DRIVERLESS REVOLUTION HAS BEGUN!

December 2014

INTERVIEW: TENNECO’S TOMORROW

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14 Automotive Design Interview
Riding on a high
Rudi Schurmans and Ben Patel head up Tenneco’s suspension and clean air divisions. Ian Adcock discovers what the automotive future holds for them

18 Cover story
Driverless revolution has begun!
Breakthrough Photonic radar promises greater accuracy at lower costs, Ian Adcock discovers

24 Focus on safety
BRAKES: breaking the mould
Automotive Design reports on recent developments in brake technology

26 Focus on engine controls
Powertrain controllers’ tasks ramp up
New systems architectures, advanced chips and new standards help design teams meet evolving powertrain and control challenges, says Terry Costlow

28 Focus on interior materials
Attention to detail
Interiors have taken on a new lease of life, with a vibrant selection of finishes on offer

30 Focus on surface finishes
Finishing in style
Automotive Design examines latest trends in surface finishes, materials and colours

32 Question time
Winds of change are here
Simulating aerodynamics will make a step-change in vehicle design, as Stephen Remondi, president and CEO of EXA, explains to Ian Adcock

5 Comment
• EV: silver bullet?

6 News
• Battle of the batteries
• Pre-turbocharger catalyst concept brought back to life
• New con rod design boost
• Toray buys Zoltec to expand product portfolio

23 The Columnist
Convergence: connectivity and autonomy
Kevin Jost, SAE International Editorial Director

34 60 second interview
Dr Christian Schmidt, head of powertrain research, BMD
Allegro’s High-Performance Angle Sensor ICs

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EV: silver bullet?

I don’t mind admitting that I have never been a fan of electric vehicles (EVs).

All the brouhaha that was kicked up about them a few years ago, both by OEMs and governments predicting that we would all be driving EVs by the end of this decade, was pure fantasy. There were too many factors against the EV: battery technology – price of batteries; where was the energy going to come from to recharge them; and so the list goes on.

But I just wonder if the EV corner has been turned?

Israeli research company Phinergy has developed a workable aluminium-air battery, although it’s more like an onboard energy generator, and has teamed up with US aluminium giant Alcoa to put the technology into production – and Automotive Design has the inside details on page 5.

Time will tell, if this proves to be the silver bullet. But if it’s as cheap and good as it is claimed then, maybe, EVs will have a bigger impact in years to come than we expected.

Except I won’t be holding my breath.

A new form of radar that could help autonomous cars is on the front cover. Photonics, developed to track aircraft with improved accuracy, promises greater precision and simpler packaging, although it will still have to be augmented by other detection systems, as Professor David Stupples of the school of engineering and mathematical studies, electrical and electronic engineering, City University, London, explained to me (page 18).

Elsewhere, we’re given an insight into the workings of Tenneco’s suspension and clean air divisions by their respective senior directors, while the secrets behind how the super slippery Jaguar XE achieved its wind-cheating design without compromising Jaguar’s styling heritage are also revealed (page 32).

Ian Adcock, Editor in Chief

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**Battle of the batteries**

Two competing battery technologies could herald a new dawn for electric vehicles (EVs), with the promise of lower prices and extended ranges within the next two to three years.

First is an aluminium-air battery that is already being field trialled in a modified Citroën C1 and rumoured to go on sale in 2017-18 in a Renault EV. However, neither the French OEM or the battery’s developer Phinergy would comment beyond its chief operating officer Jonathan Regev confirming that the Israeli-based company is in discussions with “a number of OEMs”.

The principle behind aluminium-air batteries has been known for over 100 years: that you reverse the smelting process by combining aluminium, oxygen and water to create aluminium oxide.

“Each atom releases three electrons to create aluminium hydroxide, thus creating a current,” explained Regev, continuing: “Theoretically, you’re able to draw 8.1kWh per kilo of aluminium, but some of it is transformed to heat, so we’re able to draw about 3.5kWh electricity out of the system per kilo.”

Scientists at Israel’s Barlan university developed the technology, which was then acquired by Aviv Tzidon who went on to establish Phinergy in 2008, starting work on the battery in 2000. The big challenge was developing a cathode that didn’t collapse after 100 hours or so and wasn’t platinum-carbon based – to bring down costs.

The breakthrough came with the development of an inexpensive nano-porous silver-based catalyst that, says Regev, has a surface area close to 10m² per gram. This separates oxygen from the atmosphere, allowing it into the electrode, but not CO₂, creating aluminium hydroxide and releasing energy on the way. As a result, the air electrodes are immune to carbonisation and have a life span lasting many thousands of hours.

**TRIPLE FUNCTION**

The electrolyte, which is a blend of water with potassium hydroxide, has three functions, explains Regev: one, activating the battery; two, evacuating heat from the battery; and, thirdly, creating aluminium hydroxide from the face of the anode at a precise rate, which is then evacuated from the cell into an electrolyte tank. Once all the electrolyte has been consumed, it’s an easy task to replenish it by simply adding water to it that was consumed and taking out the aluminium hydroxide that can then be recycled. “In practice, there’s a big market for aluminium,” he added. “It is being used as carpet flame retardant, toothpaste, deodorants and many other applications.”

Regev says they don’t want to “eliminate” lithium ion, but foresees future EVs having a

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**Pre-turbocharger catalyst concept brought back to life**

The concept of a pre-turbocharger catalyst has been revived with the advent of 48 volts powering electrically-assisted turbos, according to Emitec’s Rolf Brück. “It’s an old technology from 6-8 years ago, but we couldn’t bring it into production, because of the poor response time. People want quick, highly dynamic engines.

“But with hybrids, there’s a change in philosophy, as the dynamic performance doesn’t have to come from the internal combustion engine, but also from an electric motor and this combination makes a pre-turbocharger catalyst more attractive.

“In the future, temperature and fuel economy will be the important factors so the hottest location we have, especially on a diesel, is in front of the turbo.” The disadvantage in response time is compensated for by using an electric motor and optimised exhaust system, especially for real-world driving emissions, which makes it important that the system works in all driving circumstances.

There are other gains to be had as well, according to Brück. “We can take away precious metals and go with lower loadings and that will influence cost. We’re doing lots of tests with OEMs, but it won’t come before 2020 at the earliest, maybe 2022.”

Emitec has also developed an integrated in-tank selective catalyst reduction (SCR) system that can be welded directly into the fuel tank. Incorporating a pressure sensor, filter, heating system and pump, the housing reduces fuel tank capacity by just 0.52l and weighs less than a kilo. Start of production is predicted by the end of 2015.

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*Loctite has developed a polyurethane-based resin suitable for making a leaf spring, its first application being the new Volvo XC90. It’s the first time the resin transfer moulding process has been used for such a large part. Manufactured by Bentler SGL, the manufacturing process is much faster than epoxy.*
Getrag's Smart Actuation all set for launch

Getrag's electro-hydraulic Smart Actuation will be launched in the new dual-clutch transmission 7DCT300, which goes into series production in early 2015 in mid-size cars. Alongside on-demand actuation, it offers seven gears and a higher gear spread of up to 8.6. Whereas the proven 6DCT250 provides a fuel consumption advantage of roughly 6%, compared to a modern torque converter transmission, this advantage increases to 8-9% with the new 7DCT300.

The even more compact 6DCT150, being primarily designed for small cars, will compete against CVT and automatic transmissions with four to six gears in its segment. Thanks to the low actuation power needed, consumption advantages of over 10% are possible, compared to competitors.

"With the 6DCT150, 6DCT250 and 7DCT300, Getrag offers a modular and fuel-efficient transmission family that is suitable for many different applications," says Didier Lexa, chief technology officer at Getrag. "With our new actuation concept, we have succeeded in further reducing the fuel efficiency of our dual-clutch transmissions with wet clutches substantially." The 7DCT300 will enter into series production with a number of car makers in 2015 and the 6DCT150 will follow in 2016.

Materials, which, in turn, are quicker than pre-preg formats. The leaf spring has several advantages over conventional metal springs: it saves 4-5Kgs in weight, improves noise, vibration and harshness and increases boot volume; and, finally, there is a cost benefit to the manufacturer.
New con rod design boost

The prospect of variable compression ratio (VCR) petrol engines appearing around 2020 and diesel shortly after has greatly increased, due to a new, patented con rod design from engineering consultancy FEV.

The engineering consultancy started work on VCR systems in the 1990s, including one for the now defunct car maker Saab, in which the entire block moved, and others where the con rod itself was elongated. In 2002, work started on the development of the two-stage system seen here.

Moreover, as Dipl-Ing Andreas Sehr, director business development, explained, the beauty of the system is that gas forces are responsible for moving the engine from high compression ratio (CR) to low compression ratio, with the mass forces making the change in the opposite direction. “We don’t need any additional energy to the system; it’s just opening a valve, then the oil flows from one chamber to the other, and then the next movement is done by the forces from the combustion – and that’s the biggest benefit.”

In the FEV two-stage VCR system, variation in connecting rod length is achieved by installing the small end (piston pin) bearing in a rotatable eccentric.

For gasoline engines, the CR goes, for example, from 8:1 to 12:1, depending on the boosted level of the engine, and, on a diesel, from 13:1 to 17:1. “So that’s a good compromise more for the NOx and particulate emissions trade-off, resulting in an improved CO2,” Sehr explained. In addition, the maximum peak pressure requirement for the engine architecture is reduced, resulting in less friction. The actual change in CR is governed by the knock sensor, with the change taken in incremental steps over eight engine cycles, each taking 0.25 seconds to the new ratio.

The benefit is felt most at turbocharged.

Engines solve lightweighting bonding challenge

One of the big challenges in lightweighting body-in-white – bonding plastics and metals – now appears to have been overcome by engineers at Germany’s Fraunhofer Institute for Laser Technology and recently shown for the first time at Composite exhibition in Düsseldorf. While plastics are characterised by low weight, cost effectiveness and almost endless forming possibilities, metals can withstand significantly higher mechanical loads. But because of their distinct chemical properties, even strong bonds inevitably fail. The Fraunhofer ILT has developed a joining process that uses laser radiation to generate microstructures in the metallic component, explains Dipl.-Wirt.-Ing Christoph Engelmann.

A second laser joining process fuses the plastic into metallic microstructure, but, to be successful, the plasticised material needs to flow into the generated structures to harden.

The mechanical strength of the bond depends on the structural density and temperature during the joining process, in addition to the mechanical strength of the plastic. Strength levels beyond that of traditional adhesive joints can be achieved during the laser process by temperature-based control of the laser’s power to plastisise the polymers, resulting in bondings of up to 16000Ns.
petrol engines where, at part load or low engine speed, the compression ratio can be increased until the turbocharger comes in and then can be reduced, helping to overcome lag.

Another application described by Sehr could be running two different fuels. “If you have Ethanol or compressed natural gas and gasoline operations, you have different knocking behaviour and that would be another benefit to always have the possibility of the best CR for the fuel the engine is using.”

With petrol emissions, there is always the time needed to heat up the catalyst, before it reaches its operating temperature and all the emissions – HC, CO and NOx – are more or less burnt and converted by the catalyst. In those first few seconds, as the catalyst is heating up, the engine could start with a lower CR and then go to a higher one to reduce the time required for heating the catalyst. “Effectively, you reduce the engine efficiency artificially to get more energy to the catalyst and reduce the time, so that’s a benefit for the petrol engine. “For the diesel, it’s really a question about NOx emissions: can they be reduced; what does it mean for the after-treatment system; do we need an additional storage cat after the SCR or can we neglect it? That’s being investigated,” he said.

“It’s running in lots of demonstrator vehicles, and there’s a high level of interest from both OEMs and tier ones,” revealed Sehr, who accepts that it will cost more, “but it will be acceptable and the cost-benefit ratio is very interesting.”

Japan’s lightness of touch

Japanese manufacturers are embracing lightweight strategies even more keenly than before. The latest Mazda MX-5 is 100Kg lighter than the old model, says programme manager Nobuhiko Yamamoto. The central torque beam connecting the gearbox and differential is “much better grade of aluminium stamping than you might think”. Extensive use of aluminium in the suspension has reduced unsprung weight, while attention has been paid to make the engine cam cover thinner – even the seat adjusters are a thinner steel to pare off a few grams.

Over at Nissan, Dave Moss, vice president vehicle design and development, always tells his engineers that “mass is probably the hardest out of mass/cost/performance to achieve, because with cost you can always try and charge more, but nobody can give you mass – and that’s a fundamental issue to try to improve efficiency.

“For example, on Quashqai we developed an undercoat that was 60% lighter than the previous one, but with still the same level of isolation that allowed us to take kilos out of the underbody treatment and improve NVH, stone chip noise and anti-corrosion performance.

“We also developed a new bumper, going to new polymers with higher flow rates, that enabled us to reduce wall thicknesses, with the same impact resistance and the same levels of pedestrian protection.”
Better transmissions bring more flexibility

Federal-Mogul Powertrain’s new high-modulus Unipiston allows transmission designers more flexibility, including increased clutch apply pressures, higher rotational clutch speeds and larger diameter clutches. This flexibility enables transmissions with additional clutches to be packaged in a smaller space, while providing improved fuel economy, reduced emissions and enhanced vehicle performance.

Blown away

BorgWarner’s regulated two-stage turbocharging (R2S) technology boosts the 2.0-litre diesel engine for Volvo’s new Drive-E powertrain family. The technology combines two turbochargers of different sizes to allow the turbine and compressor sides of the system to continuously adapt and deliver high boost pressures over the entire engine speed range. At low engine speeds, the entire exhaust gas flow is directed to the smaller, high-pressure turbocharger, resulting in a quick rise in boost pressure. At higher engine speeds, the wastegate valve opens and the exhaust gas is redirected to the larger, low-pressure turbocharger. By optimising the full engine speed range, the R2S turbocharging system helps improve fuel economy and reduce emissions, while enhancing performance.

TomTom partners VW

TomTom (TOM2) and Volkswagen group research announced at Paris that they have signed a Memorandum of Understanding to develop jointly the digital map that is essential for automated driving. The two partners bundle their competencies by combining TomTom’s expertise in map content and map making with Volkswagen’s know-how about the car, as well as automated driving.

The Light Programme

Continental Structural Plastics (CSP) has introduced its Tough Class A (TCA) Ultra Lite, a 1.2 specific gravity (SpG) SMC formulation that provides engineers with the ability to design with a lower specific gravity material, without sacrificing mechanical properties, surface qualities and adhesion requirements.

€54m proving ground to replicate real-world driving conditions

Volvo is part of an industry consortium, including Volvo Group, Scania, Autoliv and others, that has invested just over €54 million in a state-of-the-art proving ground just outside Gothenburg, Sweden.

The Active Safety Test (Asta) facility is unlike other accident research centres, as it has been specifically designed to replicate real-world driving conditions using what Jan Ivarsson, Volvo manager safety, described as “naïve drivers”, rather than professional testers.

“Most people don’t have that type of experience, so we need to understand how normal drivers react in those situations. Normal drivers will be part of these experiments without endangering them.

“Although the naïve drivers are local Swedes, we need to bring people in from other places; it’s a cultural question and how you drive in real traffic.

“We are investigating how people behave at crossings. As a driver, you are making a decision at a junction to go or not to go and also negotiating with others. That is something that varies in different driving cultures: Paris and the USA are very different. That needs to be considered. It’s a variation of individuals and driving cultures as well, because we want systems that work everywhere; maybe with some different settings, but you need to know how to take a decision in a car.”

Establishing the facility is part of Volvo’s vision to have no one killed in one of their cars by 2020. “It’s very ambitious and, if I look at it from a market perspective, I think we can do very well with this in Sweden, Europe and the UK with similar results in the USA, where it’s somewhat different. I think the safety technologies we introduce to the market will make a significant difference, even in China.”

The 2,000,000m² facility, which will be made available to other OEMs and interested parties, includes a 250,000m² paved surface, a 5.7Kms highway connected to a city environment with four blocks, as well as rural roads and junctions.

GKN world-first

GKN has produced the industry’s first two-speed eAxle and entered production on the BMW i8 plug-in hybrid sports car.

Giving the electric motor an additional gear ratio improves acceleration and pure electric range, benefiting both driving dynamics and CO2 emissions. GKN’s two-speed eAxle also enables the motor and all its associated systems to be downsized, reducing mass and further increasing efficiency.

eAxle technology enables automakers to produce “axle-split hybrids”. A conventional or hybridised engine provides the primary power to either the front or rear wheels, with the other axle driven by an eAxle module. The technology responds intelligently to deliver an instant high-torque, all-wheel drive experience, a useful pure electric range or a refined, efficient parallel hybrid mode. No other hybrid architecture offers such a strong combination of efficiency, traction, dynamics and packaging, says GKN.
Toray buys Zoltek to expand product portfolio

Toray, a global leader in the production and supply of carbon fibre, has bought the Zoltek Corporation to expand its portfolio of product offerings, especially to emerging sectors like the automotive industry.

Zoltek specialises in “commercial grade” carbon fibre, as opposed to aerospace grade that Toray traditionally sells, as Zoltek’s director global business development automotive, Adam Harms, explained: “Our whole cost strategy since the early 2000s is that we make one standard product, so we guarantee a stable source of supply and price as it’s more of a commodity than a value-based textile. You watch how Toray’s pricing has fluctuated over the years, depending on the supply and demand of the aerospace market.

“With automotive being a big growth segment in the industry, everything is predicated on low cost and we’re 30-40% less than Toray T700, which is the fibre they promote in the automotive sector.

“A lot of the parts are stiffness driven and we match them on modulus, T700NX35. Now you have got equivalent fibre and modulus that’s 30-40% lower cost. So much of the market was demanding our fibre that they saw an opportunity for synergies, because their whole portfolio is small tow 1 to 6, 3 to 6, 12 and some of the 24k; and we have 50k, so there wasn’t really much crossover in the market.”

He went on to explain that Toray “is pricing 24k and we’re pricing at 50k. The thing is, Toray can’t guarantee that supply or price for seven years, just based on their capacity.

“They not only make a 24k, but also 1, 3, 6, 12, whereas we only make one product all day, every day, so we understand where our capacity is and have additional capacity we can bring on line,” he said. “Consequently, we can guarantee long-term pricing we’re putting into the market.”

A further attraction for OEMs, says Harms, is that Zoltek will commit to buying back scrap carbon fibre from OEMs: “If it’s dry scrap from an RTM process, Zoltek can buy that back, because we reclaim it, mill it and resell it downgraded to a filler. We can commit to that for the OEMs.”

Fusion connected platform set for 2018 launch

Visteon’s Fusion connected platform will be launched by a European-based vehicle manufacturer in 2018. Fusion is a highly innovative solution, ‘fusing’ traditional driver information, infotainment and Cloud connectivity into one connected platform, offering drivers and passengers what is described as a seamless human machine interaction (HMI) experience. Visteon’s first-to-market platform allows multiple systems to run side-by-side in a virtual environment on a scalable hardware solution that is capable of incorporating multiple operating systems and extended graphics.

For the driver, Fusion is a significant innovation, as it combines multiple levels of information into one system for the first time, including vehicle-related and safety-critical information, such as speed or warning signals, as well as personal information from the Cloud.

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New lease of life for iconic Bentley V8

Despite its origins going back 56 years, Bentley’s 6.75-litre V8 has been given another lease of life, with a redesigned top end to match the improvements made to the bottom end in 2010.

“Two real things precipitated these changes,” explained Paul Williams, Bentley’s head of powertrain engineering. “The first is that we’ve had a Speed variant in all the production lines, so we wanted a more driver-oriented car, even for the Mulsanne.

“Secondly, there are constant legislation pressures and the need to continuously improve fuel consumption, so we wanted to make a step-change on the engine, whilst also gaining a performance jump in torque.”

When the bottom end was redesigned four years ago, its torque capacity was increased to 1200Nm, the new engine’s rating. Direct injection (DI) was considered and, although that could have resulted in small power increase and efficiency, that’s at the cost of increased particulate emissions.

“So we decided to stick with MPI and, to be honest, the torque transients we get with MPI are almost equal to that of DI.”

The piston crown and inlet port combustion chamber were all redesigned to increase tumble and propagate faster combustion, without incurring knock. “We used a lot of CFD techniques to make sure we get the airflow into the cylinder in a very controlled way and know exactly what the charges are doing.”

The offset sparkplugs have been moved to a more central location and the latest 12mm long reach versions used, together with the newest Bosch EV14 injectors that promote a lower droplet size for a better spray pattern.

There has been a 16% reduction in valve train friction by reprofiling the cams to allow valve control with lower spring forces – about 30% on the intake side and 10% on the exhaust – and, because of that reduction in energy, lighter sodium-filled valves are used.

SOFTWARE STRATEGY IMPROVED

Knowledge gained from the cylinder-deactivation programme on the four-litre V8 has improved software strategy on the bigger engine, reducing the penalty incurred during the transient mode between V4 and V8 cylinder configurations.

All this has resulted in 1100Nm at 1750rpm – “we haven’t hit the transmissions limit yet” claimed Williams – and 537PS at 4200rpm. Despite this, CO2 is down 15% and fuel consumption is 14.6/100Kms (20mpg) on the EU cycle. “We’re very proud that in real life you get better than you achieve on the cycle.”

Nor does he see that the 6.75-litre is nearing the end of its life: “A hybrid concept of this engine is definitely the next step forward. If you combine it with a parallel hybrid, you get 70% fuel economy benefit and there’s no reason why you can’t have a large capacity engine,” he points out.

“One thing we have learned about hybrids as we have got into them is that the difference between a large capacity hybrid and a low capacity hybrid is very little, because in the end the powertrain is used far less.

“We have to do something unique, both from the customer perspective and the performance, and Bentley’s luxury requirements are so much greater than other VAG products.

“We have to maintain our brand uniqueness and performance levels to be a compelling purchase to the customer.

“By sandwiching an electric motor between the clutch and the rest of the transmission, we can use electric motor assist to drive only on that motor, coasting etc.

“That’s why the savings are so big, because, in addition to the electric range, you have massive effort in recuperation and engine off at 80mph, with no perceivable interruption, you’re talking about a minimum 15% benefit in both emissions and fuel consumption.”
GM steps up investment with new engines

GM is continuing investment in European product with the launch of two new engines: a one-litre direct injection petrol triple and new two-litre CDTI diesel. According to Thorsten Kniesa, assistant chief engineer for engines, GM will renew 80% of its powertrains by 2016.

The three-cylinder is a clean sheet of paper design and, for the first time in this sector, features a balancer shaft in the sump. Uniquely, one inverted tooth chain drives both the oil pump and the balancer shaft that, says Kniesa, reduces both friction and NVH.

Kniesa went on to explain that a great deal of attention was paid to minimising NVH, so the engine features a new high pressure alloy block with cast in iron liners, together with an integrated inlet manifold with, uniquely optimised for this engine, a MHI turbo specified for low end torque.

A two-piece oil pan with an aluminium bed plate, with the lower part from deep drawn steel, prevents block resonance, so it doesn’t act as a membrane.

The switchable water pump incorporates a sensor to detect when to start the pump, helping with NVH and “significantly” quicker warm-up times before switching to circulate water to the air-conditioning system.

“We concentrated on reducing noise at its source, rather than blocking it at the firewall,” explained Kniesa. As a result, the fuel system is decoupled from the cylinder head. Also, there is no metal-metal contact between the injectors and the fuel rail, while the catalyst’s heat shield is a metal sandwich construction decoupled from the engine.

Weighing just 106Kgs and with a 10.5:1 compression ratio, the new engine comes in two guises: 90 and 115PS, both delivering 170Nm at 1800rpm.

Eyes on Euro6 – and beyond

“We started to analyse the existing two-litre diesel with a view to Euro6, as well as improving NVH, CO2 reduction and performance, particularly transient response and low end torque and driveability. By the time we had done that, the result was a practically new engine, although there are some restrictions, as it’s built on the previous engine’s line, so it’s the same bore centres and iron block,” recalled Jens Wartha, programme manager and chief engineer 2.0 CDTI (LDE).

“We took over the successful design of the 1.6-litre’s cylinder head, the EGR from a concept point of view and then we added specific features for NVH, such as the balance shaft, a two-piece oil pan with a deep skirt engine block, and added a high pressure die cast aluminium upper oil pan for structural improvements and then added a sheet metal lower part of the oil pan, all optimised for NVH, stiffness with additional ribs, because in the old engine the top and bottom end emitted NVH.

“In addition, the engine cover has absorption material and the intake manifold with a single sheet absorption cover in order to avoid emitting noise. The plastic cam cover is also isolated with gaskets and the screws, in order to avoid any mechanical noise.

“Also, the timing system cover is isolated and then, basically, we optimised all the components from a NVH point of view.

“The result is that, at some engine points, we achieve a sound pressure level reduction of 5dB, which was our main target, because customer feedback from the old engine wasn’t positive when it came to NVH.”

For the first time, GM has adopted a Garrett turbocharger with an electrical actuator that reduces build-up time to peak torque, resulting in 400Nm (up from 350) at 1750rpm to 2500rpm, and 170PS at 3750rpm.

A new generation of low leakage, seven-hole solenoid injectors running at 2000 bar are used for the first time, with a maximum of 10 pulses per stroke available. “Solenoid injectors are improving a lot, so we decided to go with them,” commented Wartha. Compression ratio is 16:1.

Looking towards Euro6.2 in 2018, the engine has the “capacity for more development,” claimed Wartha, “but we need to understand what the final conclusion for that will be in context with WLTP and RDE drive cycles.

“I am sure SCR can cope with Euro 6.2, but we need to appreciate what the trade-offs will be with other parameters.”
Rudi Schurmans is executive director, global engineering for Tenneco’s ride performance division. In this role, he is responsible for leading all ride performance engineering activities worldwide. Prior to this position, he served as plant manager at Tenneco’s St Truiden manufacturing facility and director of engineering outside of North America, with responsibility for planning, directing and coordinating all research and development activities for the ride performance division. Before that, Schurmans was plant manager in Glwice, Poland. He joined Tenneco in 1989, serving in engineering positions of increasing responsibility. He holds an MSc degree in electromechanical engineering from Kihi in Diepenbeek, Belgium.
Riding on a High

Rudi Schurmans and Ben Patel head up Tenneco’s suspension and clean air divisions. Ian Adcock discovers what the automotive future holds for them.

Product cost leadership is one of our imperatives and, if you look at Europe specifically, it’s a very competitive market over here, made even more so with the recent emergence of two additional rivals, taking the competition to seven in total now,” explains Rudi Schurmans, executive director, ride performance global engineering at Tenneco.

But he believes that Tenneco has the technology and know-how to maintain its place in the sector, especially with the growing trend of advanced technology, a movement whose benefits he believes the end consumer is really starting to understand. “The other trend is that the penetration in the market is going from the ‘B’ platform we had in 2010 to the smaller-sized platforms, such as the BMW 1-series – so really driving the technology down to the entry-level products. Our strategy is building the ride technology around each platform: so ‘A’ through to ‘F’ and sports cars.”

Intelligent Suspension

Schurmans reveals that next year its CVSA2/Kinetic active suspension system, featured on the McLaren supercar launched in 2010, will appear on a second product, along with the debut of new dual mode and dual valve technologies. “So, two new technologies in the Monroe Intelligent Suspension field. The dual mode technology is a step up in electronic suspension, as it switched between two discreet settings – a soft ride or a sporting ride, which the driver can select manually when they want. The OEM has the possibility to tune those settings completely independent of us and what this is really focused around is getting that experience of a sporty car into a comfortable car.”

Manufacturers taking weight out of their products in an effort to help reduce emissions and improve efficiency presents Schurmans and his team with its own set of challenges to overcome, as he explains: “On lighter vehicles, the real challenge is between loaded and unloaded weight. Making a vehicle lighter, but still having the capability to load four or five people and 100-150kgs, you go from a vehicle that’s approximately 1000Kgs up to 1700-1800Kgs. There’s a huge difference between loaded and unloaded conditions, but we’re developing some passive technologies, which breaks the compromise in settings that is currently the case.”

Tenneco’s suspension is also going on a diet with plastic spring seats and top mounts fabricated from plastic or aluminium, together with new monotube technology and developments in composite springs with third parties, which are “not far away” claims Schurmans. “The trick is getting it to a price point that’s attractive to the OEMs and, in the medium to longer term, the drive is to integrate composite suspension components together with the strut, therefore creating a value offering that is quite different from what is typically used today.”

Comfort Zone

Schurman also revealed that, in 2016, an upgrade to Monroe’s rebound valving system, code-named RV+, will be offered, promising “better tuneability”; so breaking the compromise between comfort and road holding is going to be made easier. “What we’re trying to do with this second generation damper is reduce the accelerations getting into the car, resulting in better noise performance that also ultimately improves the comfort feel in the car. We’re also working on passive technologies that will hit production in 2015-16.”

With the advent of 48volts, active suspension is back on the table, although it will still only be the preserve of top end products, reasons Schurman: “Nissan and especially Toyota tried that as well, but were never able to introduce it successfully, because it was too costly. On top of that, at that stage it was capable of delivering a huge improvement in primary body control, but then, when you were looking at secondary ride etc, wasn’t optimal. But with our current generation of Accocar, the secondary ride is also getting a pretty big improvement against the other types of suspension.”

Schurman, however, is not fully convinced that active suspension, using current camera detection technology, is that effective, as image resolution isn’t high enough, or that
the camera is capable of scanning the full width of the road. However, he concedes that TRW’s latest system (see September’s Automotive Design) scanning frequency is “probably enough”, adding the caveat that “whether it’s capable of detection under all road conditions and weather is another matter”.

EXCITING TIMES
Ben Patel, Tenneco’s vice president clean air, global research and development, systems integration, is in buoyant mood and has reason to be so, as he explains. “In general, it’s an exciting time in emissions globally. Last year, group earnings were just over $8billion, with two-thirds from the clean air division and one-third ride performance. That’s up from 2010 when it was roughly $6billion, although the split has been consistent and there’s lots of optimistic growth through to 2025.”

From his perspective, when talking about emissions “it’s important to distinguish what in the USA we call criteria pollutants, like particulate matter (PM), NOx, non methane organic compounds, from the greenhouse gas emissions, which are mainly CO2.

“On the criteria pollutant side, where the primary emphasis is on diesel for trucks etc, the trends going forward are all towards lower NOx and PM. The challenge, in terms of developing the technologies, relate to the trend towards smaller engines, colder exhaust and managing test cycles, and very early in the cycle directly after a cold start or the colder portion of the cycle.

“Whether it’s working with catalyst partners or academia, developing lower temperature formulations reacting with urea below 200°C, or more thermal management of the system to maintain the heat we do have, that’s where there’s a lot of emphasis.

GREENHOUSES GASES
“On the greenhouse gases, it’s down to fuel consumption: the less fuel you burn, the less CO2 is made. So that’s light weighting, downsizing, trying to do everything so customers can meet challenging CO2 regulations.

“In the case of diesels,” says Patel, “it’s very similar technology between trucks and cars; catalytic reduction transfers very nicely across different vehicles; whilst in Europe, all the cars that use selective catalytic reduction (SCR) effectively use the same dosing systems and catalyst formulations, if only smaller.

“On the petrol side, a lot is geared at test procedures, driving emissions; smaller engines, cylinder deactivation, burning less fuel, stop-start – all pose a challenge from an emissions standpoint, because what they effectively do is cool the exhaust and in emissions control heat is our friend, because those chemical reactions are accelerated with temperature.”

On account of that, he points out, “waste heat recovery is the big trend in the industry right now, mainly for commercial vehicles. I’ve just returned from a conference where six people were talking about the Rankine cycle on trucks, because of the significant potential they offer on fuel savings, although it might take six to seven years for the technology to emerge.”

THERMAL ELECTRIC GENERATORS
In principle, this steam engine-derived energy recovery system would suit any application that, due to the complexity and cost, is a challenge for passenger vehicles, Patel suggests. “What’s more likely to evolve in 10-15 years are other forms of waste heat recovery we’re investing in, principally thermal electric generators. Integrated directly into the exhaust, they use commonly available semiconductor-type materials where, by passing the hot side created by the exhaust gas, against the cold side provided by the coolant loop between those two temperature gradients, there’s semi conductor material which creates a bias that develops a voltage.

“Those systems produce 100-200v that can be used in all different kinds of ways on the vehicle, in order to take parasitic load off the engine,” Patel concludes.
Ben Patel is vice president clean air, global research and development and systems integration. He is responsible for leading global development for key clean air technologies, including establishing and leading new research programmes to continue positioning Tenneco as an innovation leader in mobile and stationary markets. A member of Tenneco’s senior management team, he joined Tenneco late in 2010 as vice president, technology development, emission control.

Prior to that, Patel worked for GE Technology Ventures, a division of General Electric’s corporate trading and licensing group, where he was most recently technology development manager since January 2008. He joined GE’s global research centre as a staff chemist in July 1998 and held numerous roles with increasing responsibility, including senior research scientist.

Patel holds a Bachelor of Science degree in chemistry from the University of Ottawa and a PhD in chemistry from Yale University.
Driverless revolution has begun!
The British Government’s announcement in the summer that trials of autonomous cars would be permitted on the UK’s roads from the beginning of next year is further confirmation, if it is needed, that the ‘driverless’ car revolution is here.

Far from being the first – California, Nevada and Florida in the US, and Japan and Gothenburg (from 2017) amongst others, already permit autonomous cars – it does mean that the UK will be at the forefront of developing this technology.

A sensor system with four key components is planned for autonomous or semi-autonomous vehicles: a 360° laser radar (LiDAR) to provide a situational map around the vehicle; a microwave radar to provide range and speed of other vehicles; ultra-sonic sensors to warn of sideways closeness; and a video camera to provide visuals. All four must be integrated safely, if the system is going to be effective in not only detecting other road users and obstacles but also warning the driver and avoiding contact.

Currently, vehicle systems use silicon technology with either Frequency-Modulated Continuous-Wave (FMCW) or pulsed waves, although the former tends to be the most favoured. Operating in either 24-29GHz or 76-81GHz millimetric bands (ka and W bands respectively), FMCW systems can fulfil the key operating factors needed in vehicles, namely: detection range, speed detection range, range precision, velocity precision, angular resolution and angular width of view. However, FMCW radar suffers from limited side-lobe suppression, making it difficult to resolve direction.

RADAR SYSTEMS: THE CHOICE

With this in mind, automotive radar systems can be divided into three sub-categories: short-, mid-, and long-range for, respectively, stop-and-go (up to 10m) and urban conditions, while the long-range system (upwards of 200m) for high-speed motorway driving.

“W Band radars have the advantage,” explains Prof David Stupple of the school of engineering and mathematical

“FMCW radar suffers from limited side-lobe suppression, making it difficult to resolve direction.”
"Avoiding the movement of radio frequency (RF) around the vehicle, which is costly and introduces signal noise, would also be advantageous."

Prof David Stupples

studies, electrical and electronic engineering City University, London, “of being smaller and offering a larger bandwidth, which improves resolution. Recently, there have been major advances in the development of low-cost phased array antennas on a single chip, which offers much improved angular resolution.

“With high angular resolution, it will be possible to use existing sophisticated radar algorithms, giving more functionality and vastly improving spatial awareness. This latter advancement will be an essential feature in driverless vehicles. However, as more and more sensors are added, it will be necessary to locate the fusion and processing of data to a centralised computer.”

Traditional radar systems as currently used have their own limitations, he adds. “Because of the microwave elements of this [radar-IA], there is a need for special cables [or, in some cases, waveguides] to move the radio frequency around. These special cables run from the front of the transmitter to the antennae and back again to the receiver.

LIGHTER AND CHEAPER
“So, if I could position the reference signal source and the signal processing away from the radar head, which could then be located anywhere in the vehicle, it makes everything lighter and a whole lot cheaper,” Stupples states, maintaining that relocating the expensive radar elements away from vulnerable areas of the car, such as the front grille or rear bumper, would reduce repair costs in the case of accidents.

Avoiding the movement of radio frequency (RF) around the vehicle, which is costly and introduces signal noise, would also be advantageous, he comments. “Furthermore, fully digital conventional radar systems will only work efficiently up to only around 80 GHz, without noise becoming an issue.”

A new form of radar successfully tested earlier this year by a team from the National Interuniversity Consortium for Telecommunication (CNIT) in Pisa, Italy, led by Paolo Ghelfi, might just provide the answer. Although the concept of photonic radar dates back to the mid-1990s, it has taken Ghelfi and his colleagues until now to devise a means of using a laser to emit radar signals and process the returning signal using photonic – ie, light-based – technology that converts the signal back into a digital waveform. “Radar based on photonics promises to provide high
precision and ultra-wide bandwidth with low noise and, importantly, with an extremely stable radio-frequency source working efficiently and effectively in millimetric wavebands (including W),” Ghelfi says.

LESS NOISE & INTERFERENCE
“Until now, the photonics-based generation and detection of radio-frequency signals have been studied separately and only recently been tested as a system. One proposed architecture exploits a single pulsed mode locked laser for generating tuneable radar signals and receiving their echoes, avoiding radio-frequency up and down conversion and guaranteeing high resolution,” says Stupples.

Because radar signals generated by laser are much more stable, there is considerably less noise or interference. In theory, that means it could track objects more accurately or rapidly sweep a larger area for objects. Photonic radars have more flexibility, meaning it’s able to scan and broadcast signals at numerous frequencies.

Moreover, because higher frequency signals are employed, the radar antennas could be smaller, therefore lighter and easier to package in the confines of a vehicle.

“The issue,” he continues, “is the more sophisticated the device becomes, the more expensive it becomes in front of the car and that is why the photonics is a way of solving that. It’s a better radar. If it can be developed properly.

“Millimetric radar is quite well developed, although it’s quite expensive, and you don’t want to put any of those electronics near a crumple zone. That becomes prohibitive, because you have losses on the RF cables as well, whereas with photonics you don’t. You have some losses down the fibre optic, but that doesn’t matter, because, when the photon gets to the other end, it will regenerate at the head.

ONE-BOX APPROACH
According to Stupples, the whole sensing system is going be a centralised computer for data processing, signal processing and navigation.

“With this one-box approach, photonic radar comes into its own, because all you need to do is connect a phased array head with a transmitter and receiver head [silicon chip based] through fibre optics to the processor, and it might be that the car would have several of these around its perimeter to give a 360° view round the car.

“Because it’s a smaller sensor, they have the added advantage of being easier to package in and around the vehicle; plus the fact that fibre optic cabling weighs less than electrical cable and can be run off the car’s 12 volt system as well, with the sensing system running off 8 amps or less.”

HIGH STABILITY
Writing in ‘Nature’ magazine, Jason McKinney of the US Naval Research Laboratory said of Ghelfi’s work: “Building a radar system using a laser requires an optical mode of oscillation that is able to maintain a

Sensing the way ahead
Whilst Photonic radar is a step improvement, in terms of technology, City University London’s Prof David Stupples (pictured left) believes it would have to be used in conjunction with LiDAR (Light Detection and Ranging).

A 3-D laser-based scanning system, it works by emitting over a million points of light each second; the returning light is interpreted using complex algorithms to build up a real-time 3-D image of its surroundings, especially when combined with a car’s global positioning system. Typical wavelengths are in the 1000nm range, which is near enough to visible light to remain safe, whilst still providing maximum accuracy.

The problem with LiDAR, he says, is its sheer cost: “These systems run into many thousands of pounds each and, until this can be markedly reduced, will remain unattainable for automotive applications,” adding that a “possible replacement could be Ubiquitous Radar proposed by Skolnik – a radar that can see everywhere at the same time. This solution would be much cheaper and the technology is already in prototype stage.”
highly stable phase relationship – that’s the hurdle the researchers had to overcome. They used a mode-locked laser; it allowed for establishing a periodic sequence of laser pulses that exhibited low timing jitter. Using it, in conjunction with a computer running software they wrote, they were able to produce an RF signal with low phase noise by adding an optical filter located past the laser.

“The next generation of radar (radio detection and ranging) systems needs to be based on software-defined radio to adapt to variable environments, with higher carrier frequencies for smaller antennas and broadened bandwidth for increased resolution. Today’s digital microwave components (synthesisers and analogue-to-digital converters) suffer from limited bandwidth with high noise at increasing frequencies, so that fully digital radar systems can work up to only a few gigahertz, and noisy analogue up- and down-conversions are necessary for higher frequencies.

ULTRA WIDE BANDWIDTH

“In contrast, photonics provide high precision and ultra wide bandwidth, allowing both the flexible generation of extremely stable radio-frequency signals with arbitrary waveforms up to millimetre waves, and the detection of such signals and their precise direct digitisation without down-conversion. Until now, the photonics-based generation and detection of radio-frequency signals have been studied separately and have not been tested in a radar system. “The proposed architecture exploits a single pulsed laser for generating tuneable radar signals and receiving their echoes, avoiding radio-frequency up- and down-conversion and guaranteeing both the software-defined approach and high resolution.”

These are obviously early days for this embryonic technology, which is unlikely to be industrialised for five years and not used in an automotive application for another decade, concedes Stupples. Indeed, three leading tier one radar suppliers contacted by Automotive Design denied any knowledge of the technology, while only one OEM admitted, off the record, to be working on it.

But let Stupples have the last word: “There is no reason why a photonic radar solution should not provide the complete sensor suite for cars in the future. Because of the very high coherence accuracy offered, driverless car control systems could be made much safer and more affordable. The software-defined systems will offer automobile manufacturers the ability to optimise safety design, whilst being able to develop single base systems to support their complete range of vehicles.”
Convergence: connectivity and autonomy

Autumotive electronics took centre stage at SAE’s 2014 Convergence event recently held in Detroit. High-level executive panellists provided perspectives on the latest technology trends in connectivity and vehicle autonomy, as well as advice for attracting and developing new engineering talent.

Ralph Gilles, president and CEO of Motorsports and senior VP of product design for Chrysler Group LLC, kicked off the event by declaring that “engineers should think like futurists”, and some of the best futurists are Hollywood writers. “They don’t have any rules. They can dream up anything they want to, and they do.”

Getting to know the future needs and wants of consumers is a big assist to designers and engineers. “I think the most important thing is observing culture. The future is already happening in micro-spots, whether it’s India or Tokyo or [elsewhere], it’s happening. Observing popular culture is the most important thing we can do. Get out and see what’s going on. And, if you aggregate all that, you can be your own futurist,” Gilles said.

Panellists addressing the topic of “Enhancing User Experience to Improve Personal Mobility” said one critical consumer element is the desire for an individual experience. “Connectivity is an enabler for personal mobility and new experiences,” pointed out James Buczkowski of Ford Motor Co.

“The next-generation experience must be much more personalised. The vehicle must look at the cloud and bring an experience that’s relevant to the driver.”

Panellists also discussed the challenges of developing autonomous driving controls. The tasks go beyond sensing and analysing input. Vehicles must know when to obey rules and when to skirt them. “One of the big challenges for autonomous driving is how vehicles interact with their surroundings in ways humans do,” said Chris Gerdes of Stanford University.

“There are rules humans don’t adhere to, like going over double lines to go around a car that’s double-parked. Engineers need to look not at mimicking the average driver; the systems should match the levels of professional drivers.”

Connectivity brings many benefits for vehicle owners, but it creates many challenges for engineers, especially on the security front. Panellists addressing ‘A Secure Personal Mobility Experience’ set the stage by citing a number of reports that show how various vehicle controls could be hacked. Then they discussed preventive techniques and technologies.

Moderator Paul Hansen of The Hansen Report noted that connectivity is the primary reason security has become a hot topic in the industry, likening the increased threat to the challenges that came when standalone personal computers began connecting to the Internet. Security experts from multiple industries agreed that automakers need to add security into their design strategies.

“Getting kids excited about this is absolutely imperative,” said Sharafat Khan of Deloitte Consulting. “It’s the key to getting a pipeline of skilled workers.”

Kevin Jost, The Columnist
SAE International Editorial Director

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www.automotivedesign.eu.com
BRAKES: Breaking the mould

Automotive Design reports on recent developments in brake technology

Brakes no longer perform just the simple function of slowing down cars. They now help to stabilise them during cornering, help provide traction on low or split μ surfaces and recuperate energy into the electrical architecture when reducing the vehicle’s speed. And as electrification of vehicle systems increase, brakes, too, are coming under that sphere of influence.

CONTINENTAL CONCEPT
Continental has developed a concept for an electric parking brake (EPB) for drum brakes. It is especially tailored to the lower-priced vehicle segment that, up until now, has had to make do with mechanical parking brakes built into the existing drum brake on the rear axle. “By combining drum brakes and electric parking brakes, we can offer easy, push-button operation on compact cars,” says Matthias Matic, executive vice president of the hydraulic brake systems business unit of Continental’s chassis and safety division.

“These cars can offer the same convenience and safety functions found on higher-priced models, but at a comparatively modest cost.” The electric parking drum brake will go into serial production by 2017.

The system consists of two actuators that are integrated into the drum-brake base panel on the rear axle, in addition to its control software. The electronics that electrically activate the actuators of the electric parking brake are integrated into the electronic stability.
control (ESC) system. A common construction for light compact cars, it features solid bracing for the two brake shoes, a dual-acting hydraulic cylinder for the service brake and mechanical adjustment. In the future, the functionality of the electro-mechanical system can also be used for the duo-servo brakes common on light trucks and SUVs.

**SINGLE HARNESS**
Continental has also integrated the cables for wheel speed sensors and the electric parking brake (EPB) into a single harness, making it one of the first manufacturers to offer such a combination of components. “Combining wheel speed sensors with the EPB cable results in lower development, product and assembly costs, compared to individual components.” says Thomas Jauch, head of the speed sensors segment in the passive safety and sensorics business unit of Continental’s chassis and safety division.

The integrated wheel speed sensor with EPB cable is one of the world’s first and is suitable for any class of car. The first serial production project, based on this new concept, will launch with a Japanese car manufacturer in 2015.

**RAPID IN-ROADS**
The EPB is rapidly making in-roads in every category of car, and is becoming more and more the standard in the market. The advantage of electric parking brakes is that they perform various assistance functions in conjunction with electronic brake systems to add safety and comfort. Moreover, they operate at the press of a button. There is an emergency-brake function, in the unlikely event that the service brake should fail. Manufacturers also enjoy greater flexibility in designing interiors, because there isn’t a hand-brake lever to protrude into the passenger compartment.

Numerous international car manufacturers have been pushing on this development and are now expecting their suppliers to integrate the EPB into their overall braking system. The next step will be integration of a common harness for EPB and wheel speed sensors in the rear axle.

The cable, moreover, is highly durable and resistant to bending. Full integration of wheel speed sensor functions is also possible. This applies to such standard functions as speed measurement, as well as to such high-end functions as capturing a change in direction of travel or indirect tyre pressure monitoring systems (iTPMS).

The electronic brake system (EBS), traction control system (TCS) and electronic stability control (ESC) calculate the rotational speed of all four wheels, based on signals received from the wheel speed sensors. This enables the systems to determine when the wheels are spinning, taking appropriate control action to maintain the vehicle’s stability and proper steering responses.

Rival supplier TRW has also launched its latest-generation electric park brake (EPB) technology with three major Japanese-based vehicle manufacturers and will begin production with a fourth OEM in the near future.

The EPB system functions as a conventional hydraulic brake for standard service brake applications, and as an electric brake for parking and emergency braking.

**WIDE INTEGRATION**
“Because EPB is electronically, rather than mechanically, controlled, it can work with a variety of vehicle systems and sensors,” comments Peter Lake, executive vice president, sales for TRW. “As an example, in the US, following NHTSA’s recent FMVSS 111 amendment that will require rear backup cameras, an EPB system could be integrated with the video signal and automatically brakes the vehicle, if a potential issue is detected.

“There is also a drive-away assist function, which holds the vehicle in a stopped position without the need to constantly depress the brake pedal – an excellent traffic jam feature,” Lake concludes.
Powertrain controllers’ tasks ramp up

New systems architectures, advanced chips and new standards help design teams meet rapidly evolving powertrain and related control challenges, explains Terry Costlow

Powertrains are getting more complex as fuel burning becomes more efficient and additional gears help transmissions maximise fuel economy. But powertrain control systems must also handle far more tasks, as new features and functions such as stop-start are added. “The key functionalities for stop-start are starter motor control, transmission hydraulics control and battery system interface,” says Donna Haiderer, global chief engineer for engine controls at General Motors. “For conventional stop-start (non-hybrid) applications, GM controls all three key functionalities out of the engine control module.”

Some new tasks managed by powertrain controllers are fairly simple, but the need for high reliability complicates the design process.

“Grille shutters adjust the cooling vents for different driving conditions, improving aerodynamics when the engine doesn’t need as much airflow,” comments William Davidson, manager of powertrain calibration and controls at Mahle Powertrain. “A secondary benefit is that engines warm up quicker, so they don’t have the inefficiencies of running cold for as long. That’s fairly straightforward. But, when the powertrain controller manages the vents, there are diagnostic requirements that you wouldn’t expect.”

DIVERSE REQUIREMENTS

Many of the electronic functions in powertrains require a fair amount of power. “Our latest generation of power trench MOSFETs provides the means to efficiently implement such functions as variable valve timing and lift control, cylinder deactivation, direct fuel injection and integrated starter/generator,” says Gary Wagner, director of automotive marketing at Fairchild Semiconductor Corp. “For power MOSFETs, advances in shielded gate power trench processes and packaging technologies are combined to offer better efficiency and small size to further enable implementation of control system functions, such as integrated starter/generator, electric turbocharger or pumps that improve overall engine efficiency.”

Complying with ISO standards may prompt some design teams to integrate engine and transmission controls into a single module.

“As OEMs become more compliant with ISO 26262, there might be more adoption of powertrain control modules because you’ve only got one controller to have to test,” Mahle Powertrain’s Davidson states.
“Developing a controller to the highest ISO 26262 SIL level is expensive.”

DECISIONS, DECISIONS
Developers must consider many technologies, as they also strive to create modules that can be used with a wide range of engines and transmissions. That increases volumes, while simplifying support.

“Package size, memory needs, connector size, pin count, development timelines – all of these are relevant factors in determining electrical architecture,” General Motors’ Haiderer points out. “The ability to respond with the right powercube, being flexible in matching engines and transmissions to meet global market needs, has also driven architectures that separate engine and transmission controls into unique modules.”

Speedy CPUs are becoming more important as engines and transmissions do more tasks. Engine controllers monitor more parameters and today’s transmissions have many more gears. “Dual-clutch systems require high-performance microcontrollers for the more complex algorithms needed to support these new types of automatic clutch systems,” says Richard Soja, automotive systems engineer at Freescale Semiconductor. “Advanced automatic gearboxes with up to 10 speeds need more sophisticated software control, as well as tightly coupled sensors and actuators.”

Providing more gears helps improve fuel economy, but drivers will be annoyed if the vehicle seems to be changing gears all the time. Shifts must be made smoothly and losses that occur when components are disengaged must also be minimised or fuel consumption will take a hit.

“Transmission gear shifts are disruptive,” adds Haiderer. “Managing control of the powertrain at the axle torque level allows optimisation of both engine performance and shift quality. Allowing the transmission to command engine torque minimises that shift disruption. For improved fuel economy, the engine and transmission controls work together to identify and place the transmission in the best gear state.”

DIFFERENT APPROACHES
Some companies are moving to centralised engine and transmission controllers, while others are using dedicated systems. “We’re seeing a split,” Davidson states. “In Europe, they tend to favour standalone transmission controllers. In America, they prefer integrated engine and transmission controllers.”

Other suppliers are basing their architectural decisions on the vehicle type. High-end designs use more sensors to control multiple parameters with greater precision, so they need dedicated controllers. “On luxury vehicles, engine and transmission controls are usually separate, using three or four microprocessor cores,” says Pat Hunter, automotive systems marketing at Texas Instruments. “If the engine has 40-plus sensors, there isn’t enough computing power to do transmission controls, too. On a small car, it’s easier to use a powertrain control unit that manages the engine and transmission.”

Distributed intelligence is another evolving aspect of powertrain architectures. Processors integrated with sensors handle some processing before data are sent, reducing the volume of information being transmitted and lightening the load of the controller. “People are adding smarts to sensors, going from 8-bit to 32-bits, depending on the complexity and the amount of conditioning needed,” comments Hunter.

There are so many parameters in engine and transmission controls that simulations are nearly mandatory. Modeling also makes it simpler to alter designs.

“Mathematical models are being created for engine management systems,” states Anil Sondur, vice president of Tata Elxsi. “With mathematical models, change management becomes much easier. Models are being merged with autocoding. Once you have models, autocoding processes are easier to run, so you can recode much, much faster,” he concludes.

Automatic stop/start system
1. 12-volt absorbent glass mat (AGM) primary battery
2. Dual battery isolation module
3. Heavy-duty isolation module
4. Stop/start generator
5. 2.5L 4 cylinder with iVLC (intake valve lift control)
6. New iVLC
7. 6-speed automatic transmission
8. 6-speed transmission

December 2014
Traditional automotive material suppliers, like Johnson Controls, are looking beyond the industry for new alliances, such as theirs with adidas. The partners want to increase automation in the production of textiles. In doing so, Johnson Controls, as the leading manufacturer of vehicle seats and seating components, intends to optimise seating trim cover production.

“Process innovations are just as important to Johnson Controls as product innovations,” says Andreas Eppinger, group vice president technology management for Johnson Controls automotive seating. “The majority of sewing required for vehicle seat covers is largely done by hand. Although increasing automation in this area is very complex, we are convinced that it is feasible.”

HUMAN AND MACHINE SPEEDFACTORY, as the project is known, aims to combine the capabilities of both humans and machines. At the project’s conclusion, the prototype of a system should be in place in which humans and robots work together to produce textile products.

While adidas seeks to automate the production of sporting goods, Johnson Controls’ goal is to automate the production of vehicle seat covers. The company intends to optimise the cutting and sewing process, as well as the handling of textiles. This new process will involve textiles being cut in a certain way, aligned and then joined to make trim covers.

Johnson has also developed a coating for fabrics that keeps automotive seats clean and hygienic. The coating repels dirt and liquid, and protects passengers from microbes and static. “Seat covers are subject to heavy use throughout a vehicle’s lifetime,” states Peter Heift, group vice president and general manager trim at Johnson Controls automotive seating. “To prevent damage caused by spilled coffee, sauces, a child’s dirty hands or microbes, for example, we have developed FreshPer4mance.”

FRESH THINKING

FreshPer4mance is a highly effective coating that can be applied to all cover fabrics. For optimum, long-lasting protection, Johnson Controls coats the entire fabric – not just one side – in the new product.

FreshPer4mance makes textiles liquid-repellent, stain-resistant, antistatic and antimicrobial. All sorts of stubborn dirt can be removed with one easy wipe, without leaving any marks. This makes the seats easier to keep clean, hygienic and odour-free.

FreshPer4mance is said to be ideal for heavily used seat covers in

Attention to detail

Interiors have taken on a new lease of life, with a vibrant selection of finishes on offer
Focus on interior materials

commercial vehicles, as well as for vehicles with constantly changing drivers – such as rental cars, car-sharing and pool vehicles. It also increases the cleanliness and value of private vehicles.

The coating enables OEMs to expand their range of trim fabrics to include lighter colours, and thus offer their customers more distinctive and customised vehicle options.

LIGHTER, CLEANER
Meanwhile, at the recent Paris motor show, Faurecia and Interval launched Automotive Performance Materials, a 50/50 venture, to develop the use of hemp-based materials for the automotive industry.

The aim behind the deal is to develop and produce bio-sourced raw materials to build on the advances already made by Faurecia in creating lighter, cleaner vehicles.

The new company will draw on the assets of France’s industrial and agricultural sectors through innovative, performance products in developing industrial uses for natural fibres, such as hemp for door panels where there can be a 20% weight reduction.

Benecke-Kaliko has developed a conductive material that can generate heat without a millimetre of heating wire being fitted. What is more, it is easy to integrate the conductive and paintable polymer compound into automotive surface materials. This new mode of heating consumes minimal power, making it an ideal solution for electric vehicles, which have to warm up without heat from the engine. Drivers of diesel- or gasoline-powered engines benefit from the surface-integrated heating, particularly on short journeys.

The conductive material has three distinct advantages over conventional systems: the new, surface-integrated heating consumes considerably less energy to generate a warm and pleasant ambience; instead of three or more kilowatt hours, only 300 watts are required to heat the areas directly in touch with the driver and passengers; and just beneath the surface and radiating two to three centimetres, the heating process only takes a few seconds.

Last, but not least, the paste can be applied in any shape to the surface material to be heated. This is a distinct advantage over conventional heating pads based on metal wires or carbon fibres whose shape is virtually unalterable. This Benecke-Kaliko innovation makes it possible for almost any component to be part of the interior heating system: seats, control levers, armrests, door trims or floor mats.

Design is no longer just about styling, but about attention to details. Personalisation is a key differentiator for consumers. To address this, Johnson Controls is focusing on surface finishes such as 3-D tactile grains. The company’s Wristwatch seat showcases creativity, with its unique 3-D trim designed to give a handcrafted appearance (left).
To achieve a class ‘A’ finish, OEMs demand premium materials in terms of both steel and paints, so advances like Tata’s recently launched Serica hot-dip galvanised surface finish enables a consistently excellent paint finish, even when thinner or fewer paint layers are used – thanks, claims Tata, to its guaranteed low waviness after forming.

The first two steel grades in which Serica will be commercially available are the formable DX56 steel – largely used for body sides – and the high-strength steel BH180, commonly used for fenders and doors.

The roughness of the steel’s surface is very important, particularly the surface waviness – i.e., the long-wave roughness of the surface, visible to the human eye. To produce steel with guaranteed low waviness and ensure stable operational performance, Tata Steel has developed and implemented various process adaptations throughout the steel’s multi-step production process. These adaptations result in low surface waviness that is very predictable and enable Tata Steel to guarantee the maximum waviness of a deep drawn part.

EXCELLENCE WITH SUSTAINABILITY

Sander Heinhuis, Tata Steel’s European marketing manager for automotive, said: “Creating a great finish on automotive parts, particularly the exposed panels which are responsible for a new car’s look, is naturally an essential part of the vehicle production process. By using steels with the new Serica surface quality, customers can achieve an excellent paint appearance on exposed body panels, while at the same time using a sustainable hot-dip galvanised coating process.”

Meanwhile, paint suppliers like BASF are increasingly looking for inspiration as to what colours will appeal to consumers in different regions in the future. In North America, for instance, they predict colours that epitomise “the rustic, hardworking, inventive spirit of the post-Recession era” will appeal. Part of BASF’s Global Coatings Colour Collection 2014/2015 report, ‘Under the Radar’, predicts five colour trends and the inspiration behind them: La Garra Charrua, a light blue representing an unpretentious look at Mother Nature that is reminiscent of the prairie spaces in middle America. Haymaker, a rich orange that seems dirty at first, but, upon a
second glance, sparkles much like the charm of a rustic factory in one of America’s rust belt cities. Fitted Green, a soft green exemplifying the look of fresh mowed grass and a gentle reminder of a simpler, sustainable life. Gray Elevator, dark silver that has an imprint of American culture woven through it, as the tone harkens to a connected world where people and technology collide. Finally, there’s Take 10,000, a brownish shade rich with sparkle that reminds individuals to remember the specialness of natural experiences.

These colours are ceratinly a far cry from this year’s Pantone colour of the year, Radiant Orchid, but, when predicting a few years out, different considerations and consumer trend preferences have to be taken into account.

BASF also worked with Citroën to develop its unique Airbumps for the C4 Cactus. These large air-filled cushion bumpers are fitted around the car to help absorb the impact from low-speed collisions using Elastollan, which combines the traditional properties of TPU with new features. The injection-moulded component is mounted to a polycarbonate and acrylonitrile-butadiene-styrene (ABS) support shell, forming flexible cavities that can be dented and still bounce back.

NURSUS ADVANTAGES
Elastollan high-performance material, created and optimised by BASF, has many advantages. It offers freedom of design and long-term durability, combined with attractive haptics and a high-class appearance.

Other claimed advantages include good tensile strength, abrasion resistance, elasticity, excellent impact resistance, low wall thickness, scratch resistance and UV- and weather- resistance.

The Elastollan HPM can be pigmented, so the Airbumps do not have to be painted. Thus, they do not require any special maintenance, which helps reduce the repair costs, if an accident arises, and are offered in contrasting colours – black, brown, light and dark gray.

AkzoNobel Performance Coatings has launched an innovative, bright metallic powder coating that provides a sustainable and cost-effective alternative to chrome plating. Interpon Cr, part of AkzoNobel’s Interpon powder coatings range, combines a chrome-like finish with the proven performance of a two-coat powder coating. The unique combination of a highly reflective base coat layer with a clear top coat is also said to offer outstanding resistance to marking.

“Special effect finishes are continuing to grow in popularity and metallics are very much in demand,” explains Mark Reekie, global marketing manager, general industrial at AkzoNobel Powder Coatings.

“Designers and stylists are always on the lookout for new ways to enhance the appearance of their creations,” he points out, “and Interpon Cr was created to appeal to those looking for a bright, durable coating that gives a creative edge to coated products.”
Simulating aerodynamics will make a step-change in vehicle design, as Stephen Remondi, president and CEO of EXA, explains to Ian Adcock

Jaguar’s new XE saloon boasts a Cd of 0.26 in its slipperiest form on skinny tyres. And while that’s the best ever yet for the manufacturer, achieved after 1,200 simulations and a staggering eight million CPU hours on simulation, Stephen Remondi, president and CEO of EXA, predicts that the “industry has got to move to 0.20 and that’s going to incur radical changes”.

Some of those changes could be seen on Renault’s Eolab concept car on which EXA also worked “That’s 0.235, with a lot of interesting features; in the front bumper, you have got ducted flow that passes the air out by the front doors, rather than going round the car. You will see more passive devices like that – the BMW i8 has them – and active devices on the back that open on the Renault.

“You will get ridge lines on the side mirrors and rear lights that help to control separation; the consumer doesn’t see that so much and it’s harder to achieve on sheet metal. But you will see more and more of them.”

SPIN-OFF FROM ACADEMIA
Like many of the advanced software solutions being adapted by the automotive industry, EXA is a spin-off from academia, in this instance the Massachusetts Institute of Technology (MIT), as Remondi explains: “The algorithm was created and developed there from computational fluid dynamics (CFD) and we’ve built on that now, but it’s a very different method that’s unique to us.”

How EXA calculate the physics, he says, “is a very long story”, and one, I suspect, he is not about to divulge to rivals. “But the key thing about the algorithms,” he will reveal, “is that they allow us to calculate accurately the car’s independent flow, transient flow and turbulence structures, and the accurate detailed geometry.” And he adds: “Traditional CFD tends to give only an approximation of steady state flow and simplified geometry, which gives you qualitative answers, but not quantitative ones, which is what we do.”

CRITICAL FACTORS
The big challenge that Jaguar had to meet, and other OEMs who want to combine their emotional design heritage with efficient aerodynamics, says Remondi, is: “How to meet the targets without killing the design and that’s the tricky part. This has been an important car for Jaguar Land Rover and us: how do you get a fuel-efficient car, yet still get soul and passion
ARE HERE

**Question time**

Exa PowerFLOW simulation of the Jaguar XE shows virtual particles tracking the flow from the vehicle A-pillar over the side of the roof, down the back glass and onto the rear edge of the vehicle. These flow features are carefully tuned to optimise the aerodynamic performance of the vehicle, creating smooth paths for the flow to follow that minimise the air resistance.

Visualisation of the wake areas around the Jaguar XE using Exa PowerFLOW shows key losses in the energy of the flow field, leading to air resistance. On this vehicle, the surfaces are contoured to deflect the flow around the tyres and to create the minimal footprint in the trailing wake. The small and well controlled wake regions behind the tyres, mirror and vehicle base show the efficiency of the shape.

pillar, as he explains. “Three things play a role here: the ‘A’ pillar plays a big influence in drag, as it actually creates suction, pulling the car forward, so you want to broaden it. “You also want water management where water needs to be ducted up and over the roof, as drivers really hate it when it comes across, overflows the ‘A’ pillar and comes down the side glass. And, most importantly, the vortex that is pulling up the ‘A’ pillar is the dominant source of wind noise within the cabin.”

**FUTURE FOCUS**

Looking to the future, Remondi predicts: “We’re going to see much more attention paid to areas around the wheels, more protection around them, more active devices around the car and wheel arches, with different protectors; active devices for scooping air into brakes when they’re cool or hot. “On the latest Porsche 911 Turbo, there’s an active chin spoiler, as well as active rear spoilers and grilles. We’re working on developing the capability to do water and dirt, as well as brake dust management on wheels.” And he concludes: “There are a lot of fixed assumptions that are going to have to change in the future.”

associated with the design? This is the conflict that’s going on, as car companies really have to work to get the regulatory requirements for CO2, fuel efficiency and aerodynamics.

“Cooling and thermal systems behaviour plays a dominant role in performance and how it affects the design. What’s happening is that the old way of designing a vehicle in the studio – as a concept that everyone likes, which is then delivered to engineering, and you move it through that process, allowing engineering to make a few small changes – is disappearing. Now, you have to integrate engineering up front into the studio. You don’t want opinions based on what worked in the past, but what works for the new car.

“We have a complete simulated environment that allows you to take the full design from the sketch in Alias, or whatever computer aided design (CAD) package is used, or clay models, scan them and bring in the whole powertrain package, and show how that car is going to perform and behave to guide decisions between engineering and design.”

A typically critical area, says Remondi, is air flow round the ‘A’ pillar, as he explains. “Three things play a role here: the ‘A’ pillar plays a big influence in drag, as it actually creates suction, pulling the car forward, so you want to broaden it. “You also want water management where water needs to be ducted up and over the roof, as drivers really hate it when it comes across, overflows the ‘A’ pillar and comes down the side glass. And, most importantly, the vortex that is pulling up the ‘A’ pillar is the dominant source of wind noise within the cabin.”

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Dr Christian Schmidt, head of powertrain research, BMW

Triple assault on emissions targets

BMW has three major strategies to achieve the 2025 emission targets: one is to find the most efficient way to design the car itself, not just from the aerodynamic shape only, but also weight and rolling resistance. Next, we want to use the energy as efficiently as possible, whether it’s pure internal combustion engine or combined with electricity. And, thirdly, we have to find a way that gives us the chance to most intelligently use the energy within the car. That means the moment when you burn fuel, you throw away one-third via the exhaust and another third is wasted in the cooling system, and only one-third is used for propulsion. We have to use it more intelligently, maybe store it and re-use it later on demand. So, those are the targets we’re aiming for.

“Part of that can be brought into the car by 48volts; the first thing you get with that is recuperation, so you can reuse more energy than you can with a 12volt system. It also gives you more energy, if you use it for powertrain or for starting the engine more efficiently and quietly.

“BMW has found that 500cc is a very good figure for cylinder capacity, as you always have to consider combustion volume, diameter and bore. From a thermodynamic point of view, this combination we have is very good for efficiency and for the range of [horse] power we want to get out of one cylinder. Whenever you change one of those dimensions of bore or stroke, you might change the others. So it’s then a case of adding or subtracting cylinders as we do at the moment, then supplementing them with electrification.

“What we found, given the combustion chamber size we have, is that the compression ratios are quite good and, if you adjust that in one or the other direction, you have to adjust other things. We have between 101i and 11.51i and for the diesel we’re 161i to 181i, depending on the injection pressure and timing, ignition timings and all the variables.

“There’s a law of diminishing returns as you increase diesel injection pressures; that’s something you have to keep in mind, because the spray coming into the combustion chamber changes, if the pressure changes, because you don’t have the same time for the same amount. NOX is strictly dependent on the temperature of combustion and, whenever you go over 2000 Kelvin, you start producing NOx. So you have to keep it down using several approaches and one thing could be the higher pressure rate, but, if you have that, you have to leverage out other things.

“Rather than cylinder deactivation, we’re following the Valvetronic approach, which means that ‘dimming’ is better than ‘switching off’.”
IMPROVE INTERIOR PACKAGE DESIGN, INCREASE VEHICLE SAFETY, AND ENSURE INTERNATIONAL COMPLIANCE WITH THE SAE H-POINT MACHINE

A three-dimensional manikin that provides the physical representation of driver H-points, the H-Point Machine (HPM) is used to define and measure vehicle seating accommodations. Offering a deflected seat rather than a free seat contour as a reference for defining seat space, it is a vital tool in the design of interior packages.

Available through SAE International, the HPM is used in conjunction with SAE Standard J826 and is currently referenced in various federal and international regulations including NHTSA’s FMVSS in the US and ISO standards. Utilized in testing for compliance to such regulations involving impact/crash, head restraint, or vision, it is the required safety certification tool for vehicle production in many countries around the world. Additionally, those who need to locate seating reference points and torso angles as reported by manufactures employ the SAE H-Point Machine.

And for advance design and research applications, the HPM-II is available, which includes reformed shells for a consistent and reliable fit in bucket seats, an articulating back for lumbar support measurement, and the ability to measure the H-point without using legs resulting in simpler installation.

Is one SAE HPM enough?
If your company tests and certifies to FMVSS 202a, it might not be.

NHTSA’s head restraint regulation is now fully in effect. That means, in the US and Canada, front—and now rear seats—must meet FMVSS 202a. NHTSA is also encouraging the EU and UN ECE to adopt similar regulations.

To meet FMVS 202a, a head restraint measuring device is attached to the SAE HPM. It is recommended in revised SAE Standard J826 Nov 2008 that a separate and unique HPM and HMPD for head assessment be used to eliminate any measurement variability that the HRMD may introduce.

Ensure North American compliance and be prepared for changes in EU/UN ECE regulations. Consider a second, dedicated SAE HPM—one for conventional HPM measurements and one for head restraint assessments.

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