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■ Valeo and its quest for lower emissions

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LIGHTWEIGHT CHAMPION

All-aluminium Range Rover exposed



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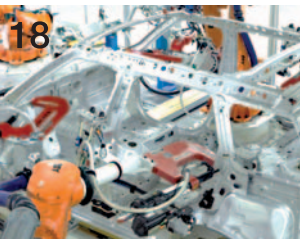


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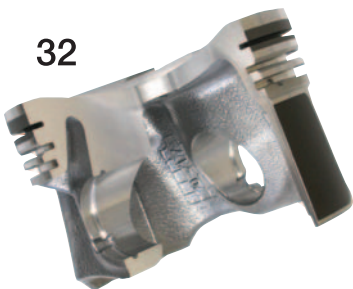


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The Shape Of Things To Come In The Automotive World



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Tough US regulations can benefit Europeans



President Barack Obama's endorsement of tough new rules for car efficiency, which will see the near doubling of Corporate Average Fuel Efficiency (Cafe) from today's 27.5 mpg to 54.4 mpg (8.5l/100kms to 4.3 l/100kms) by 2025, must be bringing a quiet smile of satisfaction to the engineering team at Jaguar Land Rover.

As you can read on page 18, the new all-aluminium Range Rover is a staggering 420Kgs lighter than the outgoing model, mainly due to its aluminium body shell. For every 100Kgs weight saved, there is a direct 2% improvement in fuel efficiency and that's before any other fuel-saving technologies, such as direct injection or stop-start, are included in the equation.

The new Solihull factory, where the bodies are assembled, has a potential annual capacity of 100,000 units, a clear intention that JLR's future is firmly wedded to a family of aluminium cars and SUVs. And that will auger well for both marques' prospects in the USA; add to that another decade of material development and how much lighter and fuel efficient will the 2025 model year Range Rover be?

Whilst Obama's announcement hasn't been greeted with universal enthusiasm by all OEMs, Volkswagen in particular thinks the rules discriminate against small cars and diesels, they must be welcomed not just by the US OEMs but, especially, by the European ones and their supply chain. Both sectors have world-class technology when it comes to reducing fuel consumption and, consequently, improving emissions and Obama's stringent legislation provides European innovators, such as Valeo (see page 12) with an ideal launch pad to promote its expertise to the US automotive industry.

We're all used to in-car connectivity these days and its growing sophistication, but does that extend into the realms of health monitoring? That's the thorny issue Andrew English tackles on page 29. Having an asthma alert app might be one thing, but in this litigious age is having your car monitoring heart and blood pressure, for instance, going one beat too far?

Ian Adcock, Editor in Chief

Improved DCT reliability

SKF has launched a new series of products specifically designed to improve the performance, reliability and lifespan of double clutch transmissions. The SKF Double Clutch Bearing Set and clutch support angular contact ball bearing have been designed to provide robust performance, with the capability to resist high temperatures and loads, improving transmission reliability, as well as achieving an extended lifetime in a compact package.

The SKF Double Clutch Bearing Set is used to decouple the engine from the gearbox for gear changing. The two bearing units can be used in dry or wet clutch applications, and are compact and lightweight, utilising sheet metal stampings for the structural components.



Internal bearing geometry has been optimised to minimise contact pressure and to be able to carry the high loads associated with double clutch

transmissions. Selected materials have been used for the bearing cage, grease and seals (for dry clutches) to withstand the increased temperatures in such transmissions. The design includes self-alignment and radial guiding of the bearings, plus support possibilities for actuations by mechanical fork contact or hydraulic piston.

The SKF clutch support angular contact ball bearing guides and locates the clutch driving plate as it transfers loads from the engine to the gearbox. Designed to carry extremely high axial loads coming from the two clutches, the bearing is greased and sealed for life with selected materials to withstand temperatures up to 240°C.

Ford and Seat light up Paris

Ford and Spanish car maker Seat both debuted new Valeo LED lighting systems at the Paris Motor show.

The new Ford Mondeo features a full LED headlight module that incorporates 22 monochip LEDs: three in the bi-LED module for low beam (650 lm) and high beam (880lm), eight for the turn indicators, nine in the daytime running lights, plus a further two.

The new headlamp also features a dynamic bending light system that illuminates an additional 11m of roadway as they turn and a motorway function that automatically increases the lights' range at speed.

"We're seeing LED headlights take over for two reasons," Derek de Bono, Valeo group product marketing director, told Automotive Design. "Low consumption and the equivalent performance to xenon – 26 watts consumption, compared to 35 watts with xenon, which

translates to a fuel economy benefit. The second big driver with some of the LEDs on the market today is very high styling signature. We believe that new market introductions in the next few years will surprise and delight many people." Moreover, de Bono predicts that, by 2020, 40% of global car production will be



Healthy option is not to the taste

Ethical and legal concerns are holding back the development of in-car health monitoring, according to some automotive manufacturers. While most monitoring sensors are already available, and communication with auto makers' existing infotainment electronics has been successfully achieved, the full potential of such devices is not expected to be realised, as legislators' and manufacturers' concerns are unlikely to allow the car to do much with the data it collects.

Although medical authorities in Europe and America are increasingly turning to the development of artificial intelligence for initial assessment of symptoms and diagnosis, car monitoring is not expected to approach these areas.

"We don't want to turn the car into a medical device," says Gary Strumolo, Ford's global manager for interiors, infotainment, health and wellness. Ford is leveraging its SYNC voice-activated technology in the US, with smart-phone health applications allowing drivers to access air-quality information, asthma alerts and even monitor blood sugar levels on the move. The first 'app' to link with Ford's SYNC technology, an iPhone-based asthma alert, went on sale in August.

The US Food and Drug Administration (FDA), however, "is very particular", according

to Strumolo, about who gives medical advice and his team has been assiduous in ensuring that any medical information displayed "is just mirroring that of the device".

But technology is moving apace. Two new health monitoring concepts unveiled last year, mounted in a steering wheel and a seat, are capable of monitoring blood pressure, stress, pulse and perspiration levels. Mikael Edvardsson, of Volvo's safety electronics and functions department, is cautious about this technology. "We cannot have a situation where the car is the doctor and we are trying to do things that surgeons do in hospital with complicated and expensive machines."

Researchers on such monitoring projects, such as the Technische Universitaet Muenchen (TUM) steering wheel developed in conjunction with BMW, have got around such problems by only coupling their monitors as USB plug-and-play devices, which don't attempt any diagnosis.

"We make the medical [monitoring device] as a separate unit," says Dr Ing Lorenzo D'Angelo a researcher on the BMW/TUM project. "Our data is only recorded, not analysed. We don't want the car to say, 'Hey, your blood pressure is too high'."

But this calls into question the value of such devices. Ford says that drivers with

equipped with LED headlamps, compared to the figure of less than 1% today.

Included in that will be an LED glare-free high beam that uses a front-mounted camera to detect oncoming, or overtaking, traffic to automatically dip the beam down from high. This will be introduced in 2013.

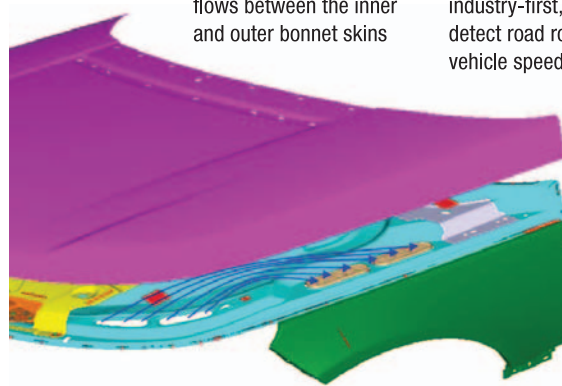
Seat is using LEDs in the latest version of the Leon. The low beam function uses six monochip LEDs with 630-640Lm, with a further three for 880Lm high beam mode.



Mighty Range of solutions

The new Range Rover (page 18) features numerous patented solutions developed by members of its engineering teams, including novel labyrinth air intakes and using the battery as an attenuator.

During the severe flooding in the UK, a number of Range Rover owners were left stranded, despite the vehicle's impressive 700mm wading depth. In the latest model, this has been increased to a class-leading 900mm, thanks partially to a novel intake system that draws air in from between the clamshell bonnet and the upper front fender. The air then flows between the inner and outer bonnet skins



before flowing down into the intake system via a series of 'Queen Mary' funnels, named after the famous liner, before it's sucked into the engine air intake box where any water is trapped; as a bonus, it saves 240 grams.

In a second, patented, development, the new lightweight aluminium air reservoir for the suspension now has the main battery suspended from it, acting as an attenuator or mass damper, rather than bulky sound-deadening material.

Meanwhile, Land Rover's innovative Terrain Response technology moves on with an industry-first, fully automatic mode: sensors detect road roughness and roll resistance, vehicle speed, ambient temperature and gradient, at the same time taking inputs from the engine, gearbox, centre differential and chassis systems, and making 100 calculations per second. Then, in less than one second, it selects the optimum traction setting. It will also suggest to the driver they should select off-road height or low range.

of everyone

cardiovascular disease are 23% more likely to be involved in a car accident, yet, in the evidence of high stress levels, such systems will only be able to ration data reaching the driver, perhaps diverting phone calls as well.

Yet Edvardsson also raises the problem of how that data will be used. "The driver needs to trust the car," he says, "and we need to explain that security is robust."

Most driving administrations mandate a driver to tell them of any pre-existing conditions. In the UK, drivers are required to inform the Driver Vehicle Licensing Agency (DVLA), if they suffer from an arrhythmia or have a pacemaker fitted, but angina, valvular heart disease or a heart murmur are not notifiable. So, what if there were real-time monitoring of various functions? Would insurance companies and driving authorities demand access to the data?

"It is important to assure people that this data isn't being reported," says Ford's Strumolo, who is concerned that such fears amongst drivers will prevent the take-up of such technology. "If you have a hypoglycaemic event and tell your doctor," he says, "in 18 US states they legally have to notify the state's department of transportation. People could be afraid of losing their licence." (see page 29)



Visteon's latest concept vehicle, the e-Bee, will make its global debut at Electronica 2012 in November. The e-Bee is Visteon's vision of future mobility. It explores new ways of using and owning cars, facilitated by innovative technologies, such as display-based controls and cloud-centred profiles, graphical user interfaces, illumination environments and 'physical app' accessories that allow complete personalisation and reconfigurability.

Fully compatible with electrical vehicle platforms, the e-Bee is an exercise in intelligent mobility where the vehicle gathers and disseminates useful driving-related data, acts as part of a wider mobility-enabling network, and integrates technology and design that is simple, flexible and frugal.

News in brief

URT appoints F1 man

URT Group – the composites manufacturer and engineering solutions provider, based at Bognor Regis, UK – has recruited Bob Simpson from McLaren Racing to the new post of innovations manager. Simpson will lead research and development into new and improved composites production and manufacturing methods, as well as help to develop URT's in-house apprenticeship and training schemes

Eplan expands

Eplan has taken over the development and sales rights to Harness Expert, the established 3D/2D software for cable harness engineering. Harness Expert is said to be an easy-to-use software suite that fully supports all aspects of cable harness engineering. Typical harness or wiring loom design processes are shown by the software in 3D. All 2D production documents are produced by the system, which allows "comprehensive openness" when it comes to the import and export of third-party systems in design, administration and production, while reducing engineering time and costs.

New composite facilities

Dow Automotive Systems is expanding its composite processing technology with the opening of two development facilities to service its global customer base – one in Freienbach, Switzerland, and the other in Midland, Michigan, USA. These laboratories support the advancement of strategic relationships with automotive and commercial transportation customers, with an emphasis on carbon fibre composites. The Freienbach Composite Technology Centre offers a comprehensive state-of-the-art infrastructure to develop composite applications, paired with the appropriate joining technology. The 200 m² laboratory is equipped with a large, high-pressure resin transfer moulding machine (RTM) for prototype production. It also offers development and testing facilities for resins and related adhesives.

Lightweight seating

Johnson Controls has developed an especially lightweight seating system that contributes to the vehicle's sustainability of the latest Kia cee'd – that is up to 5.7kgs lighter than the previous model.

Johnson Controls' engineers achieved this weight reduction, without sacrificing safety, by using a lightweight metal structure of high strength, thin-walled steel for the front and rear seats. A Keiper Taumel 2000 is used as a backrest adjuster in the front seats.

The modular rear seat structure is also particularly innovative: for the first time, Johnson Controls replaced thick-walled seat pipes with wafer-thin metal frames made of high-strength steel. This adds stability to the split rear seat system.

In addition to the mechanical version front seats with adjustable lumbar support, the Kia cee'd offers an optional electrically adjustable driver's seat with a tilt adjuster – a unique feature for a vehicle in the compact class.



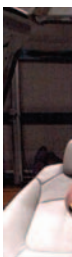
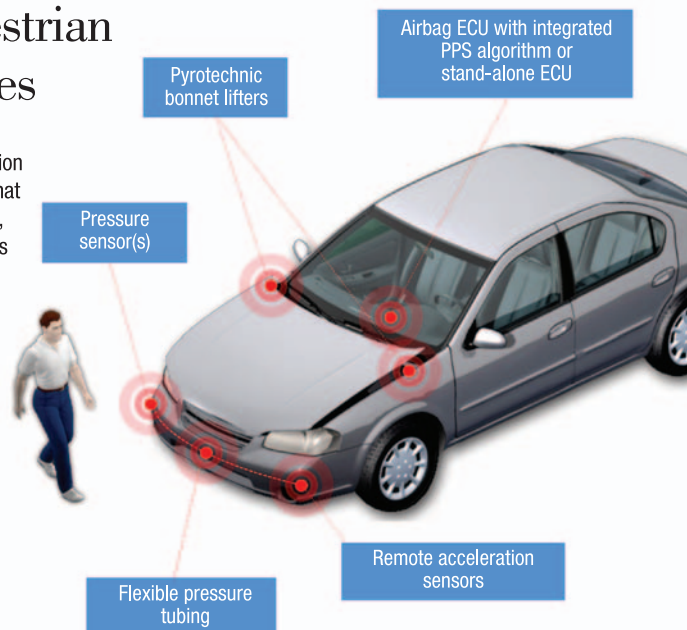
Enhanced Pedestrian Protection arrives

TRW has announced its next-generation Pedestrian Protection System (PPS) that utilises pressure sensor satellite data, measured via flexible tubing, that runs the width of a vehicle's front bumper, in conjunction with up to three remote acceleration sensors to detect an impact and identify which side of the vehicle the pedestrian has struck.

The system will also help automakers maintain 5-star safety ratings in Europe, where pedestrian protection accounts for 20% of a vehicle's overall score.

Originally launched in 2009, the first systems were comprised of remote acceleration sensors and either a dedicated ECU or an airbag ECU, which integrates the pedestrian protection system algorithm to detect a pedestrian impact, along with bonnet lifters that can be deployed to increase the gap to the vehicle's engine and help cushion pedestrian impact. When the sensors detect an impact, pyrotechnic actuators then raise the rear area of the vehicle's bonnet to increase pedestrian head protection. This helps to decrease the impact of the most drastic, and most common, cause of pedestrian injury and death.

TRW's second-generation systems work in a similar fashion, but add additional sensing capabilities to improve system performance and robustness. TRW anticipates the new system will be ready for production by 2016.



Battery breakthrough claimed

Envia Systems, of Newark, California, has announced test results that verify the company's next-generation rechargeable battery has achieved the highest recorded energy density of 400 Watt-hours/kilogram (Wh/kg) for a rechargeable lithium-ion cell.

When commercialised, this battery is expected to slash the price of a 500Km range

electric vehicle by cutting the cost of the battery pack by more than 50%. The testing was performed by the Electrochemical Power Systems Department at the Naval Surface Warfare Center (NSWC) in Crane, Indiana, under the sponsorship of ARPA-E.

Testing at various cycling rates confirmed that the battery cell demonstrated energy

density between 378-418 Wh/kg for rates between C/3 to C/10 for a 45 Amp hour (C/3) cell. Similar cells have been cycling in Envia's test labs for more than 300 cycles.

"Since the inception of Envia, our product team has worked tirelessly and logged over 25 million test channel hours to develop each of the active components of the battery – Envia's proprietary Si-C anode, HCMR cathode and EHF electrolyte," said Dr Sujeet Kumar, Envia's president and CTO.

GM launches first front centre airbag

General Motors will introduce the industry's first front centre airbag – an inflatable restraint to help protect drivers and front passengers in far-side impact crashes where the affected occupant is on the opposite, non-struck side of the vehicle – on the 2013MY Buick Enclave, GMC Acadia and Chevrolet Traverse.

The front centre air bag deploys from the right side of the driver's seat and positions itself between the front row seats, near the vehicle's centre. This tethered, tubular airbag is designed to provide restraint during passenger-side crashes when the driver is the only front occupant, and also acts as an energy-absorbing cushion between driver and front passenger in both driver- and passenger-side crashes. The airbag is also expected to provide benefit in rollovers.

GM analysis of the National Highway Traffic Safety Administration's Fatality Analysis Reporting System database found that far-side impact crashes, which the front centre airbag primarily addresses, accounted for 11% of the belted front occupant fatalities in non-rollover impacts between 2004 and 2009 involving 1999 model year or newer vehicles. These fatalities, where the occupant is on the non-struck side of the vehicle, also represent 29% of all the belted front occupant fatalities in side impacts.

GM and technology supplier Takata developed the front centre air bag over the course of three years, testing many design iterations to achieve packaging, cushioning and restraint for a variety of crashes and occupant positions.



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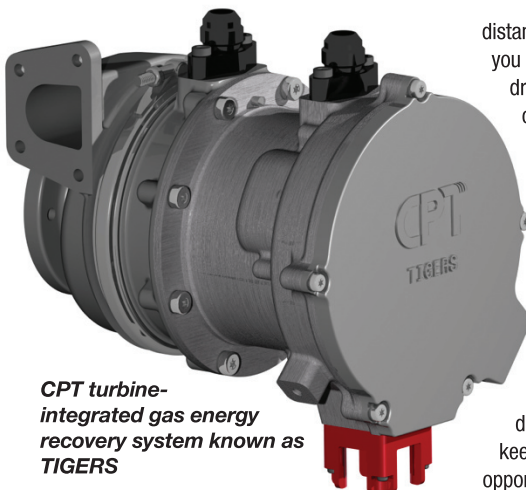
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Turbo generator recovers waste exhaust energy

Only a third or less of the energy contained in an internal combustion engine's fuel is converted into useful work for propelling the vehicle; a further third goes into the coolant and the remaining third is wasted in the form of hot gases escaping from the exhaust.

Traditionally, says Nick Pascoe, CEO of Controlled Power Technologies, engineers have regarded this waste heat as no more than a nuisance. But now, with every gram of CO₂ counting towards an automaker's environmental – and financial – credibility, exhaust heat is coming to be seen as a resource to be exploited, in order to improve emissions performance.

Jaguar's VIPERs project is one such example, being designed to maximise the recovery of thermal energy in the exhaust. Various avenues are being explored, including electronic thermoelectric generators (TEG), using



CPT turbine-integrated gas energy recovery system known as TIGERS

the Seebeck effect, and CPT's own turbo generator unit.

Labelled TIGERS, for Turbogenerator Integrated Gas Energy Recovery System, CPT's unit can be packaged anywhere in the exhaust system and generate up to 2 kW of electrical power in its current form. This power is used to charge the vehicle's battery and so relieve the load on the alternator; on some luxury vehicles with power-hungry accessories, the turbine could replace the second alternator.

Overall fuel savings of 5% are a conservative estimate, says Pascoe. "It depends what test cycle you are working with," he explains. "The NEDC is a very poor drive cycle for technologies like this. This is not really an urban device, like stop-start: it's more for longer

distances, with quite a different usage profile. If you start using Artemis or one of the real-world drive cycles, you get many more opportunities for harvesting."

One of the major issues with the generator, which measures just 240 mm in length and weighs 10 kg, is that of thermal management. "You're dealing with temperatures of 800 Celsius, yet the electronics don't like to see more than 100." CPT has designed its own temperature-tolerant electronics, which are integrated into the unit.

Complex strategies, including varying degrees of bypass, are used in real time to keep temperatures in check and seize every opportunity to harvest energy. A low-inertia rotor and switch-reluctance generator ensure that the device spins up to its 70,000 rpm operating speed in minimal time. But, states Pascoe, the exhaust gas flow must be carefully managed to avoid the water-cooled turbine overspeeding.

Today's unit operates on 12 volts in the VIPERS application, but later units could work at 48V. "We'd like to see outputs of 4 kW by 2017," he says, adding that this is the timeframe automakers are considering for production applications, most likely on a "premium saloon". In terms of cost, the device is likely to cost many times the price of an alternator, but rather less than that of a variable geometry turbocharger.

The likelihood is the device will be at the much more efficient level of 48V, he notes, to coincide with the arrival of the first 48V vehicles on the market in 2016.



Nick Pascoe, CEO of Controlled Power Technologies

Inventor revives engine ideas

The principle behind the variable capacity e3 Mayflower engine, which was first shown in 2001, has reappeared in the guise of the Powertrain Technologies variable capacity engine, shown as a prototype single cylinder unit at the 2012 Low Carbon Vehicle event in the UK.

The copyright for the engine, which had become embroiled in the 2004 bankruptcy, has been acquired by Andrew Barnes, managing director of PTech. The engine was being evaluated by Audi, using a standard four-cylinder unit, explains Barnes, but development ceased when Mayflower called in the receivers and the copyright reverted to Joe Ehrlich, the original inventor.

The e3 engine owes its claimed 40-50% extra efficiency to an additional link between the crankshaft pin and the connecting rod, allowing

the rod to describe an elliptical, rather than a circular, arc. This, in turn, allows the piston to spend more time around top dead centre, permitting more complete combustion of the fuel, it is stated.

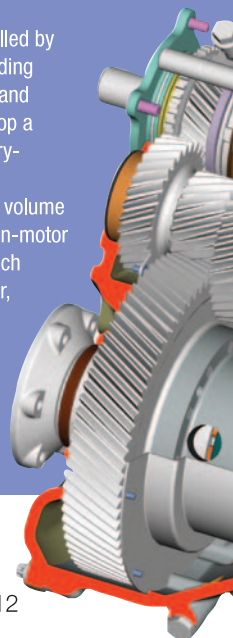
Barnes is now reporting a 12% efficiency improvement on gasoline engines, which drops to an effective 8% once the additional friction in the extra bearings is taken into account. The engine can be run unthrottled, he says, controlled by varying the compression. A simplified actuator could be installed, providing 85% of the benefit of the complex device in the original design.

Diesel engines could also benefit from the principle, he maintains: NO_x levels can be lowered by quickly reversing the piston at TDC, then slowing it at BDC to extract the most expansion from the gases.

Four-speed electric

Vocis, the gearbox developer controlled by Oerlikon Graziano, has received funding from the UK Niche Vehicle Network and Technology Strategy Board to develop a four-speed transmission for a battery-powered minibus.

The new transmission will be a volume market version of the innovative twin-motor unit first shown in 2011 on the French Furtive eGT exotic electric sports car, says Vocis head Mike Everitt. The company will partner with Zytex Automotive and the University of Surrey to build a demonstrator vehicle. No timescales have been announced, but Everitt is confident



On-board hydrogen generator reduces CO₂

The prospect of being able to reduce tailpipe emissions without significant penalty on fuel consumption has always been an attractive one to engineers. The UK Technology Strategy Board, charged with incubating new technologies that might be of interest to a low carbon automotive industry, is supporting the CREO programme for CO₂ Reduction through Emission Optimisation, which seeks to do just that.

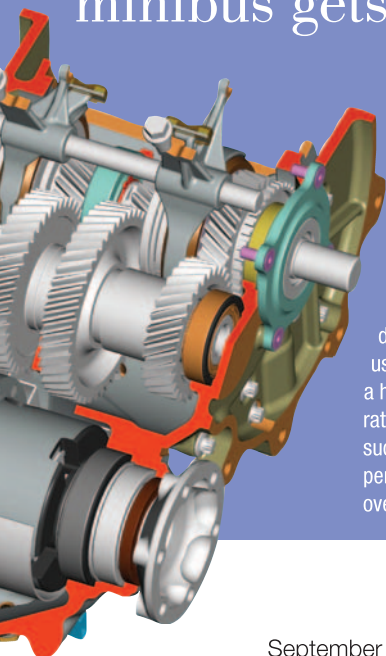
Bringing together Jaguar Land Rover, Johnson Matthey, several universities and fuel cell specialist ITM Power, the programme takes a novel approach. Current generated by an exhaust-driven turbo generator is used to electrolyse water into oxygen and hydrogen; the hydrogen is then fed strategically into various points of the after-treatment system, especially the lean NO_x trap (LNT), to reduce or even eliminate the engine's need to produce a rich spike to purge and reset the LNT. Hydrogen injection can also speed catalyst light-off on a cold start, reducing the need for mixture enrichment.

The electrolyser stack gets its energy for free from the hot exhaust gases, the resultant hydrogen acting as a reductant in the after-treatment process. This, says Frederic Marchal of ITM Power, could be offered as an alternative to the urea-based SCR systems now common on new-generation trucks and certain diesel passenger cars sold in North America. Urea has disadvantages, including weight, cost and the fact that it has to be produced from natural gas, adds Marchal.

The electrolyser stack uses no precious metals, and is both low in cost and high in efficiency, taking under one second to reach full hydrogen output – essential in view of the intermittency of the current from the turbo generator. The stack is not subject to rapid degradation and uses an everyday electrolyte – tap water, filled up in exactly the same way as a screenwash bottle.

Though this is a pure research programme and the partners are not yet sure whether sufficient hydrogen can be generated, the potential for saving fuel by allowing the engine to run leaner is clear, as is the potential for specifying different, and perhaps less precious metal intensive, after-treatment systems.

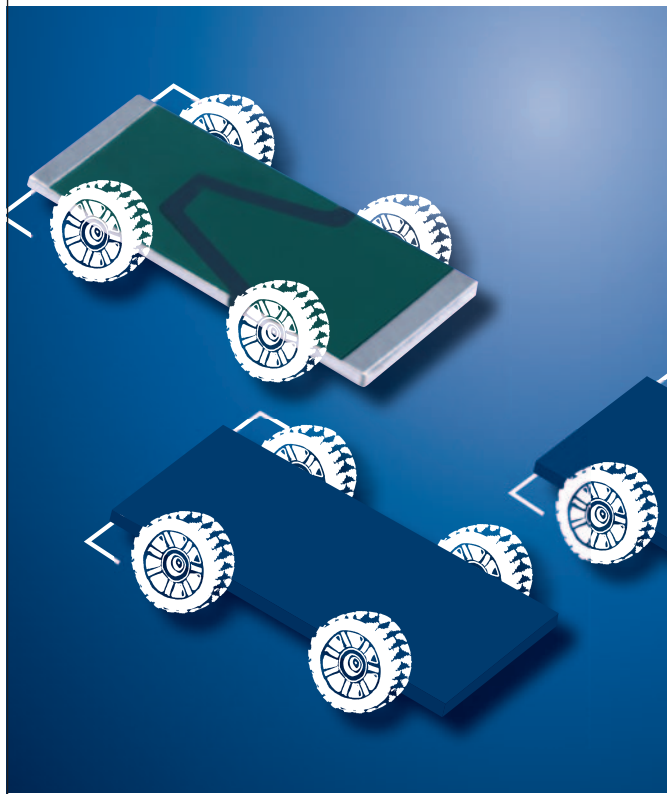
minibus gets R&D funding



of the advantages of the transmission, whose architecture mimics that of a conventional dual clutch system, even though the twin-motor layout means no clutches are required.

In particular, he says, the eDCT's twin motors are more versatile, lower in total cost and much easier to package than a conventional single motor drivetrain. And while the Furtive supercar uses the four-speed transmission to achieve a high top speed, the broader spread of ratios will give a light commercial vehicle, such as the minibus, benefits not just to performance, launch and gradeability, but to overall range, too.

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WALKING the TORQUE

A system that fills in the torque gap of a turbocharged diesel engine, allowing a smaller power unit to punch well above its size, without the dreaded 'lag' – that has to be a winner, surely. So, a decade later, why has it yet to come to market? Ian Adcock ponders the reasons

“Necessity,” the saying goes, “is the mother of invention”, but there are times when the invention, no matter how good or applicable, is ahead of its time.

Take, for instance, the electrically-driven supercharger that Visteon developed back in 2002. I remember driving a car equipped with the Visteon Torque Enhancement System and being impressed by the way that it filled in the torque gap of a turbocharged diesel engine, giving a larger capacity feel to a smaller power unit, with none of the dreaded lag until the turbo spooled up to operating speed.

It seemed only a matter of time before an OEM would scoop it up, but a decade down the road and it has still to make series production. However, it is closer to reality than it has ever been since the technology was bought from CPT, itself a spin-off from Visteon, in December last year by French tier one Valeo, following a

three-year partnership programme with the British company.

Guillaume Devauchelle, Valeo's group research and design director, is reluctant to put any firm date on the technology's industrialisation or introduction by an OEM, beyond saying that: “Currently, it's in advanced engineering,” adding: “It's a nice piece of technology, but we need to integrate it into a more complex system. It's not a standalone component, but intimate with the powertrain, so there are various features required to offset turbo lag.

Best trade-off

“We're working very closely with OEMs and engine developers, in order to find the best trade-off between add-on cost and performance, and how we can match it with other Valeo products, in order to have a bundle of a system, as it's not a separate product, but part of our air intake technology and systems.”

However, it wouldn't be difficult to imagine that its introduction is

“We're working very closely with OEMs and engine developers, in order to find the best trade-off between add-on cost and performance, and how we can match it with other Valeo products”

likely to coincide with future emissions legislation. “Powertrain growth is driven by regulations like the (in)famous 95 g/Kms CO₂, and that is really an opportunity for Valeo to develop new components and equipment. So it's fuel economy, without compromising driving pleasure – the mix between pleasure and efficiency,” Devauchelle states.

Reducing CO₂ is a natural growth area for the French tier one, he explains, that embraces a wider range of technologies beyond just powertrain systems, “We're not defocusing, but following our road maps. Just take, by way of example, the fact that 10 years ago we were experts in ultrasonic sensors, which is a bit narrow, so we decided to offer more functions.

“We put on the market more complex sensors, plus cameras, in order to have more sophisticated functions, such as semi automatic parking, plus viewing cameras to check what's happening.

“So this is exactly the same road map, as we move towards fully automated, low speed manoeuvres and city driving – starting with parking, then low-speed manoeuvres etc, so everything that contributes to this target map will be included in the Valeo technology portfolio.

“It seems that we're apparently adding more technology, but we're actually focusing on very few roadmaps, one being CO₂ reduction, one being the semi-autonomous car and one being new human machine interface (HMI).”



Guillaume Devauchelle

CV

Guillaume Devauchelle is R&D director of the Valeo Group, and acting Group R&D and product marketing senior vice president since January 2012.

Prior to this, he was deputy general manager of Valeo Electronic & Connective Systems.

He joined the Valeo Group in 2000 after the acquisition of Sylea where he was research and development vice president.

Devauchelle has a master's degree from Ecole Centrale de Paris (1981) and is vice president of the Pôle de Compétitivité MOVEO, vice-president of the Société des Ingénieurs de l'Automobile and member of the board of the University of Versailles – Saint Quentin en Yvelines.



Valeo is also developing low-cost hybrid technologies

Valeo, he points out, works on a technology development plan with 10-year horizons, “Every year, we check if we’re on line or off, so we modify it for each of the four business groups. We ask, ‘What is going to be the future? And what are the trends and mega trends; what will be the social values etc?’

Then, what will be the impact of those values in the automotive sector, and what will be the influence of those values on the Valeo road maps and how can Valeo contribute to megapolicy trends?’ For sure, more and more city conditions, with severe congestion and more regulations etc. Autonomous driving is viewed by Valeo as a clear target, so what shall we do to be a player on that field?” Although not usually associated with turbocharging and forced induction, Devauchelle maintains it is a natural fit for Valeo.

“Turbocharging is really part of our air intake road map, and we really believe anyway that the air intake will grow more and more, because it’s a key factor for engine efficiency. So we have the charge cooler etc and EGR valves; we need to compete with a multi-function air module, including turbocharging.” So how did the CPT deal come about?

“We did some benchmarking and technology scouting; we’re as open

as possible and we pay for that. We research what technologies are relevant and are they accessible to Valeo. Sometimes we need to bet on technologies, as it’s not always a matter of judgement. We try to sort them out and we have a very structured plan: P3, P2, P1 and P zero. P3 is technology scouting; just looking at P2, we decided to invest in advance engineering and, if that’s successful, we move on to P1.

Clear deliverables

“CPT was part of the white panel technologies that were available. Some others weren’t accessible to Valeo, due to the market, or some very strong players were already there, or it wasn’t so relevant or efficient. “In powertrain, it’s easy to judge, as it’s a matter of Euros per gram of CO₂ you can save. If it’s below, we think it’s interesting; above and we more or less forget it. Then we set up a project team with clear deliverables to see if we decide to invest – yes or no.”

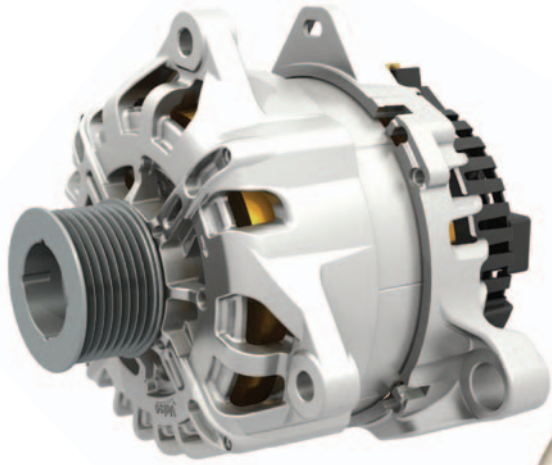
Devauchelle is adamant that the system’s on-costs are “far below” a diesel, for instance, and can be competitive with hybridisation. “When you see the product, it’s really simple: you have a turbine and then a reluctance motor – no rare earth elements or copper. Okay,

electronics, but that is knowledge we have and mechatronics is one of our competencies, so our assumption is the price will be very low and competitive to other solutions, else we wouldn’t be interested.”

One of the benefits of the CPT technology, he says, is that it’s an “easy” add-on, in that it doesn’t require major investment in new engine or vehicle architectures, as it would be relatively easy to install the system on an existing platform, as well as all-new architecture.

While the electrical supercharger might well be dominating Valeo’s headlines, that would certainly be at the expense of ignoring other technologies currently under development. Pre-eminent amongst these is autonomous driving, says Devauchelle. “We consider driver autonomy and HMI as overlapping, as well as delivering CO₂ reductions. For instance, when city driving, a camera will spot a red traffic light far quicker than a human, so the engine



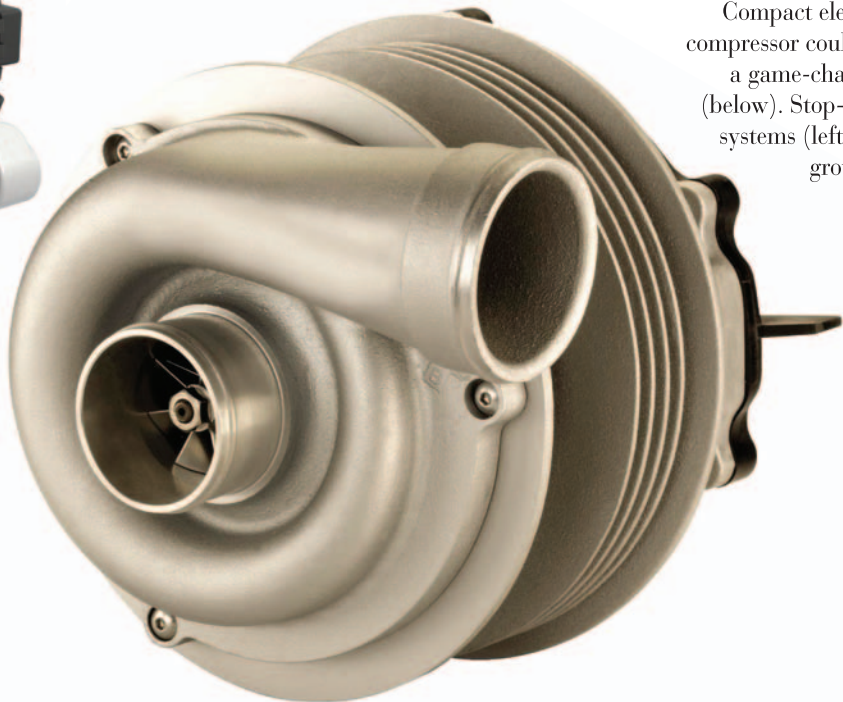


Compact electric compressor could be a game-changer (below). Stop-start systems (left) are growing

could be automatically switched off and energy recovered that little bit faster. Just doing that can improve fuel consumption by 5%. We have demonstrated that with GPS. You know the route and the terrain, so you can decrease the battery level and use that electrical energy to power the car, because the system knows it will be able to recover it later. We can prove that adding mapping to the energy management profile will reduce emissions by 5%.

"The challenges are different from one group to another. Asia is strong, and it's our role to be present there and assist them. Meanwhile, the European market isn't so strong, but

Human Machine Interface: seen by Valeo as part of the emissions/consumption challenge



we anticipated that and shifted to growing markets, including Brazil.

"Valeo offers affordable solutions, with nice features. We try to be more efficient in research and design, so the OEMs don't pay so much for it, because it's shared. And we offer value for money, always asking ourselves: 'Is what we propose meeting or suitable to their needs?'"

Supercharged thinking

The Renault demonstrator, with its four-cylinder 1.2pfi engine, would have struggled with four adults onboard, but an additional 250kgs in the boot and a 25% increase in gear ratios would have crippled the car's performance, without the addition of the electric supercharger.

In this application, the supercharger is upstream of the compressor, but Valeo is also working on downstream systems. So as to prevent the electric supercharger draining the battery, Valeo has installed regenerative braking, linked to a generator and capacitor in the boot. It is this that drives the supercharger. Using a separate 48-volt harness, the regenerative braking system can

develop in excess of 7kW – more than enough to power the supercharger.

At an engine idle speed of 800rpm, the supercharger is spinning at 4,000rpm. But, as soon as you start to accelerate, it instantaneously spools up to its operating speed of 70,000rpm, immediately compensating the turbo lag until the turbo comes on full boost above 1,800rpm when the electric supercharger becomes redundant. Originally, Visteon claimed a spool uptime of 0.3 milliseconds to more than 50,000rpm, but Valeo declined to put a time on its latest version.

Certainly, from my short demonstration drive, it seemed and felt instantaneous, the bottom end lag absent; and that, combined with the ability to short shift up to higher gears – or hold on to a gear when going up a slope, rather than changing down – made for more relaxing driving and, one would expect, more economical motoring.

While this system might aid downsizing, it would be equally effective when combined with large turbochargers or provide additional boost in performance cars.

Diesel Engine Technology

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Built upon a goal of being a thought leader and not just an information trader, SAE International's approach to the different sectors it serves – aerospace, automotive and commercial vehicle – is set in motion by the market drivers affecting each, especially those that cut across all three.

Determining those market drivers is an extensive and ongoing process. General drivers are broken down into more specific ones, related to each industry. The major areas used to categorise these are economic, environmental, legal, political, social and technological.

SAE International staff members such as Andrew Smart, who serves as director of industry relations and business development, then take these market drivers and use them to help determine what the organisation currently is offering, in terms of programmes, products and services, as well as what should be offered to best meet member and customer needs.

Such extensive research begins to paint a clearer picture of what factors are influencing each industry specifically, as well as what major market drivers cut across all three.

Some of the common drivers for each industry include workforce development; environmental and sustainability concerns;

connectivity; and intellectual property management.

SAE International considers these and all market drivers in the development of its programmes, products and services. Each has a unique and lasting effect on how business is done and how organisations need to respond.

As an example, workforce development is something that affects all sizes of organisation and engineers at all levels. This covers areas of career development, lack of qualified personnel, and retaining and attracting talent. Today, people are weighing many factors to see if they want to stay in the industry and make it a career, and how to meet their career goals. SAE International can help them with a wide variety of career-related and continuing education programmes and services.

Such knowledge is the foundation not only for personal development, but also for the continuation and growth of mobility engineering as a whole. Knowledge-based engineering is developing quickly and SAE International has a vast repository of technical knowledge – and continues to build upon it. Such assets help to increase efficiency and stimulate innovation. The rate of change of technology is very high, and engineering professionals need to have the tools and knowledge to change with it.

“The rate of change of technology is very high, and engineering professionals need to have the tools and knowledge to change with it.”

Socially, the world is changing. Sustainability and environmental impacts are far greater issues now because of increasing population density in certain areas. In addition, how consumers – especially the younger generations – view vehicles is changing. Consumers expect more from their transportation choices and SAE International stands ready to provide the knowledge know-how, regardless of whether a vehicle traverses land or flies through the sky.

Understanding the needs – and the drivers that affect those needs – of the aerospace, automotive and commercial vehicle industries is a crucial part of SAE International's mission.

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The original Range Rover revolutionised the automotive industry when it was launched. Some 42 years later, the latest version looks very much set to do the same, as Ian Adcock reports

With its new Range Rover, Land Rover has dramatically leapfrogged its rivals by delivering a vehicle that establishes new boundaries. Not only is it the world's first all-aluminium SUV, but its bodyshell is 40% lighter than the outgoing model, saving some 420Kgs.

To put that into perspective, says chief technical specialist body structures, Mark White, that's the equivalent of five fully-grown adults or, in automotive terms: "The new Range Rover bodyshell is 23Kgs lighter than a BMW 3-series' bodyshell, or 85Kgs less than Audi's Q5, and well over 150Kgs lighter

than its steel competitors." And he adds: "For every 100Kgs we save in weight, that gives a direct 2% improvement in fuel consumption; our plan was to get over 400Kgs weight out of the new Range Rover, delivering a real-world 8% saving in fuel economy."

Start of a new journey

However, the car is about more than just reducing emissions and improving driving economy. It is the start of a new journey for Jaguar Land Rover, says White. "Our goal is to make aluminium so affordable that it's a no brainer to make everything out of lightweight materials. Our goal is to make a lightweight car for the


same cost as a steel car; to minimise the cost to JLR and maximise the benefits for the customer, in terms of fuel efficiency and CO₂, combined with using 75% recycled aluminium by 2020."

When Jaguar launched its all-aluminium XJ a decade ago, it marked a step change, but the latest Range Rover is even more significant, as it scores a number of notable firsts within the automotive industry, as well as ingenious, patented, engineering solutions.

The most significant development is the one piece body side pressing. "The largest single aluminium stamping in the automotive industry," boasts White,



Cover story



using 0.9 to 1.05mm gauge for the skin panels, depending on the application, AC600 alloy. Similar to that used on the Airbus 320, it is its first automotive application.

In great shape

“Generally, we use 6000 series on our skin panels, as it’s a bake-hardened alloy. If you heat it up, it gets stronger; so, when it’s put through the paint shop at 180°C, it takes a naturally harder set than a 5000 series alloy would.

“Because it’s more ductile before bake hardening, it makes it easier to form, and that’s why we use bake-hardened alloys to get great shapes and design features. We don’t need warm form tooling for deep draw parts, but we are looking at that

technology and you may hear about that in the future. We are focused on lightest weight, at lowest incremental cost. That’s our mantra in body engineering.

“We developed AC600, because we wanted to make these really nice sharp radii; we’re getting much tighter 2.5mm radii on some of these opening. And you will see on a future product that’s not too far away that we’ve gone even further.

“So we will develop alloys that give us a weight-saving or formability advantage, so we can make more complex panels, have fewer joints and therefore save further weight. By making stronger alloys, we can down gauge and, by making more formable alloys, we can get better parts integration and



Underbody rails house sub-woofer for the entertainment system: a patented industry first

Suspension systems are all aluminium, but components such as driveshafts remain steel for optimal weight, strength combination (right)
 Opposite page: AC300T61 body rails in red (top), roof bows shown in purple (second right)

Mark White:

“So we will develop alloys that give us a weight-saving or formability advantage, so we can make more complex panels, have fewer joints and therefore save weight.”



therefore lower cost and weight. On the XJ, for example, the body side panel would have been two parts.”

Although the one piece body side is significant, White claims the “biggest” development on the Range Rover is the use of high-strength AC300T61 in the underbody structure to improve their strength by over 20%. “We now have an alloy for a front side member, for example, that might have been 2.8 mm thick in the previous alloy, we can now make in 2.5mm. This is the main crash rail that goes up to the dash, under the floor and then over the seat pan to the rear of the car.” It is also used in under-floor cross bracing, saving a total of more than 7Kgs.

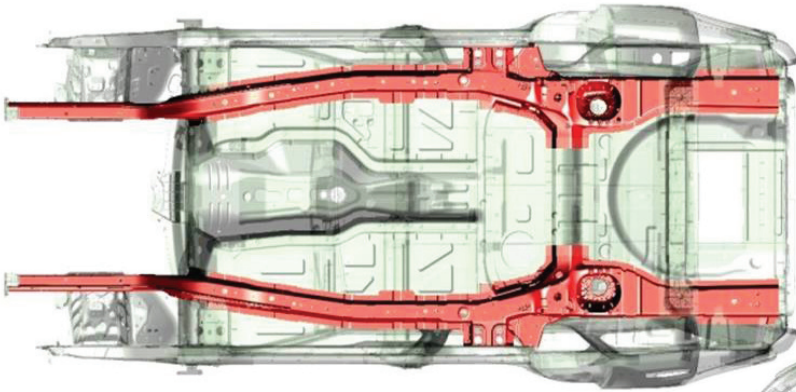
Multi-functional

White is very keen on components having more than one function, as this also drives down weight, so when Neil Harwin, an engineer in the body team, suggested locating the entertainment system’s sub-woofer in one of the longitudinals, White was only too happy to take the idea on board, “We’ve taken the box section of the rail, which is very deep on a Range Rover, because it’s an off-roader, with quite a large volume, and, instead of having a separate woofer, we’ve mounted the speaker in that open cavity, turning that long box section into the sub woofer.”

Also being used for the first time are rolled section alloy roof bows that



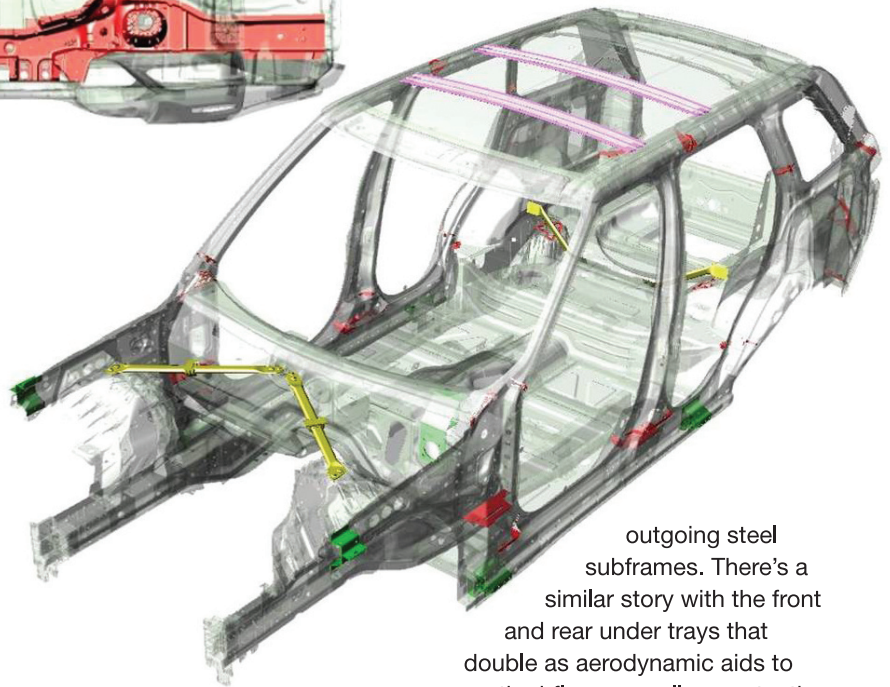
Cover story



virtually eliminate any waste during their manufacturing.

In the past, says White, the concentration has been mainly on saving body weight, but “now we’re into saving weight on the whole vehicle, so the obvious thing to do was look at the subframes, corner geometry, knuckles, wishbones and see how much weight we can save on them. With the added advantage that the more unsprung mass or weight you save, the better it is from a dynamics point of view”.

The subframes are a combination of A6082 extrusions and castings that save over 10Kgs versus the



outgoing steel subframes. There’s a similar story with the front and rear under trays that double as aerodynamic aids to smooth airflow, as well as protecting the underside during severe off-roading. Previously made from steel, White’s team bake-hardened the alloy up to its maximum temper, resulting in steel-like toughness, but with a 50% weight saving.

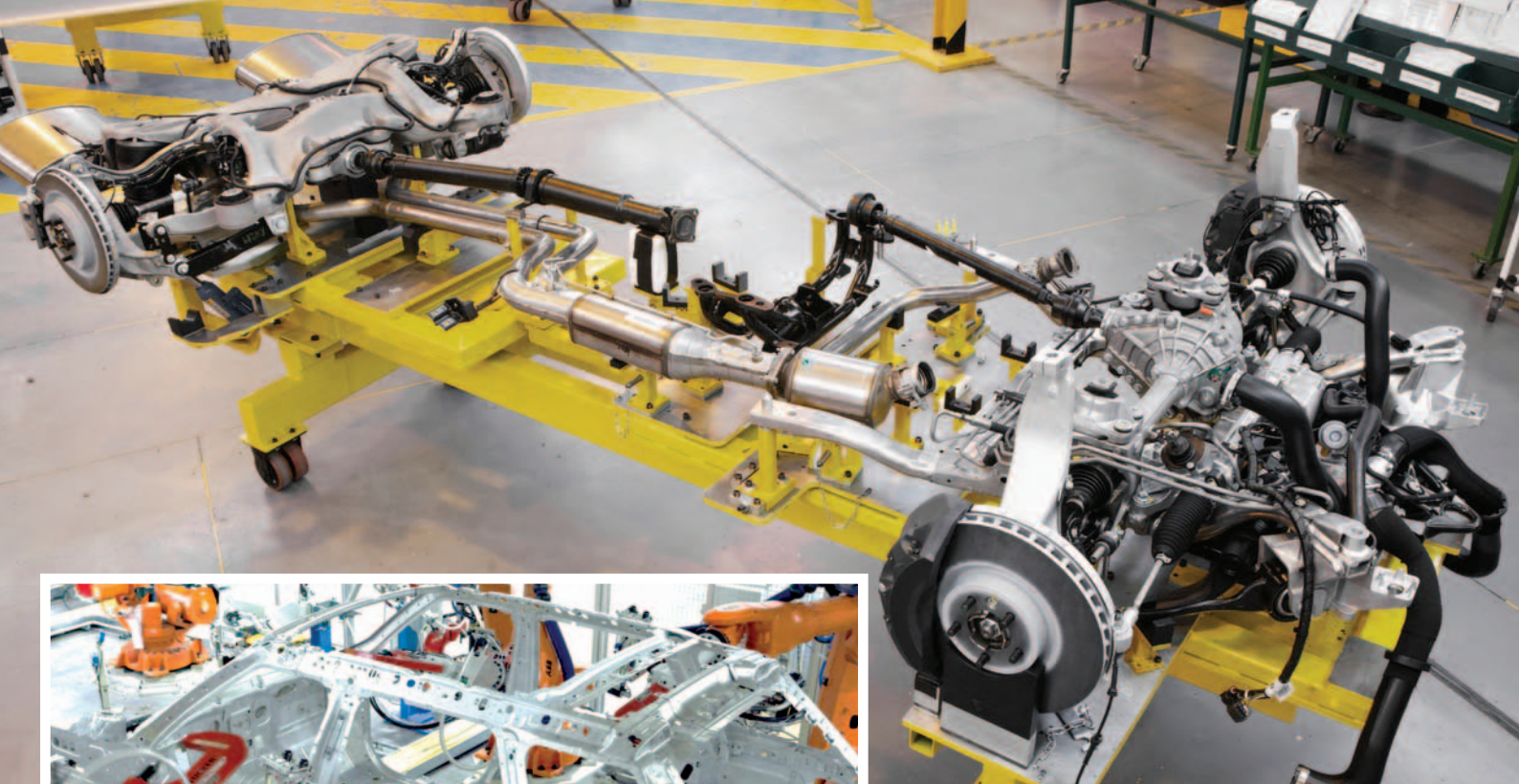
Steel is still the material of choice for some applications, though, with driveshafts still manufactured from high strength steel, as are small diameter struts or tubes.

Weighty matters

Nevertheless, there is significant weight-saving to be gained in castings like the suspension shock towers, riveted to the four corners of the car that vary in wall thickness from 8mm to 2.8mm at the thinnest, with 2.5mm a future target. “That will be achieved through new processes and materials, although there is a finite limit as to how quickly you can get molten metal into a die to fill a



Cast and extruded subframes save 10Kgs over steel ones



All-aluminium Range Rover sets the pace in its class: front and rear subframes (above and below) are part of the weight-saving programme. Automated robots (left) rivet and bond the body structure

cavity and still get good mechanical properties, “explains White.

“2.8mm is competitive and amongst the leaders in the business. They are very ductile and have 15-16% elongation, so you can rivet them into the structure, just as you would a sheet part. But the advantage of the casting is that, if you look at the top, its 8mm thick to get the strength where we need it and then quickly bring it out to the thin wall sections where it’s joined to the surrounding sheet metal.”

Even the wheels have come in for some serious dieting, he reveals. “Chassis engineering looked at the loads and worked with design to come up with wheels that are optimised for strength, as well as design, put them on a diet and that’s saved about 2-2.5Kgs a wheel; about a 10% saving over the old wheels and it’s less unsprung mass as well, whilst replacing the steel space saver with an aluminium one saved a further 8Kgs.” Over 60Kgs were saved throughout the chassis systems through the use of lightweight

materials and design optimisation

There’s been a step change, too, in the vehicle’s body assembly, with 17 types of rivet used, depending on the application and material stack up. The latest Tucker rivet guns now blow-feed the rivets, rather than use taped cassettes as in the past, which speeds up delivery to 1.5 seconds or even less, while their ability to handle more than one rivet improves cycle times by some 20 seconds, as the rivet guns don’t need changing.

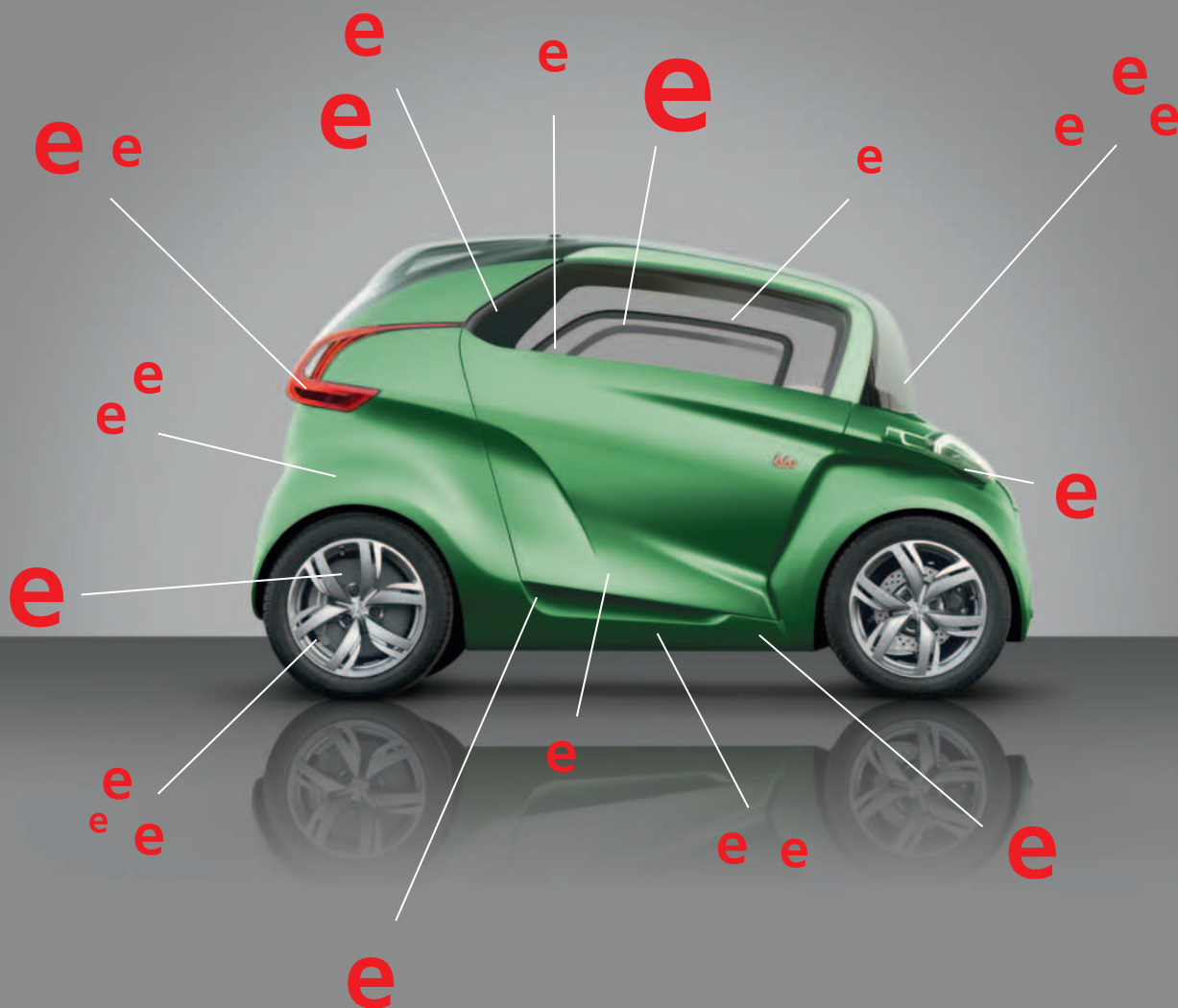
Major investment

Another major manufacturing improvement in the all – new Solihull body shop - part of a £370m (€462m) investment at Solihull – is the total automatic adhesive application, resulting in quicker and more consistent application.

Way back in 1948, Land Rover started building the original Defender in aluminium, recycled from war-time aeroplanes at Solihull. Now, 64 years later, its descendent, in the form of the latest Range Rover, maintains that heritage.



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Can computers take

In the name of improved safety, some favour a future where automation takes charge of a fast-moving vehicle. The more cautious support advanced systems that simply warn drivers of potential problems. Who will win out? Chris Edwards reports

The automotive industry is faced with a big decision over its strategy for vehicle safety. Governments are keen to push the number of road casualties down and more widespread use of computer technology in vehicles looks, at first sight, to be the answer. Computers in the car can act as a second driver – for example, hitting the brakes when the human is too slow to react.

Industry groups have joined in the call. In the spring, the UK's Institution of Mechanical Engineers (IMechE) called for greater levels of

automation to be brought into vehicles, potentially giving vehicles much greater autonomy. But the carmakers are not so sure.

In his keynote speech at the Safety Club Symposium earlier this year, senior Jaguar Land Rover engineer Roger Rivett showed a demonstration video from 2010 of an automated braking system to illustrate how the automotive industry needs to think how far it should go in taking over from the driver, in the name of reducing casualties.

Rivett asked: "The question is: does technology make the world

a safer place? Technology works best when we use it to extend our capabilities. It works less well when it constrains them."

In the video, the curse of demonstrations took hold: the car failed to spot a box truck in its way and simply drove into it. Similar demonstrations later that year to show how the vehicles could spot and avoid pedestrians resulted in several dummies being run over.

David Price, CTO of Pi Inno, says: "It's a big step to do things without the driver. It is something that everyone has been very nervous of."



control safely?

As manufacturers and tier ones work to integrate safety-related systems, they are likely to take the lower-risk route of informing the driver, rather than taking control of a fast-moving vehicle.

The IMechE's calls for mandatory installation only go as far as more advanced warning systems, such as those developed under the EU-funded Lateral Safe programme. This was developed to warn drivers of potential problems, such as vehicles in adjacent lanes that might be hidden in blind spots. This caution mirrors that of the automotive industry itself. The autonomous

control and the warning systems have many common elements – the key difference is in whether additional compute power is used to make life-critical decisions. The sensor inputs remain broadly the same. They use radar, infrared or visible-light cameras, or all three, to provide a computer with information on the road conditions around the vehicle. "Road-sign recognition is coming in that will provide speed warnings to the driver. The radar, optical and infrared systems will provide vision enhancements and information for head-up displays, all providing the driver with more information on what's out there," says Price. "You will get multiple systems on vehicles, because some fare better in different weather conditions."

In-sync signalling

The main physical actions taken by vehicles will remain similar to those used in existing high-end vehicles, where seatbelts are pre-tensioned ahead of an anticipated accident or where greater brake pressure is applied than normal.

Some future warning systems will even rely on other vehicles. GM, for example, is developing a pedestrian detection system for urban environments whereby vehicles send signals to each other wirelessly when they spot pedestrians crossing the road. The result: in a relatively short space of time, a far greater level of compute power within even lower-cost vehicles to process all the data.

Davide Dappello, product engineering manager for digital automotive products at chipmaker STMicroelectronics, comments: "We



Vehicle Electronics – Part 1



Despite advances in electronics to avoid accidents, vehicles still need to be engineered for impacts (left)

Pedestrian recognition and emergency braking under test (below)

are seeing a degree of performance demand that is getting closer to the applications we are seeing in mobile communications. We have dedicated vision processors, as well as different types of microprocessors.”

A more subtle change is the level of integration across the vehicle. Information processed by cameras, sensors and wireless communications will be fed to a variety of electronic control units (ECUs) within the vehicle. The increased complexity of these emergent systems is giving vehicle manufacturers another reason to think about how far they can go.

A question of ownership

“Cars grew up largely within a mechanical engineering discipline,” states JLR’s Rivett. “It was relatively easy to grasp the systems in your head. But the systems we put in place cut across all those divisions. For speed control, you may have a radar unit passing information to the engine management system. And, if it needs braking beyond engine braking, it will pass information on to the ABS.

“The question is: who owns the joined-up system of all those parts? It is a more ambiguous question than who owns the EMU or ABS. At the moment, it’s conscientious people.”

The recent introduction of the ISO26262 standard for safe systems development is likely to slow the pace of development, says Pi Inno’s Price: “ISO26262 is making people think more about the process. The biggest thing is that the more systems interact, the more scope you



have for affecting the dynamics of the vehicle. ISO26262 will get into many more places than originally thought. It will get into the electronic parking brake, suspension and transmission controls, because they will all be hooked in. Anything on the networks – because they have the potential to command other things – will have to be engineered to a higher standard.”

A knock-on effect of the focus on ISO26252, caused by the integration of multiple systems, is the rise in use of fault-tolerant technologies to avoid mistakes from a single unit feeding forward into a catastrophic failure. Helmut Lang, responsible for automotive device test and reliability at Freescale Semiconductor, says the company has developed automotive processors with multiple processor cores to detect and fix faults.

“We have two computer cores, running in lock-step,” he explains. “A management unit checks that both cores provide the same results. If not, the unit decides what to do. The

second compute shell consumes power, but does not add any functionality, so you can see the big impact of functional safety on design.”

The information generated by driver-assistance systems can bring its own hazards. In the early trials for the UK government-funded Foot-Lite system, designed to gauge the effectiveness of real-time information for improving both fuel economy and safety, drivers reported increased stress from the quantity of pop-up messages the display produced.

“You are into similar problems as with people using mobile phones – their capacity to process information is being used elsewhere,” says Price.

A second problem of assistance features is when they fail silently. “With a blind-spot warning, if an icon isn’t flashing, it might mean nothing is there. It might mean the system has failed. It says in the handbook you are responsible under any conditions. But will people know this?” Rivett asks. “It’s not clear yet what the answers are.”

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SAE International

Is there a doctor in the car?

How are you feeling? A bit peaky? Tightness in the chest? Sit back in your car and let's carry out some tests. Andrew English explains all

Welcome to 'Doctor Car', a direction that in-car electronics is taking where cars will be capable of monitoring drivers' vital signs: pulse, blood pressure, stress, perspiration, even blood sugar levels.

Unsurprisingly, the medical-mad US is driving a lot of this research, but, even in Europe, real-time health monitoring is on test. Given Europe's ageing population, perhaps the research is well placed. EU figures posit a rise from the 2010 average age of 40.9 years to 47.6 years in 2060 and, in the same period, the proportion of 65-year-olds and above will increase from the current 17.4% to 29.5%. Ford reckons that drivers with cardiovascular disease are 23% more likely to be involved in a car accident. But what if the car could monitor the driver, perhaps even take control of the vehicle in an emergency, driving it to a safe place and calling the emergency services?

Last year saw the launch of two in-car medical monitoring interfaces, mounted in a seat and a steering wheel. Ford's European Research Centre in Aachen and Rheinisch-Westfälische Technische Hochschule



(RWTH) at Aachen University unveiled a car seat capable of taking the driver's pulse, while a research team at the Technische Universität München (TUM), in collaboration with engineers at BMW, showed a steering wheel that can detect not

just pulse, but also oxygen saturation and skin conductivity.

The Ford seat has sensors that detect the heart's electrical impulses and are capable of measuring 95% of drivers for 98% of the time. According to Dr Achim Lindner, Ford



The TUM/BMW technology

research centre medical officer, “as always in medicine, the earlier a condition is detected, the easier it is to treat, and this technology even has the potential to be instrumental in diagnosing conditions drivers were not aware they suffered.”

Hands-on monitoring

The TUM/BMW steering wheel has two monitoring systems: one measures infrared reflectance through fingers to establish heart rate and oxygen saturation; the second measures the skin’s electrical conductance to gauge stress and blood pressure. The data is radioed to a microcontroller, which is displayed on the vehicle’s information display. Again, it’s not without its issues and, like those heart-rate sensors on gym machines, a driver’s hands must be in constant contact with the wheel

sensors. Most of this monitoring equipment is available on the open market, with specialist firms supplying medical establishments and hospitals.

As Dr Raghunath Govindachari of Mindtree pointed out when he talked to Automotive Design (July/August 2011) about the company’s new EtherMind Bluetooth 4.0 dual mode technologies – that include a low-energy health thermometer and prototype heart-rate monitor – these are basically “a personal version of the well-known bedside patient-monitoring systems or those in ambulances”.

The main issue is getting such technology to ‘talk’ to the cars’ electronic architecture. “We used a USB connection to get the data into the infotainment system, while the application of the data interpretation we did at our end,” says Dr Ing

Lorenzo D’Angelo, a researcher on the BMW/TUM project.

Ford’s SYNC system allows drivers to voice-activate smart phone health applications and link the phone’s display to the car’s screen. Last year, medical and healthcare was the third-fastest growing category of smart-phone applications, with more than 17,000 available and, according to a Frost and Sullivan report, the market is expected to be worth €317 million by 2015, with over 500 million users.

Ford’s first commercially available health application has just gone live on the Apple Store with an air-pollution asthma alert app. “There are 26 million asthma sufferers in the US,” says Gary Strumolo, Ford’s global manager for interiors, infotainment, health and wellness. “Wouldn’t it be great for them to know what pollution levels will be

Driver Health Monitoring

and take the appropriate meds? All we are doing is allowing drivers to activate these devices verbally," he says. "We don't want them digging around in their coat pockets when



they have an alert." In the US, Ford, mindful of the strict guidelines on who (and what) can issue medical diagnosis and advice, is focused mainly on linking with and mirroring medical apps, although Strumolo does see a future where diabetics might be able to monitor their blood sugar levels constantly via sensors, with appropriate medical advice coming in from an outside agency via the SYNC system that has recently also become available on some European Ford products.

Vital signs uploaded

The company has a prototype system on test linking with interactive services provider Healthrageous, which captures biometric and vehicle data as the basis for real-time health monitoring and subsequent advice. So the driver's vital signs are uploaded to

the HealthVault Cloud, along with verbal details, such as current medication, exercise regimes and so on. All of which could provide a basis for a diagnostic tool for a doctor. As the medical industries look to artificial intelligence solutions to symptom recognition and diagnosis, such systems could become more and more popular.

At the far end of the spectrum are the systems that monitor real-time health, recognising medical emergencies and, in conjunction with autonomous driving systems, take control of the car and alert the emergency services.

While this might seem like the stuff of science fiction, such systems are already on test under the aegis of a pan-German project aimed at extending the mobility of those whose health might ban them from driving under current regulations.

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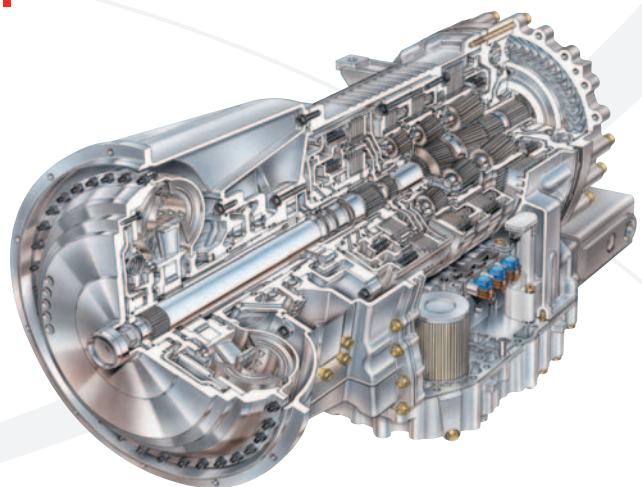
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Pushing piston progress

Ian Adcock talks with Arnd Baberg, Federal Mogul's chief engineer product engineering powertrain energy, about its latest piston technologies



The drive to improve engine efficiency and the constant quest for reduced emissions is impacting every aspect of the internal combustion engine, none more so than the piston.

There are currently on the market engines that produce 90kW/l, but Baberg predicts that, within three years, 115kW/l will have been achieved, and 120kW/l by 2017 and beyond. Combine that with increases in ignition pressures for petrol engines rising to 210-220bar within a similar timeframe, and the challenges facing him and his team to develop durable pistons become more understandable.

And with pre-development projects underway, using compressed natural gas (CNG) as the fuel source, he thinks pressures up to 160 bar could be the norm, even broaching 180-185 for engines using E100 fuels.

"However, the limiting factor is more the fuel than anything else at the moment," he says. "Ignition pressure can be influenced by the compression ratio and the higher that is, the higher the ignition pressure will be, and with it the higher the risk of knocking."

All these factors come together to influence not only the piston's design, but also what it is manufactured from. "Aluminium is quite interesting, because we can go up to 400°C, which is already challenging, in terms of durability.

"Its appeal is that the manufacturing costs of an aluminium piston are quite low, compared to other materials, such as steel, which has pretty low thermal conductivity.

"Maximum temperature is a challenge, but more important is the cooling gallery temperature. This gets

very hot with carbon deposits in the gallery, which stick on the gallery surface, dramatically reducing its efficiency. Then the bowl rim of a diesel piston gets hotter, which starts to erode and oxidise, and finally it ends up with a cracked steel piston."

Making advances

There's been talk of alternatives, such as titanium or steels with high nickel content or graphite, but the former doesn't have the high temperature tolerance of aluminium, and there are cost and noise issues with graphite, he points out, adding: "We benchmark different materials and analyse them, but as yet haven't found an alternative to aluminium."

Despite this, advances are being made, as Baberg explains.

"On the gasoline side, we try to improve the cooling, which then affects

the combustion. If you can cool a gasoline piston better than it is done today, and here I am talking about combustion bowls on the crown side, and replace the gallery round the bowl, you can reduce the temperature and lessen the risk of knocking. The calibration should come to the initial level of knocking, which means the temperature benefit of 30°-50°C is sent back into the calibration. With a lower piston temperature, you get higher compression ratio, higher

ignition pressure and more efficient combustion. We try to improve alloys for higher temperatures, but you come to a physical limit at about 480°-500°C. The challenge is: how close can you get to the limit?

"The key is efficient cooling. That's already pretty good in diesel applications and we are more focused on how we can incrementally improve the alloys or the piston's reinforcement. We think we can go in the direction of 440°C.

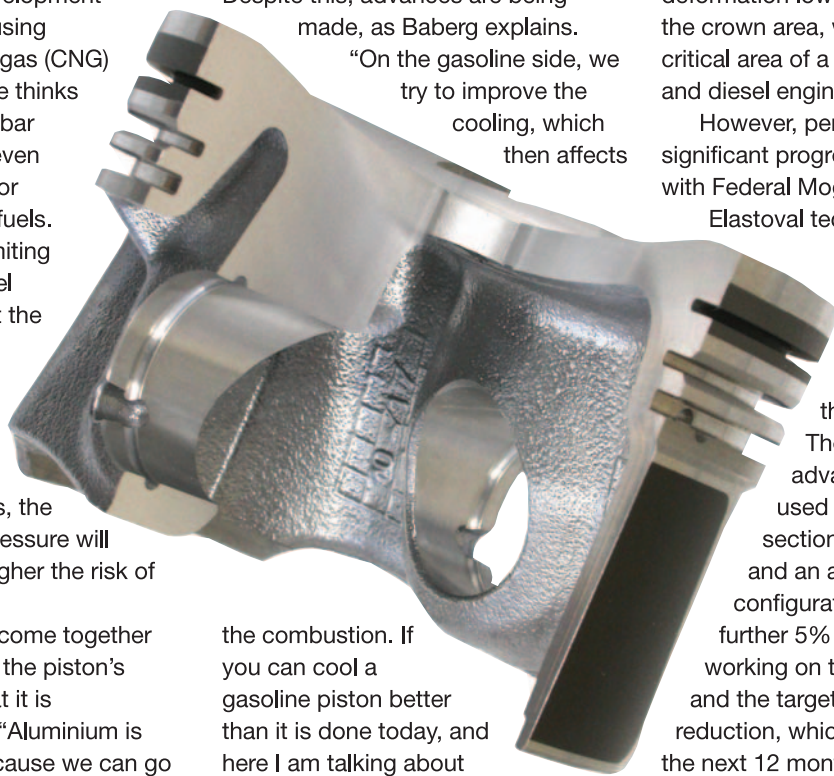
"High compression ratios for gasoline mean high ignition pressure, meaning high structural strength, which we can provide with our advanced Elastoval design. The main target is to keep the crown deformation low; lower stresses on the crown area, which is the most critical area of a piston for both petrol and diesel engines."

However, perhaps the most significant progress is being made with Federal Mogul's proprietary Elastoval technology, adds

Baberg; "Elastoval 1 has a very solid structure and we achieved a 15% weight reduction in the second version.

The next step to advanced Elastoval 2 used even smaller cross sections, deeper pockets and an asymmetric configuration to achieve a further 5% saving. We're now working on the next generation and the target is another 5-8% reduction, which we'll achieve within the next 12 months.

"The idea is to reduce the amount of material used, but there's always the conflict for friction and scuffing later on. If you make the piston too rigid, you come into dangerous areas of friction. But, by using CAE tools and material improvements and process improvement, we think that's the way forward for weight reduction by 2015."



Eradicating points of friction

“We first started research into nano lubricants in 2006-07, but it wasn't for another 12 months or so that we had our first lubricants developed. It just so happened that they were motorsport gearbox oils, but we quickly got feedback that the transmissions were lasting two or three times longer between rebuilds, so it was a natural progression for us to move into engine lubricants, initially for motor sport, but we're hoping to break through into production vehicles as well.

“If you look where frictional losses occur in engines, there's a huge slice of power loss in the piston rings and bore – up to 40-50% of the losses in the cylinders; to a lesser extent in the valve train; and then, to a smaller degree, the big end and main bearings.

“The engine oils, which we commercialised at the beginning of this year, use nano particles and other materials as well. Basically, we've taken the coefficient of friction of engine oil that's measured by sliding friction techniques, steel-on-steel at various load stages, using frequencies and amplitudes, and lowered that coefficient by roughly half.

“The feedback we're getting from real-world dynamometer tests when the oil is changed from one grade to the same viscosity with the nano technology is a power gain upwards of 11-22kW, depending on the engine.

“We've got a product range to cater for all requirements and it goes down as low as a 0-20, which is becoming more common when chasing fuel economy and low CO₂.


“Stop-start does concern me. In terms of oil durability, the particles for this range of oils act like very small ball bearings, 40-60 nanometres in diameter, and that is there to assist the conventional chemistry like the zinc compound that creates a chemical barrier, rather than just relying on the oil to provide a cushion between the components. So, if anything, nano lubricants will be slightly more durable. And they're equally applicable to diesel, as well as petrol.

“We've just completed some tests at Millbrook Proving Ground specifically for CO₂ reduction and the extra power we've seen on the rolling road is an indicator of improved efficiency; a 4% gain or slightly more is typical.”

“Compared to a conventional oil costing £50 (€63) for five litres, Millers would be roughly £70 (€89), but that's not a huge extra cost over 12-15,000 miles (19-24,000Kms) – especially when the improved fuel efficiency is factored into the equation.”



“If you look where frictional losses occur in engines, there's a huge slice of power loss in the piston rings and bore.”

The background of the entire page is a grayscale photograph of an internal combustion engine. A prominent yellow rectangular box is overlaid on the upper left portion of the engine, containing the event title and an icon. The text 'SAE 2012' is positioned above this box in a large, white, sans-serif font.

SAE 2012

A circular icon containing a stylized engine or motor symbol, located to the left of the words 'ON-BOARD' in the yellow box.

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Do not miss out on the premier OBD event of 2012!

Mike McCarthy from the California Air Resources Board (CARB) and other legislators and experts in the field of On-Board Diagnostics will present at the event to enlighten attendees on the latest U.S. and European Commission regulations and regulation changes and how these will impact OEMs, suppliers and other industry professionals.

The engineering challenges of meeting OBD requirements are complex, but this meeting provides an opportunity to meet with other engineers and those responsible for legislation so that clarifications can be obtained, status determined and the overall attitudes to the engineering process can be appreciated. Attending can therefore provide an effective investment in getting successful and reliable compliance systems in place.

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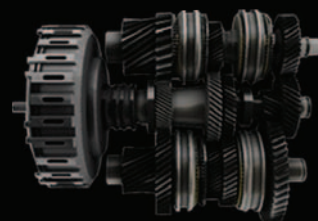
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