel, even lower than 70g/kms.

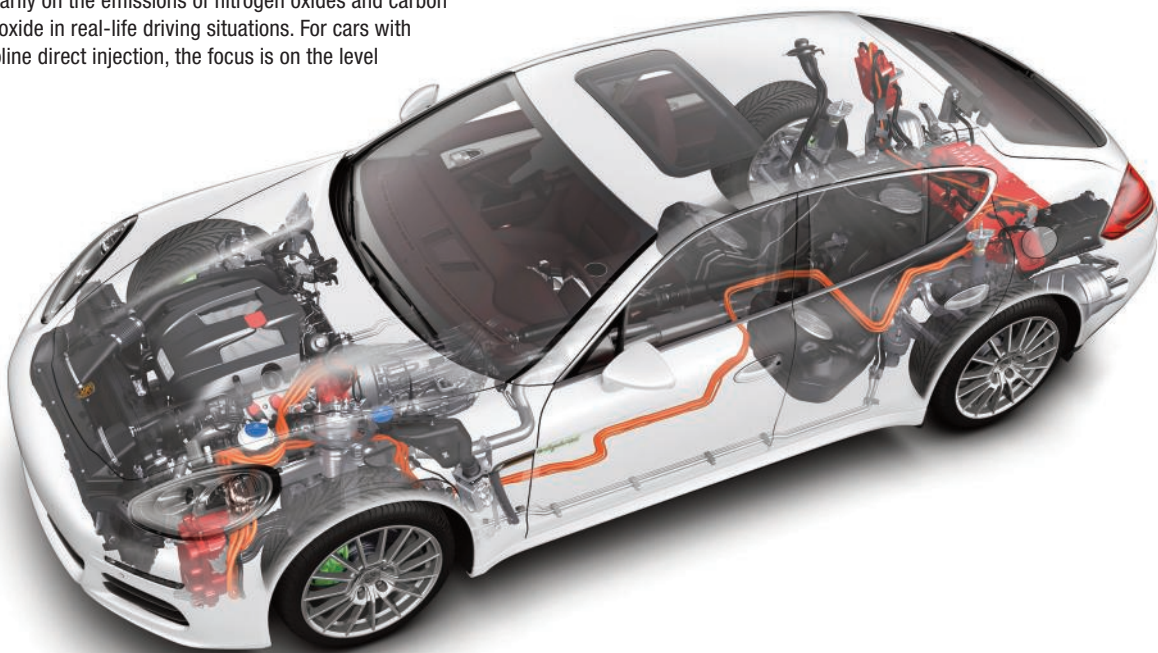
The EU is discussing whether to introduce real driving emission tests in 2017. This measuring method for diesel cars concentrates primarily on the emissions of nitrogen oxides and carbon monoxide in real-life driving situations. For cars with gasoline direct injection, the focus is on the level

of particulates emitted. One example to help achieve these figures is the innovative direct injection system with laser-drilled spray holes in gasoline engines. The holes’ precise edges swirl the fuel in the combustion chamber in such a way that it burns extremely efficiently. Increasing the injection pressure from 200 to 350 bar cuts particulate emissions to an even greater extent – especially under high load points and dynamic engine operation.

In diesel engines, Bosch’s new 48-V boost recuperation system reduces nitrogen oxide emissions in the engine, making exhaust gas treatment still more efficient.

Through the judicious application of boosts, the system can markedly reduce untreated nitrogen oxide emissions, especially at high loads or when the car is accelerating. The crucial factor here is that this effect cuts emissions directly at the point of combustion by up to 20%. This has the effect of significantly lowering exhaust pipe emissions: Bosch believes the system could allow the storage catalytic converter to reduce nitrogen oxide emissions by up to 80%.

Electrification will also increase the level of efficiency for urea-based systems, as well as SCR catalytic converters. These exhaust gas treatment applications consume much less AdBlue, which means the fluid doesn’t need to be refilled as often.



*Bosch demonstrated its predictive hybrid powertrain in a modified Porsche Panamera S E-Hybrid with 48-V 28 amp/hrs battery and a 11kW electric motor mounted to the engine via a belt to enable instant start-up. A DC-DC convertor is fitted between the 12v and 48-V circuits.*

*The system delivers stop-start, coasting and also additional torque, and during braking can recuperate energy back into the battery, resulting in a 15% improvement in fuel consumption over the entire drive cycle; although that depends on how an individual OEM programmes the strategy.*

*In the demonstrator, Bosch has linked a forward-facing camera into the car’s SatNav system, so it recognises city centre or restricted speed zones 2 Kms ahead. The vehicle automatically charges the battery to full capacity, in order for the car to be powered, emissions free, by the batteries alone.*

## The right blend – and values

According to JLR's director of vehicle engineering, Mark Stanton, "some OEMs are walking away from their brand values to meet environmental targets. Jaguar won't do that".

He revealed that aluminium will play a big part in JLR's future, but not exclusively. "Aluminium continues to be expensive for the lower-priced products, so steel will continue to be used and, done the right way, is very effective. Moving forward, mixed materials will become more common; strategic use of carbon fibre is something I certainly see coming in certain applications. It can be really tailored to the application."

Stanton expressed the hope that legislation would be clever enough and real-world oriented such that "we're not forced arbitrarily down the battery-hybrid route. It frustrates me that electrification is seen as this wonder solution by governments around the world.

"Worldwide harmonised Light vehicle Test Procedure (WLTP) is driving us to right-sized engines, rather than downsized, and I am all in favour of that; although I am conscious that it still might overemphasise hybrids. The trouble is it comes in 2017 and we still don't know what the legislative requirements will be.

"If you look at total lifecycle analysis, the internal combustion engine isn't as bad as it's portrayed to be; under a lot of circumstances,



a diesel XJ is better for the environment than a Tesla. In China, it's massively better, because they generate their electricity from coal.

"The role of the combustion engine will continue for some time. Electric vehicles can be the right solution for some people,

depending on how they use them and how the electricity is produced," added Stanton.

"We have to offer the substitutes; there's not a single alternative solution. We have to be clever in moving forwards as to what is the most appropriate vehicle for particular customers. That's something the industry as a whole has to be more savvy about."

JLR's new Ingenium engine shares about 30-35% common components, states chief programme engineer Paul Whitwood. "The cylinder block is essentially the same on diesel and petrol engines, bore centre and deck heights, but the blocks are subtly different. Petrol engine blocks are getting closer to diesel as boost pressures increase and mega-knock becomes an issue as peak cylinder pressures increase to about 200 bar for the diesel and 140-160 for petrol. With mega knock, that can go up to 200 bar in a petrol engine."

A theme of Ingenium is a common bill of process for every variant, in machining and assembly. "We've gone out of our way to drive friction down with roller bearings on camshafts and balancer shafts, a 12mm offset piston to crank centre line, so the greatest pressure on the piston is when the rod is vertical to minimise bore wear; common variable cooling and oil pumps, lowering friction 17% over the outgoing diesel engine."

## Silica seals deal with Huawei

Silica has announced a franchise agreement with Huawei, the worldwide vendor of cellular wireless infrastructure and modules. Under the agreement, Silica is marketing multi-standard 3G and 4G wireless modules in a choice of popular form factors, including LGA, PCIe and PCI-SIG M.2. Based on Huawei HiSilicon chipset technology, the new modules offer features specific for M2M communication.

"This is being driven by the demand for innovative connectivity," said Laurence Dellicott, Silica's technical director. "Huawei are the only supplier to have automotive grade silicon and modules which is key to coping with OEMs durability demands. We're only focusing on 3G, 4G and beyond that, so it is future processed for years to come.

"Guaranteed connectivity at certain data rates will become increasingly important; 5G will transform the world, in terms of connectivity, and for the automotive sector will deliver the true connected car and the ability to stream maps, media or data about the journey will increase significantly. There will be the ability for OEMs to sell new services, opening up additional revenue streams to them."

Dellicott claims Huawei has "a big cost advantage", because it has its own chip set technology. He expects the first European OEM deal to be announced before the end of the year.

## Test pods are blueprint for global engine development

Delphi has opened new testing and durability pods at its Gillingham, UK, diesel engine development centre. Initially, the pods will be used for commercial vehicle engine development, but they provide the blueprint for similar facilities, developing passenger car petrol and diesel engines around the world, said powertrain vice president John Fuerst.

"It's a next generation for us, where we've made significant improvements not only in terms of standard testing, but we have reconfigured for safety, noise and 24/7 operation, and come up with something that is more customised than ever before."

Fuerst maintains the new pods will allow Delphi to develop new emissions technologies to meet future legislation better, faster and cheaper than before.

"We have decided to do more of the integration ourselves; we've improved how quickly we can change over, how many operators it needs and how quickly we can repair systems." By including remote cameras and monitors, the system can be unmanned for 24/7 testing.

Dr Sebastian Schilling, powertrain system's engineering director for Europe, added: "The problem with injection systems is that you need different solutions for various applications, petrol and diesel, and individual architectures."





## Advanced vehicle simulator to slash validation times

A new £2m (£2.8m) research and development centre featuring one of the world's most advanced vehicle simulators has opened in Hethel, Norfolk.

The facility features Ansible Motion's new Delta series simulator with a 6 degrees of freedom motion system, which is powered by a total of 16 5GHz computers, with five projectors offering a frame rate that is five times faster than a cinema projecting a 240° wrap-around view on an 8m screen. The centre also features a full

control room to monitor up to 300 channels of data, separate viewing gallery and secure conference rooms.

Ansible Motion designs and builds 'Driver-in-the-Loop' simulators used by vehicle manufacturers to develop and test vehicles. It focuses on 'engineering-class' simulators so advanced it is claimed they can be used to validate safety vehicle systems and sign off vehicle settings. By working in a consistent virtual world, engineers can cut months from

a vehicle test programme with significant cost savings by being able to test road and weather conditions from anywhere in the world in a laboratory setting.

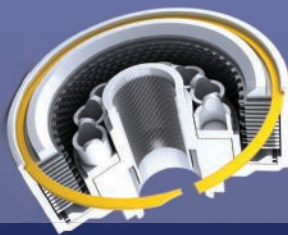
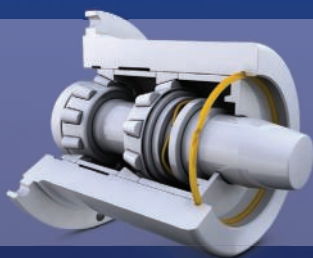
"Simulators such as the Delta series offer vehicle manufacturers a no-compromise method to reduce development costs and time," said Kia Cammaerts, founder of Ansible Motion. "Using our simulator has cut the validation time from 10 days to just three for an electronic stability control (ESC) programme for one manufacturer. Apply those kinds of savings in cost and time across the whole car and it explains why we are now getting more enquiries from OEMs to see what our simulator can do."

With a strong emphasis on getting the driver to engage in a realistic way with the simulator, Ansible Motion focused on creating an immersive experience by embedding a model of the human vestibular system in the software and eschewed the usual hexapod machine architectures to ensure the most realistic vehicle motion.

"Experienced drivers feel the difference straightaway when they drive this simulator," stated Cammaerts.

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## News in brief

### Elektrobit bought

Continental Corporation has purchased Elektrobit Automotive GmbH, headquartered in Erlangen, Germany. The company is a specialist for highly innovative software solutions and has worked closely with Continental for more than 10 years.

### Millbrook deal

Millbrook, one of Europe's leading independent technology centres for the engineering, test and development of vehicles and vehicle systems, has signed a strategic Memorandum of Understanding (MoU) with The International Centre for Automotive Technology (ICAT), Manesar, India. As part of the MoU, both parties will establish a presence at each other's premises and develop mutual business representation in their respective countries. The agreement also seeks to identify and engage both companies in joint programmes of work, and find opportunities to leverage their test facilities, laboratories and expertise.

### Testing, testing...

A ground-breaking test centre for research and development in the field of vehicle safety in Germany is being established at the Ingolstadt University of Applied Sciences. The goal for the CARISMA (Centre of Automotive Research on Integrated Safety Systems and Measurement Area) project is to become the leading scientific centre for integrated safety in Germany. For the first time in Germany not only will partial aspects such as airbags, vehicle body, and active safety systems be studied, but also the overall concept of all safety-related topics in the vehicle will be studied at a central location.

### Novel tyre concept

The outer third of Falken's concept tyre comprises a primarily low rolling resistance slick surface with intelligently placed water dispersion grooves that prevent hydroplaning and also enhance wet road grip. To offer better grip under hard cornering, the inner third of the tyre features a curved surface that comes in greater contact with the road while the car is being pushed harder, as with a motorcycle. No production date has been set for the novel tyre.

## Tenneco leverages expertise in particulate filter technology

Tenneco is leveraging its expertise in diesel particulate filter technology to develop gasoline particulate filters for 2017 model year vehicles. These filters are designed for gasoline direct injection (GDI) engines to reduce particulate emissions in compliance with the Euro 6c emissions regulation, which takes effect on 1 September, 2017.

GDI engines can have higher particulate emissions, due to shorter in-cylinder fuel/air mixing times, compared with multiport fuel injection engines. Advanced fuel injection strategies are currently used to control gasoline particulate emissions in-cylinder, but are designed for a specific emission test cycle and may be less effective under real driving

conditions. Gasoline particulate filters effectively control particulate emissions under all operating conditions.

"At Tenneco, we understand the functional requirements for gasoline particulate filters, based on our experience as one of the first global suppliers to offer diesel particulate filter technologies in serial production," said Josep Fornos, executive vice president, clean air, Tenneco. "With our design, engineering, systems integration and advanced manufacturing capabilities, we provide customers with flexible solutions for any powertrain to meet future emissions regulations, without compromising vehicle performance or durability."

*The LT8616 is a 42-V input capable, high efficiency dual synchronous monolithic step-down switching regulator. Its dual channel design delivers independent 2.5A and 1.5A continuous current to outputs as low as 0.8-V. A dual channel synchronous rectification topology delivers up to 95% efficiency, while Burst Mode operation keeps quiescent current under 6.5µA, making it ideal for always-on systems.*

*Its 3.4-V to 42-V input voltage range exactly meets the requirements of automotive applications that must regulate through cold-crank and stop-start scenarios, with minimum input voltages as low as 3.4-V and load dump transients in excess of 40-V.*

## Multi-component turbine housing to help slash emissions

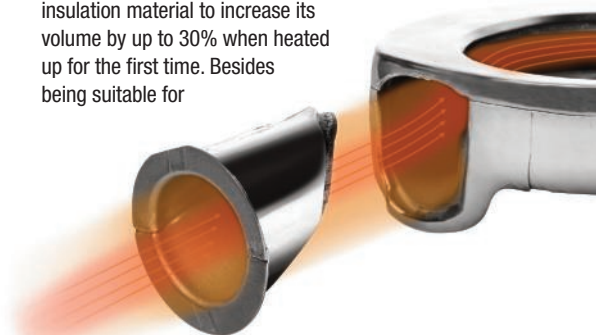
Isolite, in cooperation with a leading manufacturer of turbochargers, has developed a patented multi-component turbine housing that is effectively protected from the inside using a snap-in insulation. This means that the exhaust gas after-treatment components reach their operating temperature more rapidly, without requiring additional heat or energy, resulting in lower emissions.

Increasingly stricter legal CO<sub>2</sub> and NO<sub>x</sub> standards are causing OEMs to search for alternative solutions in the form of additional insulation systems for use in the exhaust tract. As a result, as much energy or heat as possible is conserved in the front part of the components that conduct the hot gas.

This energy is required for heating up the exhaust gas after-treatment components.

Temperature conservation, with an innovative internal insulation featuring a sandwich design in which an inner and an outer liner surround the insulation layer, solves that issue.

Isolite uses the proven XPtechnology, with the so-called 'popcorn effect', allowing the insulation material to increase its volume by up to 30% when heated up for the first time. Besides being suitable for





### ‘Groundbreaker’ technology for free piston research engines

Libertine FPE has developed what it claims to be ground-breaking technology for free piston research engines. Libertine says its technology can be applied to accelerate combustion research necessary for the development of automotive hybrid powertrain modules, such as range extenders.

By eliminating the crankshaft and connecting rods of a conventional engine and using a linear electrical machine to generate power directly from the piston's motion, free piston engines can generate a third more power from the same fuel input and be scaled to suit applications from 1kWe to over 100kWe.

“Major investment by OEMs and leading universities across the globe over the past decade demonstrates a broad recognition of the benefits of free piston engines,” explained Libertine CEO Sam Cockerill. “Our patented

design architecture overcomes the challenges of control, complexity and system losses that have previously held back commercialisation. We can provide ready-made research engine hardware to advanced technology groups, delivering the digital piston motion control necessary for the most demanding free piston combustion research applications.”

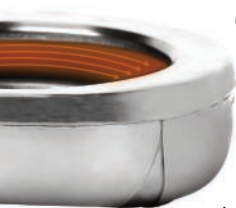


geometrically demanding installation spaces, the material offers a high acoustic absorption potential and low specific thermal conductivity.

With this internal insulation, it is possible to achieve an approximately 10% higher preheating temperature of the exhaust gas after-treatment components using only one insulation body, whereas two to four external insulation systems are usually required for the same result.

An internal insulation offers various advantages, in comparison with conventional external insulations. For example, the reduced thermal load on the turbine housing and the adjacent components allows manufacturers more flexibility in their choice of materials.

At the same time, an internal insulation is ideally suited for use in restricted and demanding engine compartment geometries, as external insulation systems can be dispensed with as little as 25 to 50% of the usual tolerances required.



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## Driver assistance takes the wider view

Continental has demonstrated a driver assistance function based exclusively on Surround View camera technology that encompasses the vehicle's surroundings in a 360° view and can be used for various functions.

"Until now, fish eye camera technology was used to assist drivers while parking by showing the vehicle from a bird's eye perspective and the vehicle path while reversing. This allows drivers to better estimate the distance to objects in their surroundings," explains Wolfgang Fey, director of the

surround view segment of the advanced driver assistance systems business unit within Continental's chassis & safety division.

"However, we see additional applications for the surround view systems, including automatic brake intervention while reversing, cross traffic assistant and automated parking."

Four fish eye cameras are built into the prototype – one at the front in the grill, one at the rear and one at the base of each side mirror. Each camera has an aperture angle of more than 180°,

making it possible to have a 360° view of the vehicle's surroundings, without any gaps.

Objects in the vehicle's path that obstruct the space needed for manoeuvring are recognised in the image analysis. Continental uses the image analysis from the rear camera for the back-up assist, in order to avoid a collision with objects behind the vehicle. The electronic control unit for the Surround View system is connected to the vehicle's electronic brake system and automatically brakes when a collision with an object cannot otherwise be avoided.

"Compared with most technologies currently used for this purpose, Surround View camera technology has several advantages," says Dr Benedikt Lattke, project manager for surround view. "These include its range of up to 15metres and the recognition of markings." The camera's longer range increases its flexibility, which allows the brake intervention strategy to be adjusted to the vehicle manufacturer and market expectations – from a late, powerful intervention to early, gentle braking. Combined with additional image analysis or other sensors, the robustness of the back-up assist can increase even more.

Another key strength behind the camera technology is its ability not only to recognise objects, but also classify them; for example, as pedestrians or cyclists.

## Mahle reinforces clean technology commitment

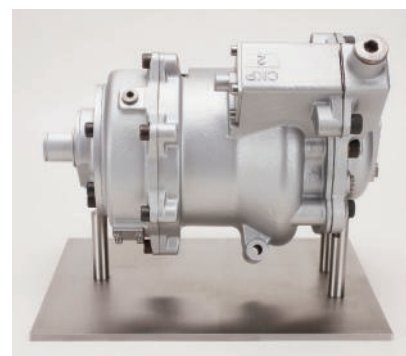
Mahle has acquired Amovis GmbH, driving forward its strategic commitment in the field of clean technology products, processes and services that increase efficiency, while reducing the consumption of natural resources and pollutant emissions.

Amovis was founded in Berlin as a start-up in 2003 and has a high level of competence in intelligent exhaust gas heat recovery, using the Organic Rankine Cycle (ORC).

ORC systems are an advanced development of the steam cycle, in which the waste heat from combustion engines is not released unused into

the environment via the exhaust gas, but used to generate electrical or mechanical energy. This means that fuel consumption in commercial vehicles, for example, can be reduced by up to 4%, and contribute to a significant reduction in the levels of CO<sub>2</sub>.

Amovis is currently developing a highly efficient and cost-effective axial piston machine. Mahle already has considerable expertise in the field of heat transfer for ORC applications. Combined with the expertise of Amovis, the Mahle portfolio now includes essential key technologies for a complete ORC system.



## Brose electric oil pump (eOP) boosts stop-start payback

Brose has developed an electric oil pump (eOP) to deliver the economic benefits offered by a stop-start system, without compromising the driveability. Stop-start engine solutions are estimated to improve fuel economy by as much as 6%. "Brose has emerged as a leader in transmission electrification. We used our product knowledge and grasp of market trends to create solutions that are flexible and quick to meet evolving customer needs," said Richard Illingworth, customer team director of DTA North

America. "When combined with the eOP, the stop-start system shuts down the internal combustion engine when stopped in traffic, saving fuel while maintaining transmission oil pressure. The eOP delivers a significant improvement in driveability, compared to mechanical methods of maintaining oil pressure," he added. To achieve its production goals, Brose North America took advantage of its 'Baukasten', a modular kit for electric drives and powertrain that enables Brose to offer

competitive products for both low-volume and high-volume vehicle programs. The North American eOP solution leverages the 'Baukasten' to ensure flexibility and fast-to-market development as demands in the highly-dynamic electrified transmission market increase.

North American production of the eOP is slated to begin in 2018 at Brose's El Marqués, Mexico, manufacturing location. Brose will produce more than 5 million full stop-start eOPs in the next five years.



## Harman secures EOC technology deal

*Harman will equip Fiat Chrysler vehicles with its Engine Order Cancellation (EOC) technology.*

*EOC uses active noise cancellation technology to reduce the drone and rumble induced by the engine vibrations in the car cabin. It uses engine rpm signal as a reference to generate a sound wave opposite in phase to the engine-induced low frequency noise. E*

*Error microphones mounted in the roof of the car provide adaptive feedback on the cabin noise level, in order to fine-tune the cancellation. By decreasing perceptible cabin noise, EOC enables vehicle makers to pursue various measures to reduce weight as part of the move to improve fuel efficiency without impacting in-cabin noise.*

## Melexis lights the way to HMI advances

Human Machine Interfaces (HMI) – the ‘spaces’ where humans interact with technology – are set to become a key differentiator in future vehicles. They are making a variety of automotive control functions easier to execute, as well as helping to ensure improved safety for passengers and road users.

There are, however, a multitude of challenges associated with implementation of cost-effective and robust HMIs into demanding automotive environments, as the effects of ambient light variations and electro-magnetic interference need to be addressed.

Melexis automotive grade HMI products include the MLX75030/1 ActiveLight ICs for optical gesture and proximity sensing. Via these devices, simple hand movements (such as left/right or up/down swipes) can be determined – allowing operation of infotainment, communication, climate control and navigation



functions, without requiring drivers to take their eyes off the road ahead. This is complemented by its MLX75023 high resolution 3D time-of-flight (ToF) sensor, enabling capture of detailed real-time information relating to the driver's or passenger's hand, head and body movements.

“Incorporation of more effective HMIs will have numerous benefits for vehicle occupants,” comments Gaetan Koers, product line manager for ToF Sensors at Melexis. “Our ToF and ActiveLight sensing products have put Melexis at the forefront of this exciting new sector. We have the state-of-the-art technology that car manufacturers need to fully address the impending opportunities for automotive HMIs.”

## MOST® Breaks Through the Mass Market for Automotive Infotainment



MOST technology is the de-facto standard in the automotive industry for infotainment networks. Now, Microchip's new OS81118 simplifies in-car mobile and Wi-Fi® connectivity over MOST150.

Join the winners! MOST has already been adopted as infotainment network technology in more than 180 car models worldwide. Choose OS81118 for your next infotainment development: Ultra low latency, standard interfaces, low power and cost-optimised solution for audio, video, control and packet data transmission with up to 150 Mbit/s.

To simplify the development of MOST150-based systems, Microchip has released the latest member of its MOST150 INIC family: The OS81118 that features an on-chip USB 2.0 highspeed device port for easy USB connection to standard Wi-Fi/3G/LTE modules and to multi-core Systems-on-a-Chip. Additionally the optional integrated coax transceiver offers a low cost electrical physical layer.



[www.microchip.com/get/euOS81118](http://www.microchip.com/get/euOS81118)

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A professional headshot of Dr. Paolo Mantelli, a middle-aged man with short, dark hair, smiling slightly. He is wearing a dark blue suit jacket, a white shirt, and a blue tie with a brown leopard print pattern. The background is a light-colored, vertically striped curtain.

## Dr Paolo Mantelli

CV

Dr Paolo Mantelli is a vice president of Oerlikon's Drive Systems Segment (ODS). He was recently appointed global head of Business Development, M&As, JVs for ODS, assuming this responsibility in addition to the role of head of the Automotive Product Line, a position he has held since 2013.

He joined Graziano in 1996 as a product manager in Graziano Voith Transmissions, before becoming business manager for special vehicles customers and then director of sales in 2004.

He was appointed head of Automotive Transmissions in 2006. Prior to joining Graziano, Mantelli was a product engineer in the Packard Electric Division of Delphi Automotive Systems.

He graduated from the Polytechnic of Torino in mechanical engineering, specialising in automotive engineering.



# TRANSMISSION: on a mission

**Transmission systems are in line for a technology revolution, as Ian Adcock discovers from Oerlikon Graziano's head of performance, automotive, Paolo Mantelli**

**A**lthough Oerlikon Graziano is one of the smaller players in the transmission sector, selling about 215,000 units a year – divided into 10,000 manual, automated manual, dual clutch (DCT); 5000 electric vehicles (EVs) transmissions, the balance being power transfer units (PTUs) and rear differential modules for all-wheel passenger cars and high performance rear-wheel drive cars – it has ambitious plans to make further inroads into the sector with some innovative technology. Moreover, that goal is driven by what the company sees as a fresh approach to meeting OEM demands, as they strive to offer greater choice to their customers and meet the inevitable emissions/efficiency challenge.

"Our heritage comes from the sports cars angle and our developments with the 1999 Ferrari 360 Modena, which was the first assembly we did in automotive," Mantelli tells me, before adding: "We grew the business from zero to almost €90m – I would say €100m, if we include some utility vehicles transmission, which isn't going to be

part of the automotive sector any more. Traditionally, the volume has always been in the few thousands in high performance cars, to tens of thousands in four-wheel drive and special markets with electric drives, although that depends on how they are going to grow."

## **BIG AMBITIONS**

"Going forward, we will keep our focus on those product lines, but we have a big ambition to grow further in automotive and enter into more of the mainstream volumes, but still

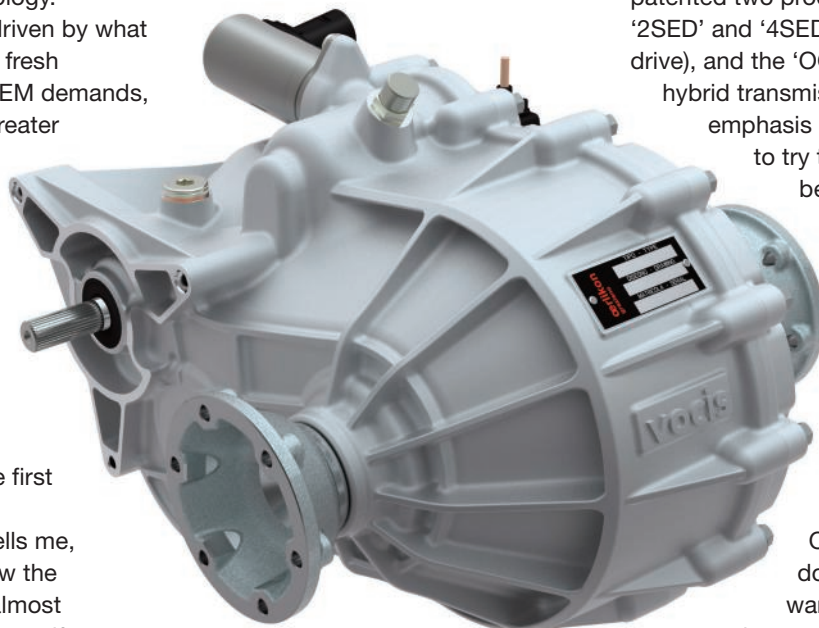
remaining in niche applications, so the future effort will be more on all-wheel drive (AWD), electric and hybrid applications."

He explains that, in the past few years, the company has invested "quite a lot" of money into hybrid transmissions and for EV applications – a policy, he claims, that differs from some of Oerlikon's rivals. "We didn't wait for the customers to come and ask for solutions. We invested in mainly two technologies: multi-speed electric applications, where we have patented two products called the '2SED' and '4SED' (speed electric drive), and the 'OGeco' torque infill hybrid transmission. The

emphasis in the future will be to try to switch more from being opportunistic to anticipating what the customer is going to desire.

"We're not going to betray the traditional experience of our company, which is liked by most OEMs, because we do what the customer wants and that's not

just a slogan. We step in and replace competitors because we listen and are willing to



Graziano works closely with its UK partner Vocis to develop electronic controls systems and motors

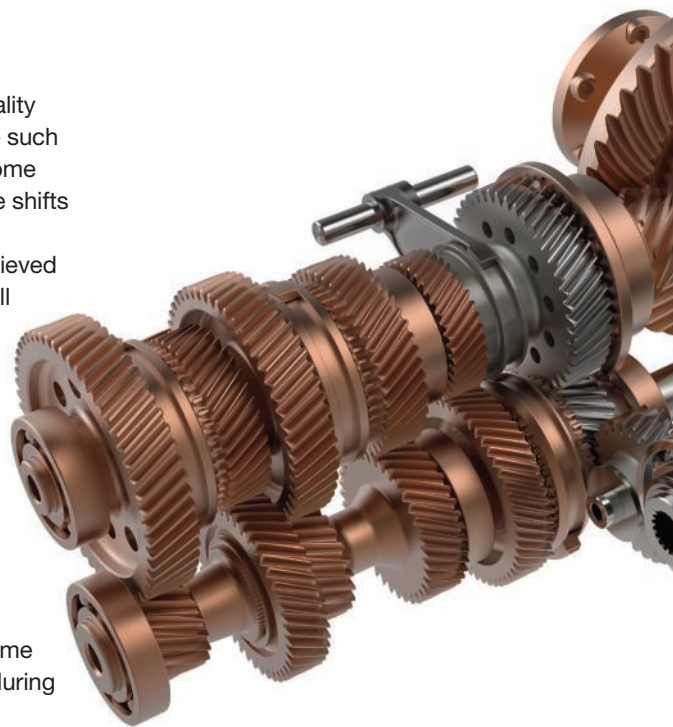
change things that rivals won't." The implication is that some rivals go to the OEMs with the attitude: 'This is how it is and if you don't like it, it's still like this.'

Although Oerlikon is conducting feasibility studies on eight-speed DCTs, what Mantelli classifies as 'traditional' transmissions, he is more interested in the hybridising automated manuals, such as the six-speed AMT, coupled with a 120kW electric motor connected to the primary and secondary shafts by a two-speed epicyclic reduction unit; the OGeco provides torque in fill, electric boost, regeneration, limited electric drive and engine cranking without affecting packaging. A prototype unit has been installed in a Mercedes-Benz SLS AMG by

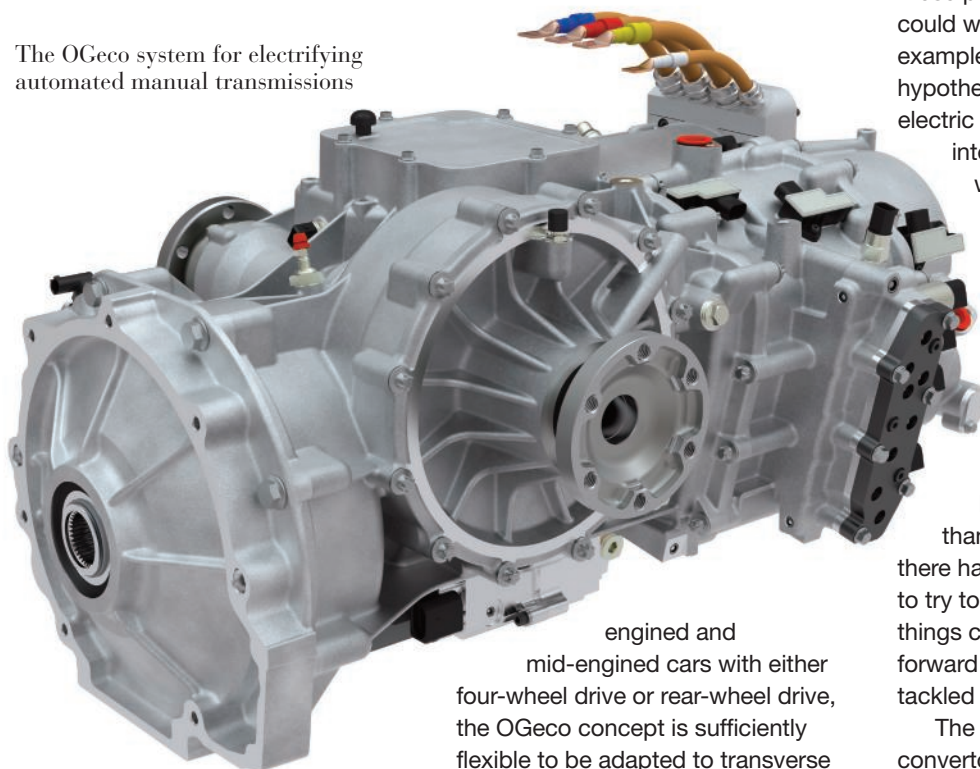
Mantelli claims that the quality and speed of the gear shift are such that, when demonstrated to some OEMs, they failed to detect the shifts from one ratio to another.

"With OGeco, this was achieved by a combination of torque infill from the electric motor and a gear change actuation system that integrates each shift valve into its corresponding shift rod. The smooth shifts we achieve at low-to-medium vehicle performance levels match current DCT expectations, without compromising the rapid shift time and responsiveness required during spirited driving."

Currently suitable for front-



The OGeco system for electrifying automated manual transmissions



engined and mid-engined cars with either four-wheel drive or rear-wheel drive, the OGeco concept is sufficiently flexible to be adapted to transverse transaxles in the future, too.

Oerlikon Graziano and its UK partner Vocis. The packaging is so effective that the OGeco with integrated electric motor fits into the same space as the 7-speed DCT normally fitted to the car.

"The transmission is scaleable, but we are starting from a sports car application, because that's where our DNA is. But in showing it to customers, they have demonstrated a strong interest in applying it to cars in A, B and C segments as well.

"We believe that in those products this transmission could well be with fewer speeds – for example, just four – and, if in a hypothetical future driveline you have electric power equivalent to the internal combustion engine, then we believe you would have a very efficient, compact and light driveline.

"I think hybridisation offers the opportunity to go to simpler drivelines and revamp what we used to know as AMTs and, appropriately coupled with electric power, you could have different combinations than we see nowadays. Today, there has been a race to more ratios to try to optimise economy. I think things can be reshuffled going forward when the car's powertrain is tackled in a different way."

The appeal of traditional torque convertors is that they are manufactured in very high volumes keeping costs down. But in Oerlikon Graziano's field of exotic cars, like the McLaren 540C or the Lamborghini Aventador, the power and torque levels, together with the performance, are such that a torque convertor isn't the optimum solution, explains





AMT hybrid six-speed transmission with infill capability

Mantelli. "So you come from a different angle; you either hybridise a DCT or an AMT. But if you do hybridise a DCT, you're putting in more weight, because you're adding an electric motor and ancillaries like batteries, cables etc on something that by default is already heavier.

"We believe that a cheaper proposition is to hybridise an AMT, which is more effective and efficient, and still offers everything at low or medium speeds. When you go high speed, depending on the brand, some want to really feel the shift and, funnily enough, some of the DCT users are exaggerating the torque gap in some applications, whilst others want a really smooth gear change."

## PRODUCTION PREDICTIONS

With the growth of EVs, Mantelli predicts that Oerlikon Graziano's 2SED and 4SED patented transmissions "could" enter production in 3-4 years' time, with initial application for the 2SED being in the electric performance car sector. "So far, the demonstrators we have built are in the range of 50 to 70 kW, both for 2SED and 4SED [in the latter the overall power is obviously the sum of the two motors].

"The very first vehicle equipped with a 4SED has been a full electric super sports car. In that case, we used two electric motors (EM) of 120kW each and we are currently working on a 48-V application with two EMs of approximately 15kW."

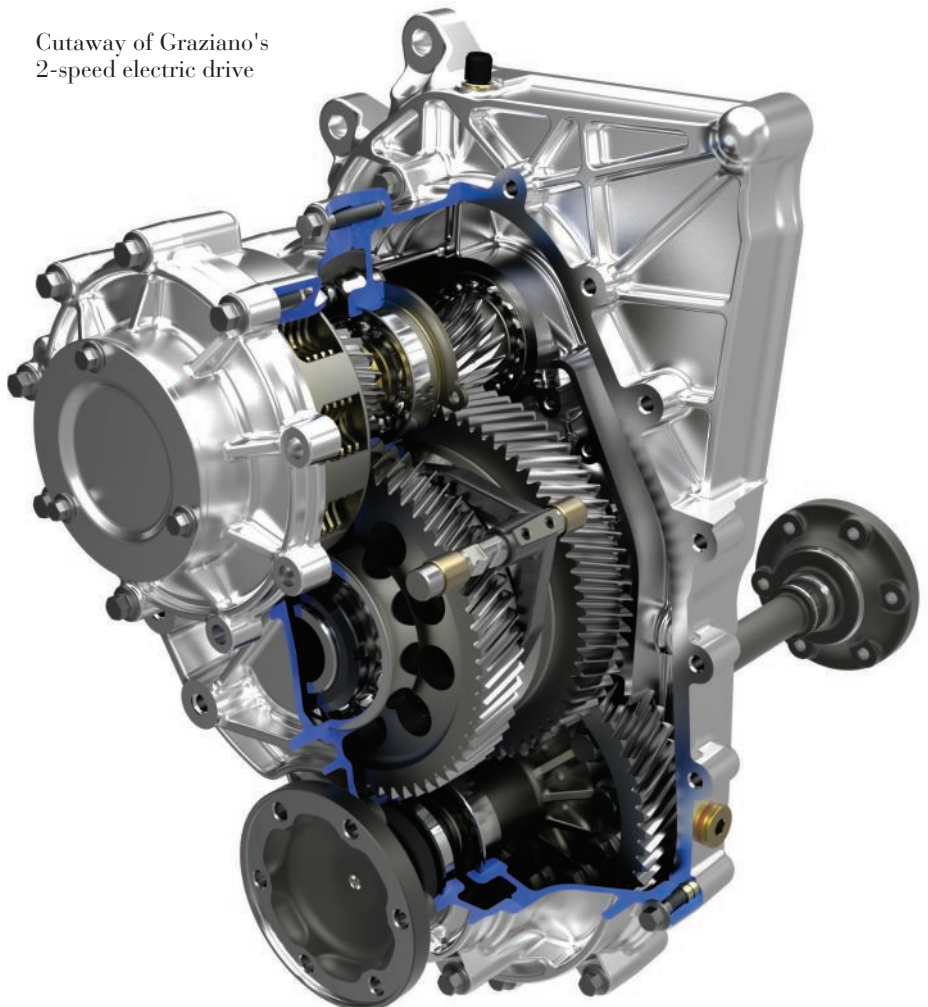
Mantelli is also predicting a strong growth in all-wheel drive (AWD) systems. "OEMs want less impact brought in by 4x4 variants and it is growing as a share in the market. For instance, in the Daimler A- and B-class, the volume nearly doubled over the initial predictions from 350 to 600 units a day. Why is that possible? Because the customer's perception of AWD is not necessarily consuming more fuel or is more polluting – and that's achievable because it's as light

as possible, with the best bearings available reducing drag to the minimum. We're in production with Fiat for the Panda, GM with the Epsilon platform and we have other programmes in the pipeline.

"I can see a switch in the way the powertrain guys are looking at these developments not just adding an AWD option, but a functionality such as torque vectoring. Another parallel trend is E-differential options being integrated into power transfer units or in rear differentials."

Mantelli paints a vivid picture of future transmission technology that seems destined to play an increasingly important role in vehicles as hybridisation strategies emerge in the near future.

Cutaway of Graziano's 2-speed electric drive



# INSIDE THE PROVING FACTORY

**Ian Adcock reports on a new business model designed to bridge the skills gap between engineering start-ups and the motor industry**

**I**t's a problem unique to budding engineering entrepreneurs: you have just come up with a transformational technology, but don't have the wherewithal to develop it, never mind validate or market it to the supply chain or OEMs. So, what do you do?

In the past, you might have spent years hawking it around until someone finally said 'yes', but, arguably, that might not have meant the best deal for the inventor – what you really needed was someone who could help you validate the

technology, help market it and then put it into limited production before moving it on to an OEM or supplier.

That's where The Proving Factory comes in, as its chief executive Richard Bruges explains: "There are some similar business models, such as contract manufacturers, who will take a design and put it into production. But they find it very difficult to justify the engineering investment required to take a prototype and prepare it; they don't have the automotive product introduction process, because they're used to working in

other industries and they lack automotive experience, whereas our gateway process was specifically developed to get a new technology ready for production.

## **BEYOND THE BLUEPRINT**

The average contract manufacturer wouldn't have that capability, because their business model involves taking a blueprint or ready-to-go design and putting it into their manufacturing and sourcing sausage machine."

The concept came to Bruges, then working for Unipart, following







a conversation with Jaguar Land Rover's head of research Tony Harper, complaining he was working with technology developers who had "really nice technology that I want to take through to production or offer to my programme engineering teams for future vehicle platforms. The trouble is, it's being done by 12 people in a shed making prototypes, so how are they going to make 100,000 a year to our quality?"

Basically, he asked for Unipart's help. "We worked on it for about 18 months, but it didn't fit Unipart's business plan and they were

gracious enough to let me take it away and develop the idea myself."

Bruges' original concept was to use spare capacity in the supply chain, but for "any number" of reasons they weren't interested, he states. The concept eventually became reality following a meeting with Tata Steel's Mike Woodcock who saw it as an opportunity to expand the Indian-owned company's product portfolio.

"There are pockets of similar activities within the big tier ones, but they are skunk works. We think doing it this way, manufacturing the

first 10,000-20,000 units and then passing it onto the supply chain, is a unique approach."

#### **WATCH THIS SPACE**

"It works in the UK, as there are lots of niche manufacturers who need access to relatively low production volumes. Also, the tier one structure isn't very well invested in the UK and doesn't do much R&D here, so there's an opportunity to occupy that space."

The 6,000m<sup>2</sup> factory on the outskirts of Coventry in the British Midlands is practically deserted



when I visit, apart from a few engineers at their workstations scribbling notes on whiteboard-style desks. "You can't even do that at Google," Bruges proudly observes. "That's a big part of our ethos: we want it to be fun working here. We've even got official graffiti in the loos done by a local street artist."

There's a good reason the warehouse is deserted: most of the projects that The Proving Factory has underway have been shipped to the Japanese SAE exhibition and the business is outstripping its targets. "Our plan was to build a factory and

start doing stuff at the end of the year, but we found a facility we could buy, rather than build, and that enabled us to move in a year early, so we're six months ahead of schedule."

Another factor for the quietness is that the first three projects – Bladon Jets' micro turbine, Dearman's liquid air engines and Magnomatic's magnetically Controlled Variable Transmission (CVT) – won't enter their pre-production phase until later this year before entering full production.

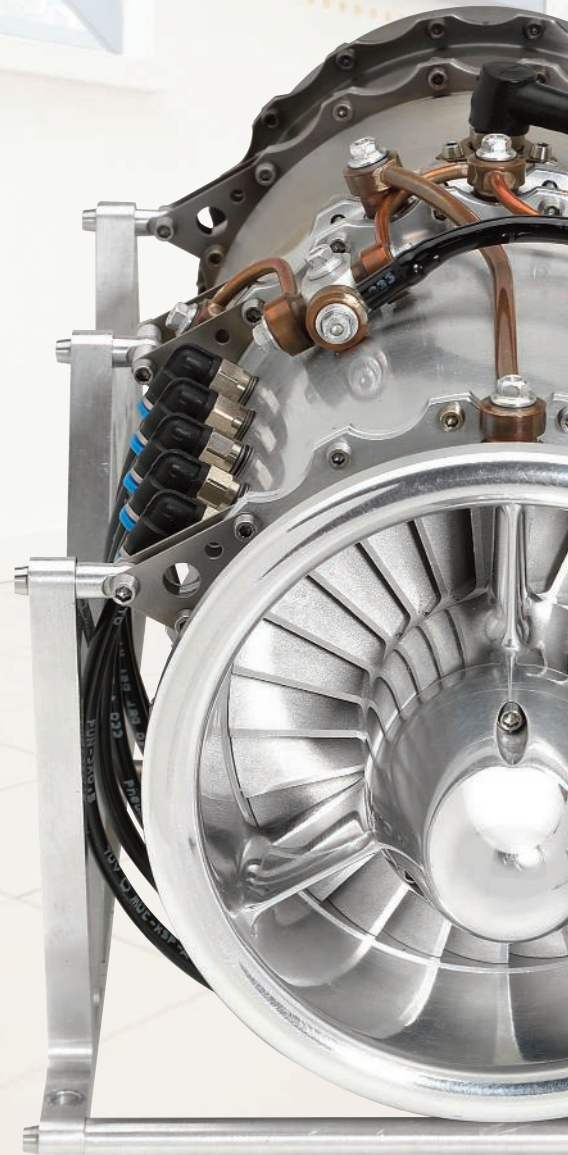
Three projects may not sound

like that much of a business, but Bruges has ambitious plans, as he detailed to me: "The number of projects we will be able to handle at any one time depends on a few things, such as the physical size of the unit. Because the bigger it is, then the more space you need for mechanical handling etc. Our heaviest system is 300kgs; that will require a lot of handling and moving. The smallest is about 10-12 kgs.

"Our capacity plan is 200,000 a year of 10 to 20 products. In three years' time, the plan is to be at 80% capacity and, by 2022, the objective



"The average contract manufacturer wouldn't have that capability, because their business model involves taking a blueprint or ready-to-go design and putting it into their manufacturing and sourcing sausage machine."  
Richard Bruges





is to be turning over £200m (€281.2m), employing 200-plus people with 20 products in the system,” he adds.

The Proving Factory’s “defining” issue, explains Bruges, “is more around the type of product we’re dealing with, so everything we’re going to be making in the next three years is a rotating machine of some kind”. Hence the commonality between the first three products and the next six, which include Libralato’s rotary Atkinson cycle engine, the Electronica electric motor generator and Evolute



### Plan, Do, Check, Act

“The one thing these technology developers don’t grasp when they come into the automotive sector is the need for repeatability,” says head of development, Neil Coope. “A lot of the companies we work with are fantastically innovative and can deliver a one-off. But, in order to get that one, it’s handmade – and you can’t rely on that for 10,000 a year. The parts have to come in right first time. You can’t afford to have people standing there with emery cloth, taking off corners.”

Which is why the Gateway process was developed as a communications tool between The Proving Factory’s internal process, in order to take a product from concept to manufacturing, whilst interfacing with the technology developer and the end customer, irrespective of whether that’s a tier one or OEM.

“They all have a fairly rigid structure on how they want to take an idea from concept to production, so we’ve taken systems from all the OEMs that we work with now, have done in the past and want to work with in the future, looked at them and taken a common theme that runs through them.

“We’ve taken that back to first principles using a standard language, so there aren’t too many acronyms. It’s clear English and you don’t need a lot of automotive experience to understand the development process.

“The spine of it is simple, but effective: ‘Plan, Do, Check, Act’.”



transmissions. There's another common thread running through all these products, of course: they all have a low carbon theme and that is no coincidence.

"The demands of emission reduction and to achieve the regulatory challenges means the OEMs' existing technology portfolio isn't going to deliver those reductions, so they will have to go and outsource it from outside the existing supply chain," states Bruges.

"It's fair to say that we set the business up to serve that particular requirement; the problem we're trying to solve is that OEMs want to access clever advanced technology that will help them solve the carbon reduction, fuel consumption and emission challenges they've got.

"They all need new technologies and regulations are driving them at a pace that the OEMs existing business model can't quite handle, so they have to go outside. That's where the compelling market need is coming from."

### **RICH STREAM**

What has also emerged is that, once OEMs have done the R&D and built a few prototypes, they can't always find a suitable tier one to take the technology forward into production as required, "Actually, we're working with JLR on that basis quite successfully right now. It's starting to be a rich seam. That's exciting, as it could happen quite quickly since they're a properly funded business. We're behaving as a low-volume early stage tier one, which is what we set out to create."

Bruges believes The Proving Factory is a unique solution for an automotive problem, but is already eyeing electronic control systems and hardware and battery technology as potential markets to which this business model could be applied in the not too distant future.

## Assembling the right strategy

Simon Danks, The Proving Factory's head of operations, isn't having sleepless nights – yet – but they may be just over the horizon. Danks is responsible for juggling the 12 production cells that will be assembling 20 or more different technologies at any one time.

"The original vision was for one assembly line down the middle of the hall that would do anything. Once I started to understand the technologies, and appreciate the differences between them and varying volumes, it became obvious that wasn't going to work.

"We will know the process and the total amount of work content – how long that piece of work takes; knowing that I can work out the 'standard line balance approach'. One cell might have three operators in, another six, that will be reviewed as customer demand and improvements change. The beauty of the business model is that, as we take one cell out and bring another in, we can rebalance the workforce. Building a flexible workforce is important to us.

"We might have a floor space issue, if a small cell is replaced by the need for a larger one. What we do at that point, we'll found out.

"That's the challenge and, to be honest we don't know the answer to all of these yet."





# Multi-material extremes



**C**ars have always been made of a combination of materials and engineers of most major systems have stuck closely with traditional material types. Now, the desire for greater efficiency and reduced emissions has accelerated the shift away from traditional materials for key applications. The new multi-material approach more closely matches materials and their properties to the intended application – with a tighter focus on efficiency and emissions.

The new Audi Q7 is an example of this new approach. Technical development boss Prof. Dr. Ulrich Hackenberg says that among the new SUV's design assets is "intelligent multi-material lightweight construction". Weight reduction, compared to the relatively heavy outgoing model, is up to 325 kgs.

Next autumn, Cadillac's new CT6 saloon will be built on an architecture that builds upon the brand's recent weight-reduction strategies. The car's aluminium-intensive body structure is one-third steel, with 21 patents pending for the General Motors

Omega II platform. "The mix of materials helps save almost 91kgs, compared to all-steel construction and it's lighter than an aluminium design would be as well," said Travis Hester, executive chief engineer.

Kerb weight is under 1,680 kgs – about the same weights as the smaller CTS.

So what does the future hold when a multi-material approach is taken to the next level?

Magna International Inc, Ford Motor Co, and the US Department of Energy have developed a multi-material lightweight vehicle (MMLV) concept with significant weight and life-cycle assessment (LCA) savings. At the SAE 2015 Government/Industry Meeting in Washington, D.C. in January, Magna and Ford engineers presented the results of an LCA study of the project.

The MMLV concept's new aluminium-intensive structure, combined with carbon fibre, magnesium and titanium, reduces the weight of a 2013 Fusion C/D class family sedan to that of a 2013 Fiesta subcompact B-car (two vehicle segments lighter), without compromising performance or occupant safety.

Combining lightweight vehicle technologies and a downsized high-output engine, predicted LCA cradle-to-grave total net savings are a significant 16% in global warming potential and 16% in total primary energy usage.

Magna, Ford and other MMLV partners presented 14 papers at the SAE 2015 World Congress held in April in Detroit that provided additional details on LCA and other tests that were conducted as part of the MMLV project.

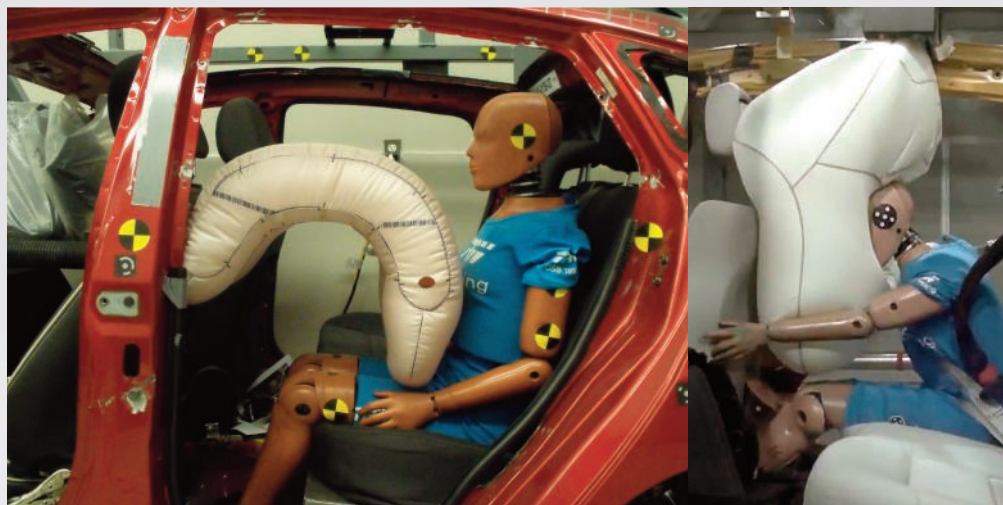


[focus@sae.org](mailto:focus@sae.org)

# Sensing danger, maximum response

Seatbelts are estimated to reduce the overall risk for serious injuries in crashes by 60-70% and the risk for fatalities by about 45%. In rollovers, the risk of fatalities for a belted occupant is reduced by roughly 75%. It is estimated that more than a million people have been saved since seatbelts were first introduced in the 1950s.

However, advances in sensors and electronics mean the simple three-point belt of a few decades ago has been transformed into a sophisticated restraint system that can pre-tension itself to the occupant prior to an impact or even during cornering – while the safety system's ECU can also tailor the airbag's deployment according to the occupant's size. An active seatbelt has an electrically



driven pretensioner that tightens the belt as a precaution in hazardous situations. The belt system then releases some webbing, if the driver manages to avoid the hazard. This function could also be used to warn the driver by letting the pretensioner vibrate the seatbelt webbing.

## FULL PROTECTION

Seatbelts also help to properly position occupants to maximise the airbag's benefits and, unlike airbags, they also protect occupants in multiple-collision crashes.

TRW's second generation Active Control Retractor system (ACR2),

featured on the 2014 Cadillac CTS, is typical of this new generation of seatbelt, combining active and passive approaches to offer enhanced safety, comfort and convenience to vehicle occupants.

Additionally, the ACR2 provides dynamic driving support to help keep the driver in a more stable position in the seat during highly dynamic situations and during rapid deceleration. This features an advanced version of TRW's proprietary situation management algorithm. "The ACR2 situation





# Focus on Restraints and Airbags

management algorithm continuously processes signals from the vehicle's relevant dynamic systems, such as ABS, electronic stability control, radar or camera systems," explains Uwe Class, senior manager of mechatronic systems for TRW's occupant safety systems. "The algorithm evaluates events such as braking, skidding or vehicle angle and, if a critical situation

Also, the belt expands to spread the shock load over a wider area of the occupant's chest, which helps to reduce injury.

In a side impact, the belt inflates between the shoulder and head to reduce lateral head movement and provide protection from impact with the side window or colliding object. Ford debuted such seatbelt

crashes than in very severe crashes, while occupant-sensing devices can determine the occupant's seating position, whether the person is an adult or a child and whether a seatbelt or child restraint is being used.

Based on this and other crash severity information, the airbag is deployed more or less aggressively, or not at all.



is identified, the ACR system pretensions the seat belt, helping place the occupant in a better position for a potential crash and acting as a warning to the driver that an accident may occur.

"Should the accident be avoided, the system automatically resets itself via the reversible actuator," he adds.

Meanwhile, Takata became the first to commercialise the airbelt, which inflates like an airbag at the time of impact to provide additional protection.

## INFLATE ON IMPACT

Inflating on impact from the side of the head, and across the shoulder and chest, the airbelt is an entirely new passenger restraining system that protects the head in both frontal and side impacts. In a frontal impact, the airbelt contracts in length as it expands, removing slack and thereby enhancing the effectiveness of its restraining function.

technology on the all-new Mondeo. It is the first vehicle in its segment to feature belts that, in the event of an accident occurring, expand in just 40 milliseconds to disperse crash forces across a body area five times greater than that achieved by a conventional seatbelt.

According to safety technology company Autoliv, frontal airbags are deployed in less than 50 milliseconds. Airbags for side protection have to be fully inflated within 15 milliseconds, which is eight times faster than the blink of an eye.

## VARIABLE VOLUME

Frontal airbags can be designed to inflate with variable volume, depending on the severity of the crash and system requirements, as well as the occupants' size and distance from the airbag.

Many of these variable volume airbags use multi-stage inflators that deploy less forcefully in moderate

## 'BAG-IN-ROOF'

TRW Automotive recently started production of its roof airbag technology on the Citroën C4 Cactus. The new 'bag in roof' replaces passenger airbags typically mounted in the instrument panel, and can allow for improved interior design aesthetics, ergonomics and functionality, while saving space.

It has also been developing rear occupant seat bags. According to Dirk Schultz, director of inflatable restraints for TRW occupant safety systems: "Protecting rear seat occupants can be a challenge, considering the larger range of occupant ages and sizes – from child to adult – and vehicle interior space that varies depending on the position of the front seat."

So TRW has adapted its front seat 'bag-in-roof' concept to the rear seat, developing a uniquely shaped advanced rear airbag that adjusts to the different distances between the rear seat occupant and the front seat.

Kevin Jost, SAE international editorial director, reports on

# 48-V systems: all set

**T**he concept of higher-voltage electrical systems in vehicles between 12-volt conventional and 200- and 600-volt full hybrids and electric vehicles is not new, with development experiencing fits and starts over the past few decades. However, tightening vehicle efficiency and emissions regulations, and increasing demand for onboard electrical power, means that higher voltages, in the form of supplemental 48-volt subsystems, will soon be nearing production.

One sign of this was on display at last November's Los Angeles Auto Show. The Audi Prologue show car, which provided a preview of the company's design future, also more quietly previewed a new 48-V electrical subsystem coming to future Audi products.

## NEXT STEP

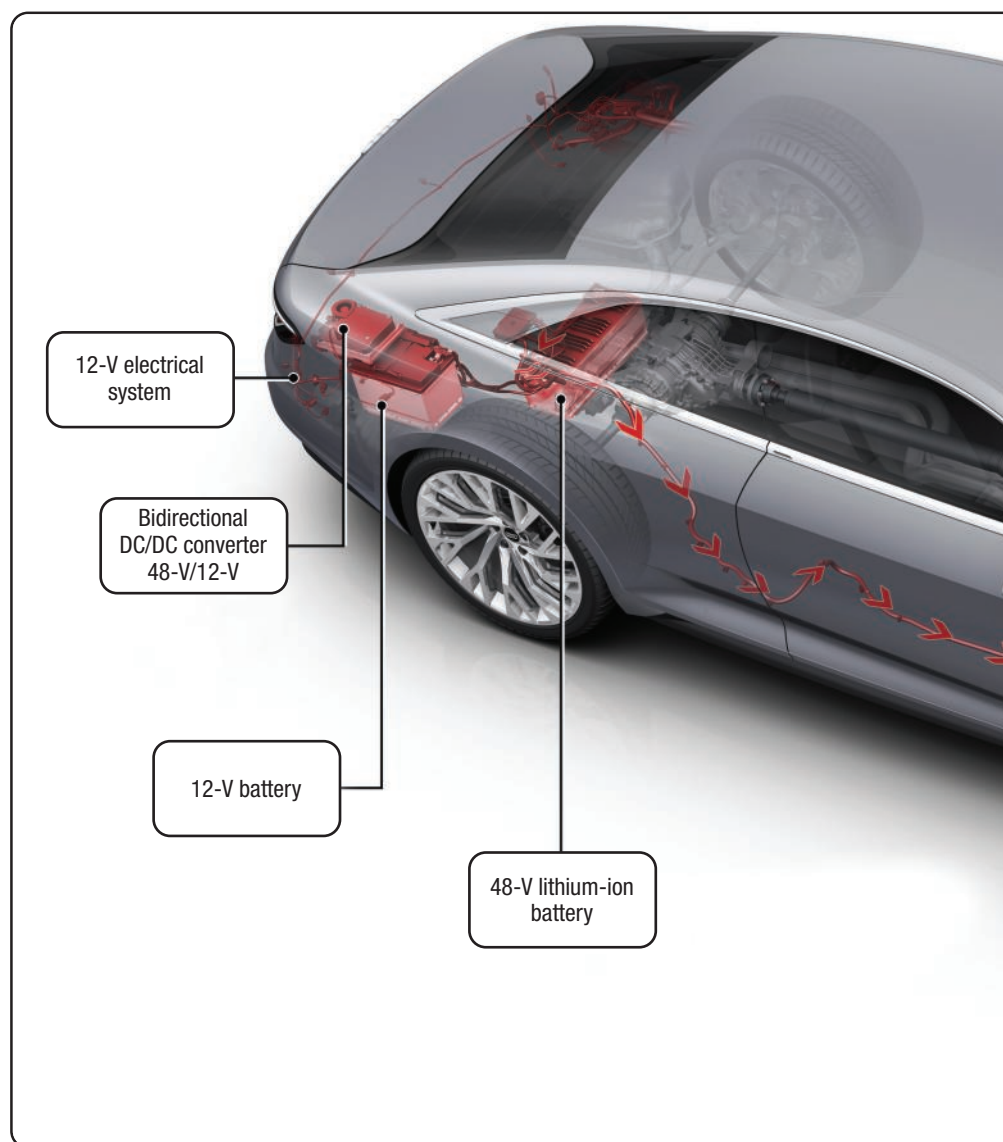
The company attributed some of the large show car's relatively low fuel consumption and CO<sub>2</sub> emissions to the new 48-V electrical system. Powered by a belt starter generator, the set-up enables mild powertrain hybridisation with brake-energy recovery in the Prologue. The displacement of high-wattage loads to more efficient 48-volt networks is expected to be the next step in the development of a new generation of mild hybrid vehicles.

In addition to improved fuel economy and reduced emissions, 48-V systems could potentially save costs on new electrical features and help better address the emerging needs of future drivers. A new report from Autelligence, called '48V and automotive electrification – systems, performance and opportunity',

analyses the technology in detail and provides an outlook on future market introductions. The new technology is "extremely economical, because it can be easily integrated into an existing vehicle architecture, and the small 48-volt battery means battery costs are reasonable," according to Christopher Breitsameter, head of business development and strategy,

Continental Powertrain Division.

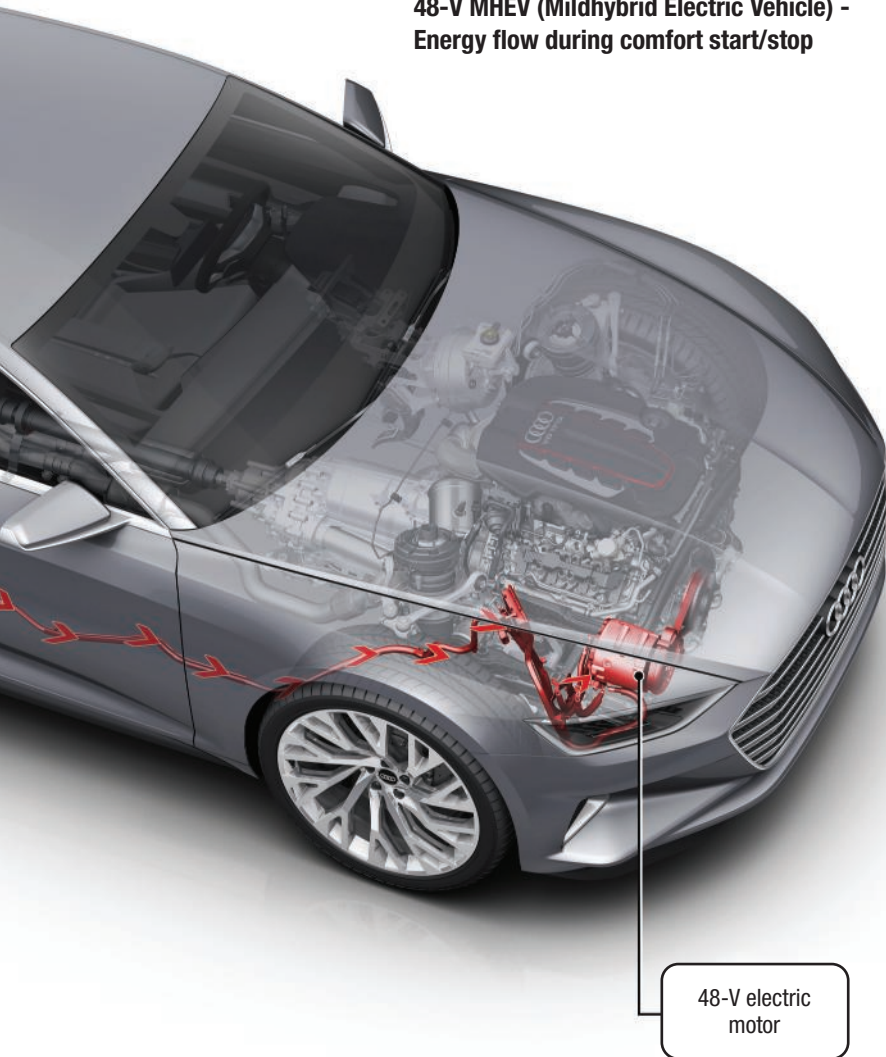
Challenges to 48-V system implementation remain. At the 2nd International Conference on Advanced Automotive 48-V Power Supply Systems, organised by IQPC Automotive in Düsseldorf last November, experts from leading car makers and suppliers discussed the need for an international 48-V





# to dominate?

**48-V MHEV (Mildhybrid Electric Vehicle) -  
Energy flow during comfort start/stop**



standard – initial steps already having been taken for the adoption of the LV148 standard proposed by Audi, BMW, Daimler, Porsche and Volkswagen.

It makes sense to have a common global standard, according to Paul Bloore, product validation manager for Controlled Power Technology's hybrid product group, because 48-V hybrids

are currently the most cost-effective way of meeting stringent CO<sub>2</sub> emissions in the build-up to 2020 European regulations. This is compounded potentially by a shift from the current NEDC to the more aggressive WLTP test, with further 25% reductions anticipated in 2025 and 2030. Electric turbo and supercharging could benefit from 48-V

networks. Hyundai and Kia are said to be developing a mild-hybrid diesel powertrain using an electric supercharger in conjunction with a 48-V network. Bloore points out that electric boosting using energy recuperated, rather than lost in friction from the brakes, not only reduces CO<sub>2</sub> and NO<sub>x</sub> emissions, but can also have a positive impact on vehicle performance and drivability.

The rapidly growing interest in 48-V networks was also discussed at the SAE International 2015 Hybrid & Electric Vehicles Technologies Symposium held in Los Angeles in February. Dr Mazen Hammoud, Ford's chief engineer for electrified powertrain systems, said that the 48-V working voltage is the best compromise for mild hybridisation.

### **SEVERAL BENEFITS**

Although the higher voltage provides no real electric-only drive capability, there is better capacity for capturing braking regen energy, up to about 60% of that available, and it's a good stop-start enabler, Hammoud said. A mild hybrid can provide more than 3% increased engine-off time versus a 12-V stop-start vehicle in real-world driving conditions. In addition, according to ECE-R 100 regulations for dc voltages under 60-V, shock protection is not required for 48-V, helping to lower cost.

So the consensus of global forecasts suggests that 48-V mild hybrids will soon come to dominate the market. Compared with 200-600-V full hybrid and battery electric vehicles, the lower-voltage approach avoids the need for high-cost safety features and large battery packs. CPT estimates that, if 48-V technology and related emissions-reduction strategies could be universally applied to the more than 100 million vehicles forecast to be produced per year from 2020 – 98% of them with gasoline and diesel engines – annual CO<sub>2</sub> emissions could be reduced by 98 million tons (99.5 million metric ton) globally per year.

# Powering AHEAD!

**Electrification of road vehicles is an unstoppable force, according to one expert. Automotive Design has been finding out the full story**

**T**he increased electrification of road vehicles, whether that's passenger cars, commercial vehicles or public transport fleets, is as inevitable as tomorrow's sunrise or sunset. That is the view of Dr Bernd Mahr, head of the hybrid electric vehicle business unit, part Continental's powertrain division.

"Regarding electrified drives, we will see a stronger focus on two market sectors in the future," he

forecasts. "One of these is plug-in hybrid vehicles, because they can be driven purely on electricity on a daily basis, without placing restrictions on the range of car journeys. The second field is vehicles with hybrid systems based on 48 volts – because this new technology can be integrated very easily into the architecture of conventionally powered vehicles and leads to considerable fuel savings. And the costs remain acceptable."

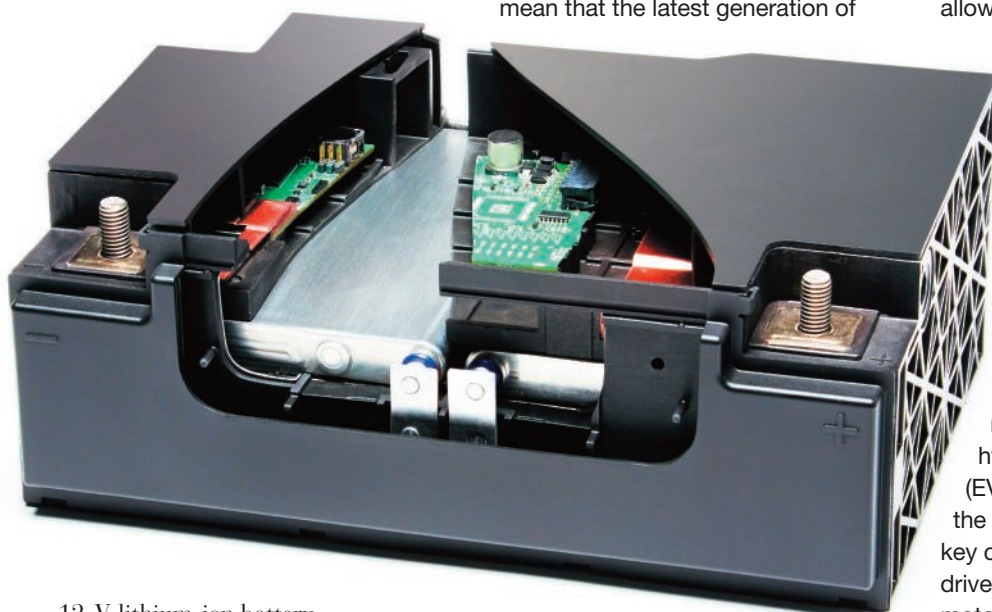
Advances made in recent years mean that the latest generation of

Bosch generators with high-efficiency diodes (HEDs) and synchronous active rectification (SAR) have been recognised as eco-innovations by the EU



power electronics are six times more powerful than the first generation, allowing them to operate an engine six times as powerful, while weight has also been reduced from about 12 kg originally to around 8 kg today. Simultaneously, costs have also decreased considerably and development time shortened.

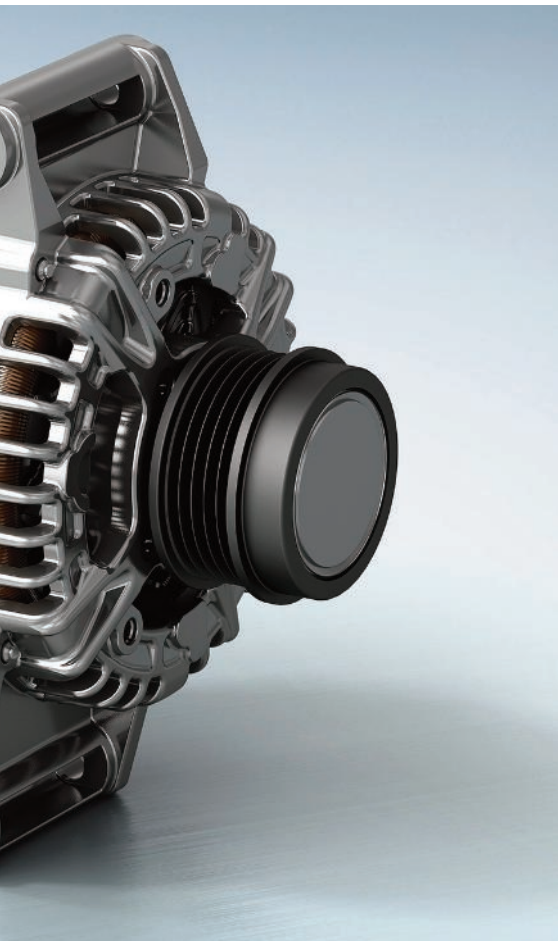
Continental's power electronics is designed as a modular and scalable system that can be used in a wide range of vehicles, from the mild hybrid right up to electric vehicles (EVs); and from the small car up to the luxury saloon. The system is a key component in every electrified drive, as it supplies both the electric motor as well as the high-volt battery



12-V lithium-ion battery



# Focus on batteries and hybrid electric motors



power electronics extremely compact.

German rivals Bosch commented that “lawmakers have mandated economical, low-emission vehicles, but drivers are looking for fun, not just efficiency”. Bosch claims these two goals can be reconciled, thanks to its latest eco-innovations. Generators with high-efficiency diodes (HEDs) and synchronous active rectification (SAR) have now been officially recognised by the EU.

These technologically advanced components make vehicles more efficient and more economical, so they are able to meet the European Commission’s strict CO<sub>2</sub> targets. European regulations set an average emissions limit of 95 grams of CO<sub>2</sub> per kilometre for new vehicles, starting in 2021. That equates to fuel consumption of just over 4l/100 kms. In 2013, average CO<sub>2</sub> emissions from new vehicles were still 132.9 grams per km.

With the ‘eco-innovation’ label, the EU recognises particularly eco-friendly technologies. Vehicle manufacturers can have these technologies count as CO<sub>2</sub> credits toward calculating their fleet fuel economy figures. The maximum permissible credit is 7 grams per kilometre. Bosch is the only supplier already offering three EU-recognised eco-innovations:

with electricity – when the electric motor works as a generator and feeds electricity into the battery (recuperation). For functional reasons, the power electronics are therefore positioned between the high-volt battery and electric motor, regardless of where the control unit is installed in the vehicle.

An important factor in the Continental system is its innovative inverter, which enables a high number of cycles and makes a significant contribution to the overall efficiency of this power electronics.

The DC/DC converter is also highly efficient, as it converts the voltage almost loss-free. Another feature is that both components are integrated into a housing, making the

generator’s CO<sub>2</sub> emissions by up to 1.3 g/kms. In addition, compared to standard generators, this version delivers 5 to 7 amperes more at low engine speeds. That is particularly important, since on-board power consumers need a reliable power supply, even at low revs.

The generator with synchronous active rectification even offers some 10 amperes more than normal generators, reducing CO<sub>2</sub> emissions by up to 2 g/kms.

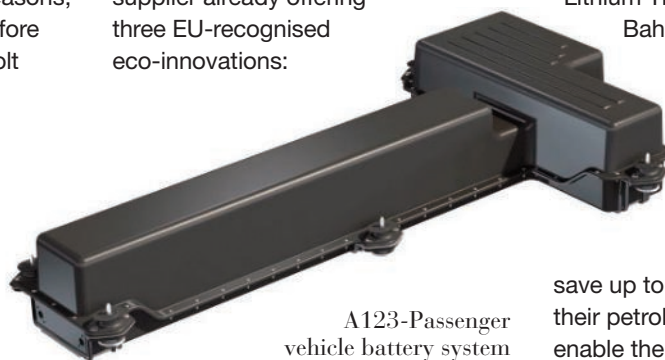
With this technology, the diodes are replaced by high-performance transistors. Both generator versions are highly efficient and help make the vehicle more eco-friendly.

The other side of the story, namely batteries, is also rapidly developing. Johnson Controls is expanding its automotive battery offerings when it introduces a Lithium Titanate battery in 2018. The company’s latest 12-volt technology, a collaboration with Toshiba, will power advanced stop-start vehicles.

“The Lithium Titanate chemistry is effective at quickly recharging, works well in a wide range of temperatures and can be easily integrated into a vehicle’s 12-volt electrical system. Toshiba, with its SCiB technology, is the established market leader for Lithium Titanate,” explains Lisa

Bahash, group vice president and general manager Original Equipment, Johnson Controls Power Solutions. And she adds: “With an advanced stop-start system, drivers could

save up to 8% every time they fill up their petrol tank, as the batteries enable the engine to shut off more frequently and for longer periods of time. This is also a great solution for our customers, because the technology allows for greater fuel savings without major changes to the existing powertrain and electrical systems.”



A123-Passenger vehicle battery system

namely a navigation-based battery management system for hybrid vehicles, plus the two new generator technologies.

The high-efficiency diodes developed in-house reduce the

**Automotive Design** reports on some of the latest powertrain trends unveiled at the symposium

# TRAINS of

**S**chaeffler has carried out simulations to demonstrate how the ongoing electrification and transmission design processes influence one another. The first calculation compares a C-segment vehicle with and without a 48v hybrid system, using an identical 1.4-litre gasoline engine in both cases. However, while the non-electrified vehicle features a seven-speed transmission, the 48-V hybrid has only four gears. The use of this electrified transmission provides a fuel economy improvement of 18% in the Worldwide harmonised Light Vehicles Test Cycle (WLTC).

In its second simulation, Schaeffler tested a sports utility vehicle (SUV) powered by a 3-litre V6 engine. The conventional vehicle features an eight-speed planetary transmission, whereas the electrified version is equipped with a 24 kW electric motor installed in a five-

speed automatic transmission. The fuel economy improvement achieved in the WLTC is 14% in this case, but significant savings can also be achieved even without electrification. "The optimisation of the internal combustion engine remains immensely important for Schaeffler," explained Prof Dr-Ing. Peter Gutzmer, Schaeffler's deputy CEO and chief technical officer.

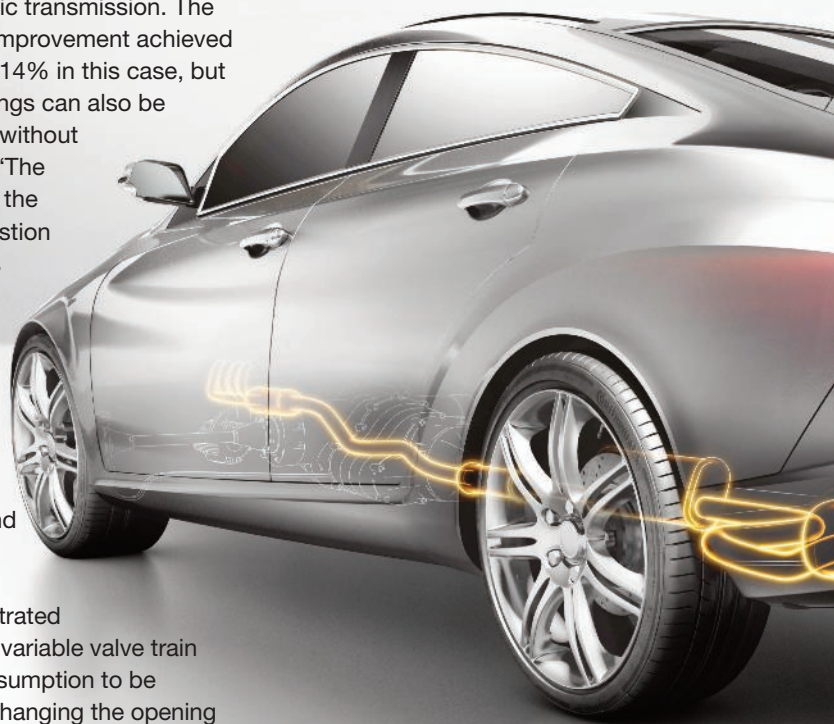
He demonstrated that using fully-variable valve train allows fuel consumption to be influenced by changing the opening and closing times of the valves. The engine can be operated without throttling at low loads, reducing fuel consumption by more than 8% at specific operating points. At high loads, lengthening the intake valve opening time reduces the tendency towards knocking and the need for enrichment. Further savings could be achieved in all relevant operating ranges through the use of variable compression.

## OPTIMISED COMBUSTION

Continental presented a package of technologies consisting of leaving the intake valve open longer (the Miller cycle), coupled with a higher compression ratio and low-pressure exhaust-gas recirculation (EGR). The optimisation of the radial compressor and use of Continental's radial-axial turbine technology (RAAX) demonstrates that modern turbocharger systems can

compensate for the disadvantages of a Miller process, even with conventional single-stage turbocharging systems. To further optimise the combustion process itself, Continental is developing new high-pressure injectors. "To achieve the European CO<sub>2</sub> targets for 2020, there will be an increasing proportion of hybridisation with electric drives of 48-V and above, particularly in the medium to higher vehicle segments," explained José Avila, head of the powertrain division and member of Continental's executive board.

One of the aims of optimising the engine is to improve the position of



Professor Gutzmer



# THOUGHT



conventional turbo technology, enabling the engine to generate more torque.

The majority of harmful emissions from gasoline engines are produced during the cold-start and warm-up phases; to counter this, Continental presented a dynamic thermal management system that shortens the time taken for an engine to heat up in the New European Driving Cycle (NEDC). Controlling the flow of coolant is important for hybridisation to retain heat in the cooling system during hybrid driving strategies, such as coasting.



the central combustion point in the knock-limited load range of the gasoline engine. Continental achieves this in a 1.0-litre turbocharged engine by keeping the inlet valves open longer and through cooled low-pressure exhaust-gas recirculation, which improves fuel consumption by 3-6 g per kWh.

Forced induction, using a Continental turbocharger with a RAAX, improves drivability when employing the Miller strategy, because a turbo with a RAAX turbine achieves higher boost pressure at lower engine speeds than with

The integrated electrically heated catalytic converter also supports engine-off strategies. The rapid electric heating of the catalytic converter dispenses with the need to use fuel to heat the catalytic converter, and prevents additional consumption and hydrocarbon emissions that would otherwise occur when the engine is restarted, due to the catalytic converter not being up to operating temperature.

## **GREATER SPREAD**

Fuel injection is key to high efficiency, both in engines with port fuel injection

and in gasoline direct-injection engines (GDI). The new Deka 10 injectors for port fuel injection (PFI) have a greater spread between the smallest and largest possible flow, which is important for higher-powered engines, as well as for turbocharged engines. Deka 10 injectors produce smaller droplets that lead to better carburetion and more efficient combustion.

Increasing the injection pressure from 250 to 350 bar on a 1.8-litre test engine, using the new XL5 injectors with an optimised injector-hole design and the gasoline high pressure (GHP) 2.5 high-pressure pump, could reduce particulate emissions by 80%, without affecting fuel consumption.

As valve control variability and low-pressure exhaust-gas recirculation become more common, engine control freedom will increase.

Conversely, this can lead to a significant increase in the number of calibration-data maps in the engine control unit. To limit the need for storage and the cost of calibration, Continental is further developing its EMS3 engine-control and powertrain system platform for use in multi-core processors.

Hybridisation helps to increase the engine's efficiency and reduce emissions. The Continental 48-V Eco Drive System has demonstrated reduced fuel consumption by up to 21% in urban areas. Thanks to the favourable cost-benefit ratio of the 48-V architecture, hybridisation is moving closer to high-volume models in the C and D segments. Production ramp-up for the first 48-V Eco Drive in Europe is planned for 2016 – and that by 2025 around 20% of all new vehicles will feature electrification in their drive systems, almost half of which will be 48-V architecture.

# Keeping up to the MARQUE

**Ian Adcock catches up with Ford of Europe's vehicle line director on the engineering challenges that lie ahead**



**F**ord was recently named the 'Most Innovative Volume Brand 2015' by the German-based Centre of Automotive Management for its safety and semi-autonomous driving technologies, but, as Uli Koesters points out, there are many pressing issues for all marques as they look ahead to 2020 and 2025, especially when it comes to sustainability.

"It's a whole systems solution – how do you put the powertrain into the vehicle and what the vehicle itself contributes," he observes. "Vehicles are going to change quite dramatically from what we see today, especially when you think about from 2020 to 2025, just because they need to be much lighter and every piece of drag – whether that's road resistance or aerodynamics – will have to be double-checked to see how efficiently we use energy to move the vehicle."

## **TRIPLE TREND**

For Koesters, there are three main powertrain trends: EcoBoost engines, into which Ford is investing "significantly" in next-generation solutions, although Koester is unwilling to go further than that. Diesels, which will continue to play a role, despite the political pressure they are coming under to minimise particulate emissions that will be met by higher injection pressures and sophisticated after-treatment systems. And finally

electrification, although he predicts it will still be "very low volumes", adding that for customers "it will be worth waiting a little until the technology is more mature and affordable".

States Koesters: "Personally, I still see a future for diesel for a long, long time. It's very difficult to predict beyond 2020 what will potentially be the winner. If one technology makes a

big a step forward, then that may swing the picture, but diesel engines from a combustion efficiency perspective are still better than petrol. It's more difficult to clean them; our S-MAX Stage 6 doesn't need SCR, we use a lean NOx trap and smart combustion and energy balancing. It is getting increasingly difficult and we know there will be a 6.2 and stage 7,

**"Personally, I still see a future for diesel for a long, long time. It's very difficult to predict beyond 2020 what will potentially be the winner"**







A sophisticated mix of structural materials reduces weight and improves safety, as in the latest S-MAX

and then it becomes more challenging and expensive to us and the customer and whether that stays affordable remains to be seen.

#### DRAG FACTORS

"There's a lot of focus on system optimisation: how to integrate them to reduce the amount of drag on accessory drives or for warm-up. Not



## Question time

only mechanical drag, but also thermal inertia or efficiency as to how you use the energy released during combustion.

"Cylinder deactivation has big potential, although there are still a few challenges, but that is something in certain drive conditions and load demands that will allow a very smart way to burn less fuel."

Reducing mass is critical to improving efficiency, but as a business that sells approaching a million units a year in Europe, instigating radical weight-saving strategies isn't easily achieved. "As a volume manufacturer, you have to watch what you invest in to see opportunities for change over the interests of the business decisions and customers," Koesters points out.

"On the Mondeo, most major chassis components are aluminium, which is a change from the old model. The liftgate on the five-door and estate are magnesium; then there are some manufacturing processes, like hydroformed tubes, that avoid having to weld brackets or pieces together to provide strength for crash and torsional rigidity without burdening the weight balance too much. I can see those steps evolving with every model change."

#### ACCELERATED UNDERSTANDING

While the recently announced GT is little more than a limited edition supercar, he does admit that it will accelerate Ford's understanding of exotic materials like carbon fibre.

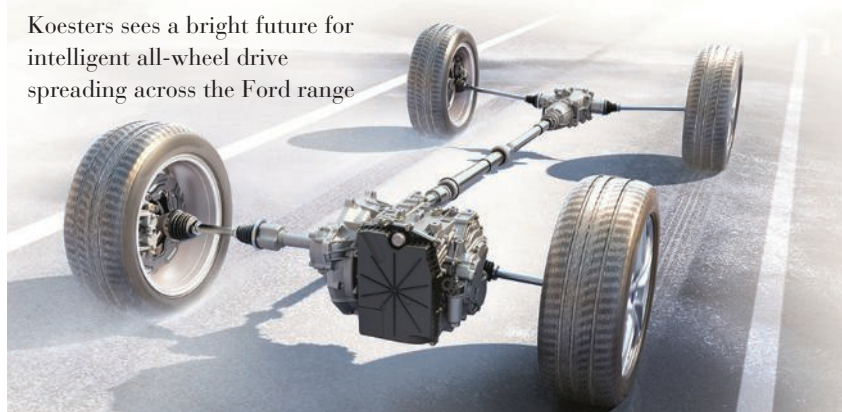
"When you go from conventional steel to high strength, you reduce the required cross sections and reduce weight; however, when you go to aluminium, you reduce weight, but the cross sections go back up again. With carbon fibre, you get a good mix, if you do that in the right area, and you can get a very good weight balance distribution without the cross sections that would impact packaging or styling. But for me, that's a technology in the 2020-25 timeframe before there is significantly higher deployment."

Koesters sees "a quite significant" opportunity for Ford to build a reputation with all-wheel drive technology. "We've had many customers telling us in the last cycle of the Mondeo, as an example, that they would like all-wheel drive, not only because of the image and reputation it gives them, but also customers really appreciate the driving dynamics or better mobility when you're on slippery surfaces."

And when it comes to transmissions, he again identifies three trends: "A greater number of speeds with torque convertors for good pull away, 8-10 ratios, or dual clutch or CVTs – all three are used in different regions, combined with various engines, and all have their pros and cons."

From our conversation, it's clear Koesters is determined Ford, while retaining its value for money ethos, should be offering even more technology in its future product lines.

Koesters sees a bright future for intelligent all-wheel drive spreading across the Ford range



## 3D printing races ahead

Dan Walmsley isn't shy about coming forward in his admiration for 3D printing, or “additive manufacturing as some call it, enthusing: “My eyes were opened beyond belief” when he first saw what this cutting-edge technology could achieve for the LMP2 race team he manages.

Using a Stratasys uPrint in the pits allows the engineers to make small components in a matter of hours, rather than days, back at the factory.

At the Silverstone 6 Hour event, where the team was competing in the season's opening race, the organisers asked that the Dome race car run a roof-mounted camera. “That was on Monday,” he recalls. “By Wednesday, it was presented to scrutineering. We also made the titanium door hinges using additive manufacturing.

“This opens a whole new approach to engineering for us,” he adds, predicting that the number of 3D-printed components in the car will grow exponentially in the coming years.

“We are looking to expand our capability in-house particularly in crash structures and I can see in the future that, if the FIA allow, the monocoque could be built from a combination of three or four assemblies of carbon fibre and metals produced by 3D printing. There's even the potential of employing different materials to those we use today. In racing, you're always looking for the strongest, lightest combination to gain an edge – and speed is always of the essence. The great thing about it is that our engineers aren't constrained by design when using additive printing.”

Currently, the Japanese-designed Dome SIO3 features a 3D printed dashboard structure, brake ducts, of which four variations were developed over the winter, as well as short fins over the wings for the unique Le Mans 24 hours aerodynamics package.

Meanwhile, back in Japan where the car is assembled, the Dome team use 3D printing for the 40% aero wind tunnel model, and also for the front dive planes and aerofoil.

“Because of its process, it means we can create half a dozen iterations in parallel, rather than in series,” adds Walmsley, “so we can arrive at optimum solutions that much faster, whilst saving money.”

Strakka is one of the first teams to talk openly about its use of 3D printing trackside. However, going by the interest shown by other teams, it won't be the last.



“This opens a whole new approach to engineering for us,” says Walmsley, predicting that the number of 3D-printed components in the car will grow exponentially in the coming years





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