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March 2015

INTERVIEW:
GKN'S
TECHNOLOGY
LEADER

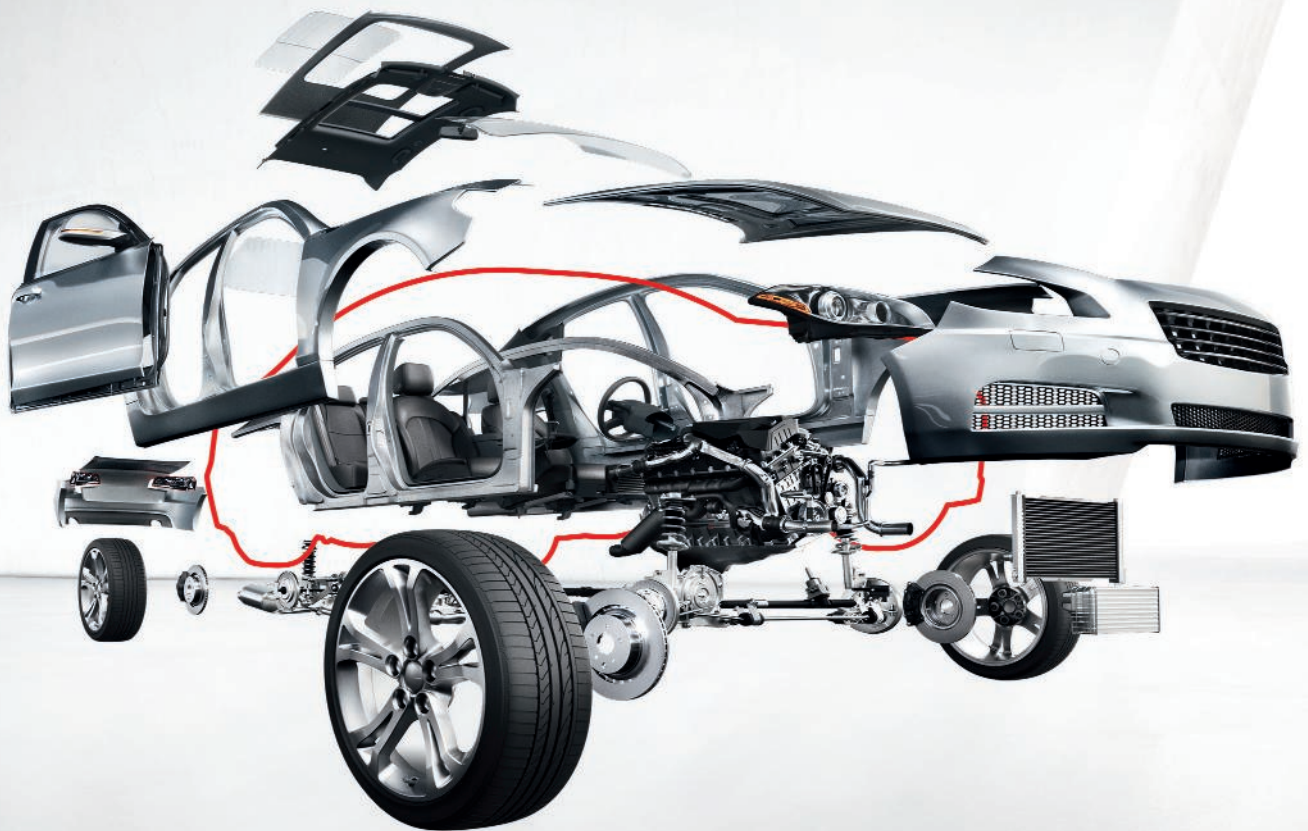
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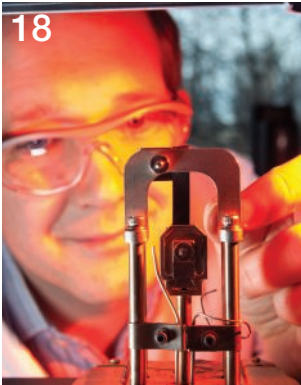
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Safe and Reliable ICs for EPS Systems



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GOOD...BETTERBEST



Sat in the back of a rather battered Peugeot taxi that was going nowhere in a downtown Geneva traffic jam on the first evening of this year's show, I got to musing on how many Salons I had attended. I stopped counted when I reached 30...

But looking back on those 30+ shows made me realise that this year's was one of the best: any show that includes debuts of a concept Bentley two-seater coupé, a limited edition Aston Martin, a Ford GT to celebrate the Blue Oval's famous Le Mans victories and a twin-turbocharged V8 from Ferrari will get any petrol head's pulse racing.

Yet there was more to it than a parade of rarefied performance cars: Kia upped its ante with a new three-cylinder direct injection engine and a seven-speed Dual Clutch Transmission; Hyundai had its new Tucson; Mazda showed its CX3. And whilst the Nissan Sway concept previewed the next Micra, Skoda was showing its new Superb – and GM a small city car for the Vauxhall and Opel brands.

In short, there was something for every taste – some very questionable, it has to be said – and pocket. And underlining it all was a confidence and optimism that remained undimmed. New technologies abounded and even the prospect of 2020's new emission regulations were being seen as a technology challenge that the industry will conquer.

A few weeks before the show, I was in Arjeplog, northern Sweden, to interview GKN's Rob Rickell about his new role to co-ordinate the engineering company's technology divisions to make them even more effective (page 14)

Whilst prior to that, I visited Manchester University's graphene centre to learn more about this fascinating material (page 18) and potential applications in the automotive sector. Come the 2045 Geneva Salon and I suspect it will be there in some form or another – unlike me.

Ian Adcock, Editor in Chief

Engine technology fever hits Geneva Salon

Engine technology spanning the whole gamut of outputs and design options was a dominant theme at this year's Geneva Salon, with new concepts seen from manufacturers as diverse as Kia, Ferrari, Volvo and Bentley.

Ferrari downsized its new dry-sump V8 not only for emissions, but also to increase engine power by turbocharging, explained Michael Leiters, chief technical officer. The headline figures for the 3902cc engine are 493kW at 8000rpm and 760 Nm peak torque in seventh gear. "It's very important with a downsized turbo engine that the performance and response is the same as a naturally aspirated engine with no turbo lag," he stated.

To achieve that, Maranello's engineers fine tuned the sizing and tuning of the turbos, including light weight aluminium titanium twin scroll turbines for minimum inertia, using ball bearing mounted shafts specially designed by IHI for this installation.

Leiters went on to explain that the equal length inlet manifolds not only helped with turbine response, but, together with the flatplane crankshaft, retained Ferrari's distinctive engine note. "We're very proud to have created a typical sound you'd expect from a Ferrari."

Compression ratio of 9.5:1 is combined with a maximum boost of 1.8 bar, but he explained that each ratio has a unique engine map to simulate the acceleration of a normally aspirated car, whilst achieving maximum torque in seventh gear. "We did this for the California, but we're the only manufacturer who does it this way really to get this instant response." Meanwhile, the multi-nozzle fuel injection runs at 200bar, delivering up to four injections per combustion cycle.

Large bore exhausts with bypass valves



advantage of this is not only about reducing CO₂ on the normal test, but in daily use." The big gains, said Frech, are under part throttle cruising conditions. "If you make it into a real 6-cylinder, you don't have any problems with balance; there was something of an issue with exhaust boom, but we have countered that with some modifications to the exhaust."

By doing it in this manner, the inlet and exhaust sensors determine when to switch between each bank, ensuring the cylinders remain hot. It also fulfils all the American OBD restrictions.

The engine also receives a power and torque increase, from 423 kW and 700 Nm to 434 kW and 720 Nm, accompanied by improvements to fuel economy of up to 5% and lower CO₂ emissions of 329 g/km, with combined fuel economy of 14.1 l/100 km.

Looking to future applications, Frech revealed that there would be "other opportunities" with the W12, including possible individual cylinder deactivation and electrical motor assistance for the forthcoming Bentayga SUV due later this year.

have been engineered to contribute towards maximising the exhaust note. Future developments, predicted Leiters, would include higher pressure injection systems; while mapping and the turbo packaging would allow Ferrari to reduce emissions even further – and there will be at some point electrification of ancillaries, including air-conditioning, oil and water pumps.

"I don't believe that in the next five to eight years there will be such dramatic demands that we can't continue to offer a naturally aspirated V12, although we will have to continue to work on emissions."

The third way

Nearly two years have passed since we exclusively revealed that Bentley was working on a cylinder deactivation technology for its complex W12 (*Automotive Design* May-June 2013) – the system is now here.

Bentley already has two methods of cylinder deactivation on its 6.75- and 4.0-litre engines, but, as Rolf Frech, member of the board for engineering, explained, the complexity of the W12's layout and firing order demanded a third solution. "It was clear that we couldn't use either of the solutions we currently employ, as that would have demanded a new cylinder head. So we asked how can we do that with an intelligent arrangement?"

The challenge is that, when the cylinders are switched off, they cool down, resulting in spikes of exhaust emissions. "The complication was to develop intelligent management just to switch the cylinders off and switch them back on with the right timing, and change to the other six."

In essence, the engine control unit simply deactivates one bank of six cylinders, while leaving the valves to operate as normal. "The big

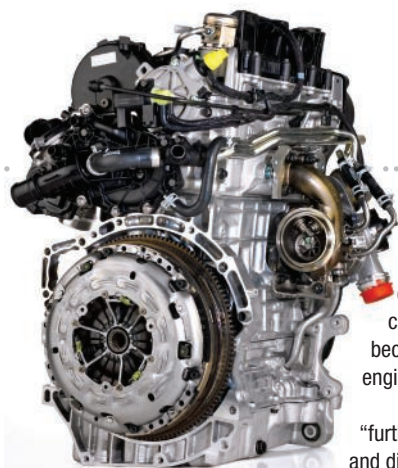
Glide path to 95 grams

"We are all struggling a bit on 'How the hell do we get to 95 grams?', " Peter Mertens, Volvo's senior vice president, research and development, told *Automotive Design* at Geneva, "especially as a smaller OEM with a third of the volumes that others have."

He explained that Volvo has focuses on reducing weight, improving aerodynamics and minimising friction through downsizing engines, combined with an intelligent electrification strategy with batteries and electric motors on the rear axle, and "all of a sudden we're on our glide path to 95 grams."

The result is a four-cylinder strategy combined with electrification that focuses on lots of power with efficiency. "That's 298kW, 640Nm that's V8 power with 2.5l/100Kms consumption. There is potential for the combustion engine with higher pressures, improved efficiencies, variable compression I really don't see. The decision to focus on the four-cylinder gives us the benefit of using all the future technologies, without having to change our strategy, because we have just one engine family. It's really easy to add technologies to that, without having to change 10 engine families or whatever. So, if variable





compression does come through, we can use it and be quicker than others, because we only have to alter one engine. “

Mertens is confident there will be “further developments” in both gasoline and diesel technology; he thinks that the pressure diesels are coming under is “unfair”, as it helps OEMs get towards the 95 grams target. “Beating us up over diesels, which is one of the ways we get to 95 grams, doesn’t make a lot of sense.”

Although he wouldn’t be drawn on a timescale, Mertens declared the i-Art injector technology – that uses a chip in each injector to determine the individual cylinders fuel injection strategy – will migrate to direct injection engines, although at lower injection pressures.

Kia unveils three-cylinder ‘Kappa’

Kia debuted its all-new 1.0-litre T-GDi (turbo gasoline direct injection) ‘Kappa’ engine. Developed in-house at its Korean Namyang R&D centre, the three-cylinder engine develops 88kW and 172Nm. “The key benefit over the 1.6-litre engine,” explained head of power train, Michael Winkler, “is that the increased torque is produced at 1500rpm, whereas the 1.6 only developed 134Nm at the same engine speed.



“The key problem with a four-cylinder engine is that you get an exhaust pulse from a neighbouring cylinder when the gas exchange occurs, delivering unwanted gas into the cylinder. With three cylinder engines and their firing order, this is eliminated.”

As is becoming increasingly common with three-cylinder engines, the single-scroll turbocharger (38mm compressor, 34mm turbine) is paired with an electric waste-gate to improve performance, with highly efficient air scavenging strategy. As well as scavenging clean air for the engine to re-use for combustion, it is able to open the waste-gate at the same time to improve waste air flow.

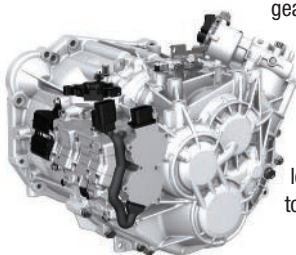
Direct injection from the intake side at 200bar features, newly developed, by Kefico, laser drilled injectors with six nozzles in a pyramid pattern, delivering an even spread of fuel and air throughout the cylinder, while, at higher engine loads, double injections occur.

The engine also features an integrated inlet manifold and a new dual-thermostat split cooling system. This allows the engine block and cylinder heads to be cooled independently – the main thermostat controlling the flow of engine coolant to cylinder heads above 88°C to reduce knocking, and an engine block thermostat shutting off coolant flow above 105°C to reduce mechanical friction and improve efficiency.

Kia also revealed its in-house developed seven-speed, 300Nm capacity dry dual clutch transmission (DCT), replacing the six-speed automatic and improving economy by up to 7%, depending on its application.

The first of its type to be developed in-house, it features a hollow double-gear input shaft that allows the system to quickly engage even gears, while a solid shaft that runs through the middle operates odd gears.

“Downsizing is just one approach to achieve future emission levels,” said Winkler, “so I am sure we will have to introduce more technology in the future. If we look at 95 grams, there is still a long way to go to reduce emissions, so we will have to go down the electrification route.”



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Maserati CEO Harald Wester inside the Ghibli S Q4 Ermenegildo Zegna Edition

Energy balance is 'being neglected'

Maserati CEO Harald Wester has come out against the current regime of measuring exhaust emissions, saying: "Personally, I have serious doubts about what we're doing... Today, in Europe, we're homologating, under the current regulations, 2000 Kgs high-end luxury cars, with plug-in hybrid outperforming the most efficient small cars like the Fiat 500 diesel, which goes slightly below 90 g/kms. We are neglecting the well-to-wheel

energy balance," he states, adding: "We're shifting the emissions from big cities to somewhere else."

The marque will launch its first hybrid in the second half of 2017, according to Wester, likely to be in the marque's first SUV, the Levante, due to make its appearance this summer. Such a development, he says, is "unavoidable".

Future engines will be downsized and

feature cylinder deactivation, central direct injection and lean burn. "All this stuff is going on; we will reduce our V8s emissions by a third using this technology and there is further space to be exploited."

He also maintains that fuel cells "will be an important technology for the future, as well as full electric". But the combustion engine, he maintains, will continue as an "integral part" of the propulsion system.

Lotus reveals future strategy

New Group Lotus CEO Jean-Marc Gales is keeping Lotus Engineering sales at about 10% of turnover, he confirms, which is £12 million a year. He reveals that he has merged both engineering teams from Lotus Cars and Lotus Engineering to deliver new cars over the next two years. "They're working flat-out," he stated at Geneva – all under the guidance of engineering director Miguel Fragoso, who was appointed last September from Millbrook Proving Ground where he was CEO.

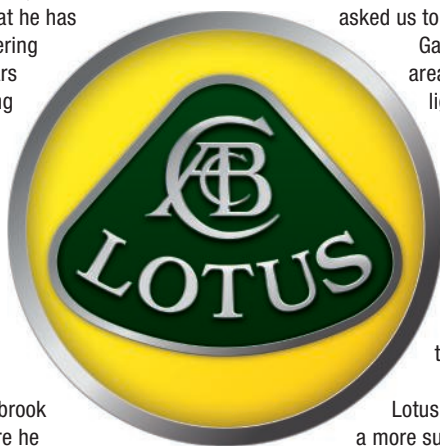
"At this point in time, we are more reactive in our approach to Lotus Engineering. Our priority is to get the company back to the

level it once was under Colin Chapman. We are happy with our current customers and there are a lot of additional projects they have asked us to do."

Gales claims that priority areas for third parties are light weighting, NVH, dynamics and power train validation. "And let's not forget that we're owned by Proton, and Proton is a very big customer in engineering as well, using a lot of power train resources."

He would only say that Lotus Engineering will become a more substantial contributor to

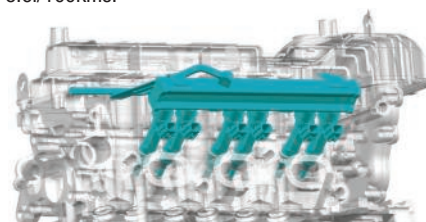
Group Lotus income in the "medium term", concluding: "If we [Lotus Engineering-IA] develop something, it's important that we put it in our cars."



Suzuki injects new thinking

Suzuki's new 1.3-litre engine runs at 12:1 compression ratio and, unusually, features twin long reach injectors per cylinder. "It costs more, but is cheaper than direct injection," claims Shigeaki Suzuki vehicle line executive, automobile engineering. Located on the intake side of the cylinder head and with both injectors firing simultaneously, the idea is, he says, to achieve a wider homogenous spray without wetting the walls.

At 50kW maximum, power remains unchanged, but CO2 emissions drop from the standard engine's 99g/kms to 84, with fuel consumption improved from 4.3l/100Kms to 3.6l/100kms.



Honda doubles conversion rate

Honda's latest 1.6-litre diesel employs a NOx catalyst, with an integrated Oxidation catalyst in the same converter as the diesel particulate filter, that increases the conversion rate to 60% at 150°C for HC and CO. By doubling the conversion rate, Honda has eliminated the need for a selective catalyst reduction system. "We had to ask ourselves if we really wanted customers to refill with additive urea, because we weren't capable of developing proper technologies that the customer could rely on," commented chief engineer Akira Hashimoto.

Improving the light off time at lower temperatures was helped by reducing engine friction by 37%, achieved by optimising the oil ducts, revising the new block and heads water jacket, and minimising the water pumps load.

Developing 117kW at 4000rpm and 350Nm at 2000rpm, it's a complex and relatively costly twin turbo arrangement, with a smaller variable geometry turbo boosting response up to 2000rpm, before a larger turbo cuts in. A sophisticated control system using three valves bleeds the charge air between the two. "Instead of opening a valve, like a waste gate to bypass the gas, by using the variable vanes we can reduce the pumping and energy loss at low engine speed. At higher rpm, the vanes open and the bypass valve diverts the gas flow towards the larger turbo," explained Hashimoto.

In predictive cruise control

The latest CR-V is also available with what Honda describes as the world's first predictive cruise control. Operating above 80Km/h, Intelligent Adaptive Cruise Control is capable of predicting and automatically reacting to other vehicles 'cutting in' to the vehicle's lane. The algorithm controlling the system was developed with input from the scientists working on the Asimo humanoid robot and artificial intelligence programme.

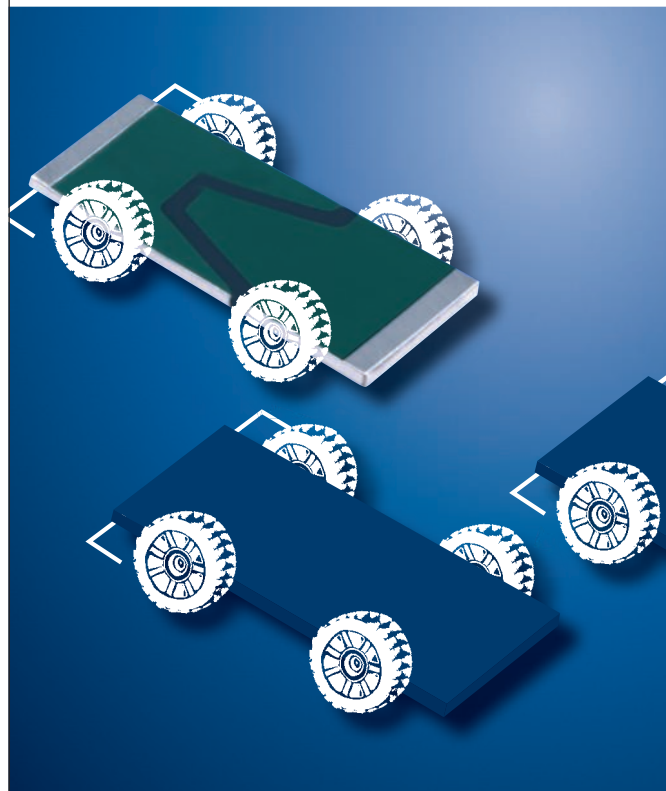
Strutting their stuff

Honda has also developed a new suspension geometry for its 228kW, 400Nm front-wheel drive Civic Type R. Dubbed Dual Axis Strut, it is designed to halve torque steer and tramp under hard acceleration, said project leader Hisayuki Yagi, explaining: "Basically, we have separated the wheel hub from the axle strut, bringing it to the inner side of the vehicle."

Although details were vague, it appears to be a similar solution to that employed on Ford's now abandoned 'Revoknuckle', as seen on the 2009 Focus RS by separating the knuckle from the strut. Extensive use of aluminium in the suspension has helped to minimise weight, added Yagi.



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News in brief

Evoque sheds kilos

The active drive line on the 2016 model year Range Rover Evoque is 7kgs lighter, says Murray Dietsch, Land Rover programme director simply through more efficient design and improving the rear differential.

Weight saving is also key to future developments with the Ingenium diesel engine 25Kgs lighter than the engine it replaces. "I think people will slowly migrate towards cars that have got the performance they're looking for, but not necessarily with larger engines."

Reverse goes

Insiders at gearbox manufacturer, ZF have revealed that by 2019-20 it will have available a five- or six-speed gearbox with no reverse. Instead an electric motor within the transmission will power the car backwards and, launch it forwards initially before the gearbox takes over.

Lighter Seats

Seat won't have a plug-in hybrid or electrical vehicle for "at least two years" according to its executive vice president for R&D, Dr Matthias Rabe.

"As a small brand Seat has to focus on what is the right answer at the right cost. For me the priority is to bring the engine's CO2 down but also lightweight structures; for instance today's Leon is 90Kgs lighter than its predecessor with better crash performance and improved space. For future products we will concentrate on more high strength steel so next year's SUV will be the lightest in its class."

Moving up a gear

Based on a new, modular platform, Getrag's new 7DCT300 is designed for a maximum torque of 300Nm. Smart Actuation, an intelligent power-on-demand actuation system, adds to the high efficiency of the 7DCT300. Its use enables power consumption of under 40W to be achieved – less energy than a light bulb and 3.5% more efficient than second generation DCTs.

Bonded on advancing bonding

Novelis and Henkel Adhesive Technologies have signed a long-term agreement to collaborate on the development of advanced bonding technologies for the use of aluminium in high-volume vehicles.

The first product to launch as a result of this partnership is Bonderite M-NT 8453 a chrome-free conversion coating that improves

the adhesion and durability of bonded joints in vehicle structures as well as paint finishes on exterior components. It can be applied using all of the most popular application methods, including immersion, spray coating and roll coating. This flexibility makes it a highly versatile and efficient solution for high-volume applications.

Audi plans powerhouse EV

Audi is planning a small series of "passenger-oriented" electric cars with more than two seats and a 500+Kms range, according to Dr Ulrich Hackenberg, Audi's director of research, although he wouldn't define it beyond saying: "It's a premium car that can be used by families; it will be a big car, with a big battery of 90kw/hrs."

It will be based on MLB underpinnings, but with a "specific design" and not based on an existing product.

Hackenberg revealed that its VDA-mandated battery cells have improved power density from 25 amp/hrs to 37amp/hrs for the mystery car, planned to rise to 50 amp/hrs by 2018-2020. "If you go to lithium sulphur or lithium-oxygen, then that will take longer to develop," he stated.

"As a premium brand, Audi cannot ignore alternative technologies like fuel cells.

"We are using Ballard as an engineering supplier and developing our own fuel cell technology with Volkswagen, as well as buying



a portfolio of patents to protect ourselves in the future, so we can react quickly – say 24-36 months – if and when the market demands fuel cells. We won't go into series production if there's no market for the cars."



Magna unveiled the latest in its family of MILA lightweight cars at Geneva: a 1520Kgs electric two-seat coupé with an all-electric range of 75Kms and CO2 emissions of 32 grams/kms. MILA Plus is based on an extruded aluminium space frame, clothed in lightweight plastic panels, with the high-voltage battery integrated into the space frame, increasing structural rigidity.



ContiTec shows light touch

ContiTech has developed a transmission crossbeam from fibreglass-reinforced polyamide BASF Ultramid for the Mercedes-Benz S-Class rear axle, which is about 25% lighter, compared to diecast aluminium versions.

It boasts optimum strength, good NVH performance and high crash-protection. As a central component of the rear axle, it supports forces and torques of the rear axle transmission.

"Absolute precision is called for in the design and production of the transmission crossbeam for the rear axle – particularly in terms of strength and dimensional accuracy of the component," emphasised Diethard Schneider, head of lightweight construction pre-development at ContiTech Vibration Control.

Polyamide components make an important contribution, in terms of reducing weight and making vehicles more environmentally friendly. Unlike aluminium, polyamide can be shaped at lower temperatures, thus requiring significantly less energy in the manufacturing process. There is also a wide range of possibilities in recycling.

Battery venture launched

BASF TODA Battery Materials has been established with 66% equity from BASF Japan Ltd and 34% from TODA KOGYO CORP. The joint venture will conduct research and development, production, marketing and sales for a broad range of cathode materials, particularly NCA (Nickel Cobalt Aluminium Oxide), LMO (Lithium Manganese Oxide) and NCM (Nickel Cobalt Manganese) in Japan. These materials are used in lithium-ion batteries for the automotive, consumer electronics and stationary storage markets. Internationally, the company will leverage BASF's global network and reach to drive growth in the battery materials market, which BASF has identified as a key growth field for the future.

Hydrogen on stream by 2030

Forty-two or 48-volt systems currently under consideration by some OEMs to power ancillary functions such as oil, water pumps or air-conditioning systems won't be a "major driver" according to Toyota's vice president research and development, Gerald Killmann.

Although Toyota will retain its diesel offerings, Killmann thinks hybrids will become "even stronger" than today possibly making inroads into diesel sales. "In parallel to that, we will continue to improve our conventional diesel and petrol power trains with lower CO₂. But the big step forward will be fuel cell, this has the advantage that it doesn't deteriorate over its lifetime. Today's disadvantage is the lack of infrastructure; we envisage that hydrogen technology has the potential to grow within 15 years."



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Synthetic sounds to please everyone



Driving down vehicle weight to help meet emission levels is leading to OEMs using a wider range of electronic sound synthesis, according to Harman's Rajus Augustine. "As engines are downsized or cylinder deactivation becomes more common, sounds that were once masked are now apparent within the cabin," he explained, adding that "low frequency droning can cause drowsiness at the wheel".

Harman already has engine order

cancellation, but is the first to bring to the market road noise cancellation: for engine order cancellation, engine speed is used for the reference signal, sent to the controller, which generates a countering noise up to 250Hz, emitted through the car's speakers.

"We have gone up to 20dBa of cancellation," commented Augustine.

For road noise cancellation, Harman locates accelerometers strategically on the suspension

and chassis that record low frequency noise from the road. These feed data to the controller, with electronic filtering to generate anti-noise. Based on what the problem is that the OEM wants to solve, Harman will locate the accelerometers accordingly and tune the system to their unique requirements.

Harman can also help OEMs achieve their target sonic picture by taking inputs from engine speed and load, vehicle speed and throttle position to synthesise a more characterful exhaust note that is transmitted through the car's speakers.

"That's created immense interest since we launched it at the end of last year and will be on the market soon," added Augustine.

Whilst Harman's Individual Sound Zones (ISZ) is a new in-cabin technology that enables drivers and passengers to create sonic zones, ensuring that all occupants only hear what matters to them.

ISZ is an innovative acoustic design and complementary digital signal processing that maximises speaker direction and minimises crosstalk in and between the zones in a vehicle for a more personalised in-cabin experience.

ISZ utilises a vehicle's existing audio system speakers with the addition of headrest speakers equipped with micro speaker technology, along with thin and flat Electro Dynamic Planar Loudspeakers in the vehicle ceiling. The digital signal processing has been specifically adjusted to the vehicle cabin and speakers, such that it will temper the signals from other zones, regardless of whether they are music, voice or other noises, so each passenger can activate and control their 'zone'.

Battery life extended

Federal-Mogul, has developed Protexx-Shield 3007, to protect batteries from high engine compartment temperatures that would otherwise shorten battery life. The unique combination of materials used in its construction provides superior thermal insulation with high resistance to contamination by fluids, and uses a high proportion of recycled content, aligning with the company's strategy of developing environmentally-friendly products for its customers.

There is a correlation between battery life and elevated battery acid temperatures. As battery acid temperatures rise, the battery life is reduced. The longer the battery is subjected to heightened battery acid temperatures, the greater the damage that is inflicted onto the battery. In independent tests carried out by Federal-Mogul's first series production customer for Protexx-Shield 3007, battery acid

temperature climbed almost three times faster in an unprotected battery than in one surrounded by a Protexx-Shield jacket. In a 100° Celsius environment, an unshielded battery took just 55 minutes to reach 75° Celsius, but when shielded this improved to 153 minutes.

Protexx-Shield 3007's insulating properties are provided by a pad formed from Federal-Mogul's QuietShield GRN which can be optimised for thickness, density and composition. This is encapsulated within a polymer-based scrim to provide a sealed outer surface, impervious to typical automotive fluids. The compound material is then formed into a structure and tailored for individual battery sizes to give optimum fit and insulation. A patent-pending integral hinge arrangement allows the shield to be shipped in a flat condition, saving space and freight cost, and simplifies installation around the battery.



Class A finishes assured

Custom colour-matched PVC compounds for automotive exterior mouldings and trim yield the pure colour, consistent gloss, and smooth, high-quality surface required for meeting the Class A finish specifications of automotive OEMs, have been introduced by Teknor Apex Company.

Apex 1545 Series products are 85 Shore A PVC compounds that provide integral colour and Class A surfaces for the external layers of co-extruded automotive parts, such as roof ditch moldings between roof and body sections, window trim between A pillars and windshield,

and body trim. Thus far Teknor Apex has formulated Apex 1545 Series compounds in more than 60 colours, a number of which are in commercial use on Chrysler vehicles such as the Dodge Challenger.



Bellows technology for air springs

TrelleborgVibracoustic has developed a new bellows technology for air springs. The 'ZAX bellows' combines the advantages of the cross-ply and axial bellows previously used in passenger cars. The new technology will be installed on several SUVs later this year. Eliminating the torsion decoupling element reduces the production costs for the ZAX bellows. The reduced space requirement is very important, especially on the rear axle. It means that the load compartment can be extended or additional features, such as greater volumes, or valves for switchable air springs, can be realised.



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Bringing it all together

**Ian Adcock catches up with GKN's newly appointed president,
Group Technology, Rob Rickell**

Isuggest to Rob Rickell that, from an outsider's point of view, it seems faintly surprising that he is GKN's first board member responsible for overseeing technology. After all, GKN is a global engineering company with an £8 billion annual turnover and is a recognised leader in its four specialist areas of aerospace, powder metallurgy, land systems and driveline.

"Yes, but we're there now and it was very much welcomed when I was invited by CEO Nigel Stein to join the board. To be honest, for the past couple of years I have been involved in group strategy as a member of the group technology strategy board and, really, we were keen to emphasise the point that technology has become more and more important to GKN businesses involved in aerospace,

automotive, land systems and powder metallurgy. It's a message that Nigel has been giving to customers and, to reinforce that message, it was felt important to have someone at corporate level representing technology.

"In any case, I had been visiting the board at strategy meetings for the past two to three years, presenting technology, summarising what we were doing in all the divisions, so I was sort of moving into that role."

PLANNING AHEAD

Having successfully grown the driveline division over the past eight-plus years – from basically being a constant velocity joint and driveshaft business into a fully integrated driveline with all-wheel drive, hybrids and

electric vehicle components – his new remit is to ensure that technology is at the forefront of all four divisions and develop a technology roadmap, as well as define the top 10 programmes for the next five, 10 or even 20 years.

"I chair the group technology strategy board, which is made up of myself, Nigel as CEO, Andrew Reynolds Smith (chief executive automotive and powder metallurgy), the four division leaders, and the senior vice presidents of aerospace, driveline, land systems and powder metallurgy. A fairly small group, and we decide on future technologies and



Rob Rickell

CV

Rob Rickell was recently appointed president, Group Technology for GKN plc, moving up from his previous role of senior vice president Engineering for GKN Driveline. Since joining GKN in 1984 as a product engineer in Birmingham, UK, Rickell has worked on a variety of projects at the company's facilities in the UK, Italy and Lohmar, Germany, and managed GKN Driveline's global Toyota account. He played a key role in launching GKN Driveline's countertrack constant-velocity-joint technologies, and developing AWD and eDrive Systems capability. Rickell has a bachelor's degree in mechanical engineering from Nottingham University and a Master of Science degree from Loughborough University in Leicestershire, UK. He is a Fellow of the Royal Academy of Engineering in the UK. Aged 55, he is married with three children.



how we are progressing on major current programmes.”

He also reviews current major projects, deciding if they should continue or not, and is actively involved in merger and acquisitions, with a goal of growing GKN to a £10 billion-plus business in the foreseeable future. “We want to do that organically and with clever acquisitions, like we’ve done in the past with aerospace and absorbing Getrag into Driveline, for instance. The Williams hybrid was a key strategic acquisition for us and clearly I will be involved in those, from a technology point of view, asking if they fit with our technology or is it good technology.

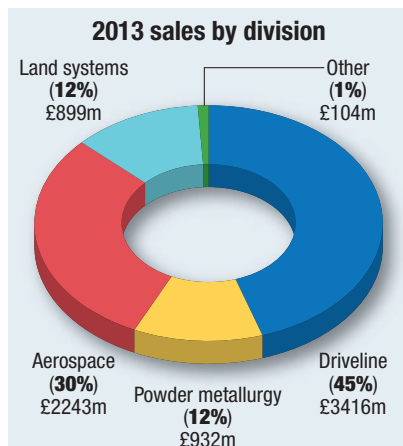
“With many of our acquisitions, we move in and acquire them, because they’re offering some technological advantage. But, business wise, we can help turn them round into profitable concerns.”

HIGHER PROFILE

As if that isn’t enough, Rickell is also charged with improving GKN’s image in the wider market. “Whilst we’re well known within the individual sectors, we aren’t at the level of Bosch or ZF in wider terms. We need that higher profile to attract future generations of engineers around the world to help sustain our growth going forward. There’s a lot of competition out there for them and we want GKN to be right at the front, attracting the best graduates, students and engineers.”

Having this broad overview means that he is ideally placed to leverage synergies between the divisions. An obvious example would be aerospace’s carbon-fibre expertise, although he is cautious about its automotive potential.

“Initially, it’s still a niche market with low volumes. We work with Toray and others for material supply and manufacturing prop shaft tubes



for some high performance cars, but it’s still hard to see those technologies being applied to high volume cars, because of the material costs. Even lower specification carbon-fibre is still significantly more expensive than steel. High strength steel is such good value for money, it’s often difficult to beat in the automotive sector; clearly, aluminium and hybrid composites are coming in premium products.

“You have to remember the cost pressure in the automotive industry is different from other sectors we’re in,”

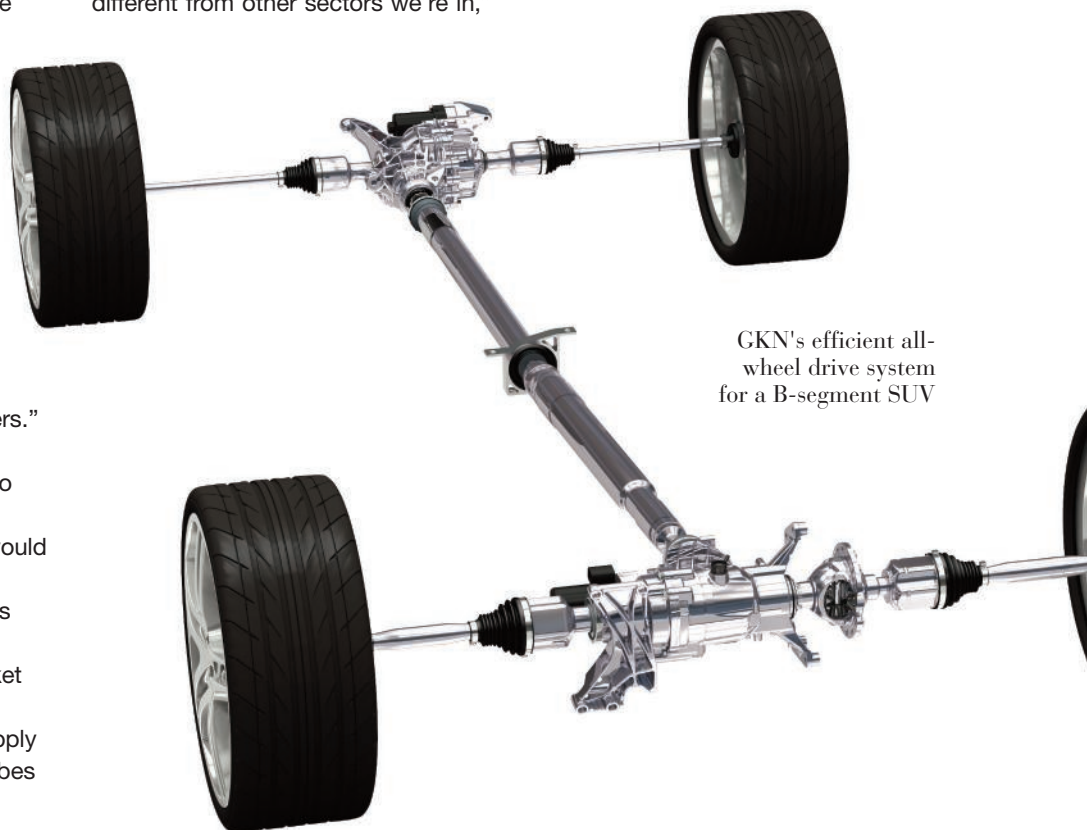
he adds. “However wonderful it is in weight saving, it can’t cost more than so many euros per kilo.”

It is the same with graphene “in the short term”, continues Rickell, and although it is now clearly on GKN’s radar for aerospace and defence, its rapid emergence over the past few years means it wasn’t predicted in the last long-term review five years ago.

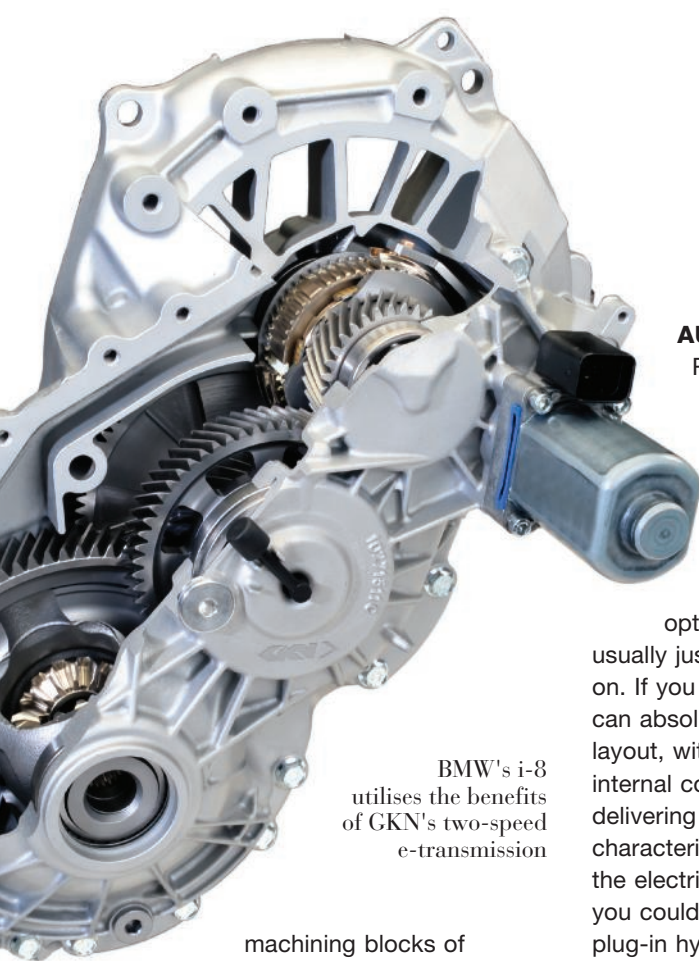
HITTING THE MARK

“I looked at one we did [then] and we missed one or two things that we know are coming, but we hit quite a few interesting ones. I think we probably got 70-80% right then and hope to do that for the next one we’re preparing.

“What we have done is identify some areas we weren’t in five years ago and have decided to look at them. One is additive manufacturing. If you look at the potential for that with titanium powder for aircraft components, it will be the displacement business to



GKN's efficient all-wheel drive system for a B-segment SUV



BMW's i-8 utilises the benefits of GKN's two-speed e-transmission

machining blocks of titanium for structures and aero engine parts. Having 80% swarf from a block of titanium doesn't make sense. That's a clear one and we are investing heavily in that area.

"It's great for our powder division, because we can produce the powders for that and there's a synergy with automotive as well, but that might take even longer.

"It's incredible what you can do with additive as you build it in 3D, putting the material exactly where the stresses are. It has potential for differential casings, suspension parts and structural components; we are prototyping an engine component that would be a skeletal, bionic form, very lightweight, that really reduces the inertia effect in the engine. If that's successful, it will be fascinating.

"It takes a day to make the part, so that wouldn't work," he points out. "But, if you could grow 10,000 a day, that's where additive can come into the automotive sector. You have to think differently from conventional manufacturing. That's one of my main agendas, as it affects at least three of the divisions."



AUTOMOTIVE HYBRIDS

Rickell also sets great store in the future of automotive hybrids, especially when combined with two- or even three-speed transmissions, "Most of today's are not optimised as a system; they usually just have something bolted on. If you go to 2- or 3-speeds, you can absolutely optimise the hybrid's layout, with optimal downsized internal combustion engine delivering the right torque characteristic and correct sizing of the electric motor – which means you could downsize the battery for plug-in hybrids."

Rickell also sees a growth in all-wheel drive systems, citing that developed by GKN for the Fiat 500X and Jeep Renegade as "best in class", in terms of weight and efficiency.

"To get a 4x4 in the 'B' segment close to what the emissions and fuel consumption of a conventional front-wheel drive on the standard cycle clearly makes all-wheel drive more acceptable to buyers, and removes that image of fuel consumption penalty and weight.

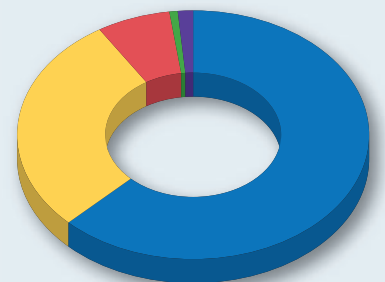
"But where it gets interesting is when you're looking at adding hybridisation. If the all-wheel drive is

an eAxe, for instance, then you've added both and, in the standard cycle, it could be up to 40% better fuel economy than conventional front- or rear-wheel drive.

"Adding all-wheel drive, hybrid and weight, yet improving economy on the standard cycle and in real life, is better. With hybrids, you get four-wheel drive for free and the best of both worlds, although the technology does add cost."

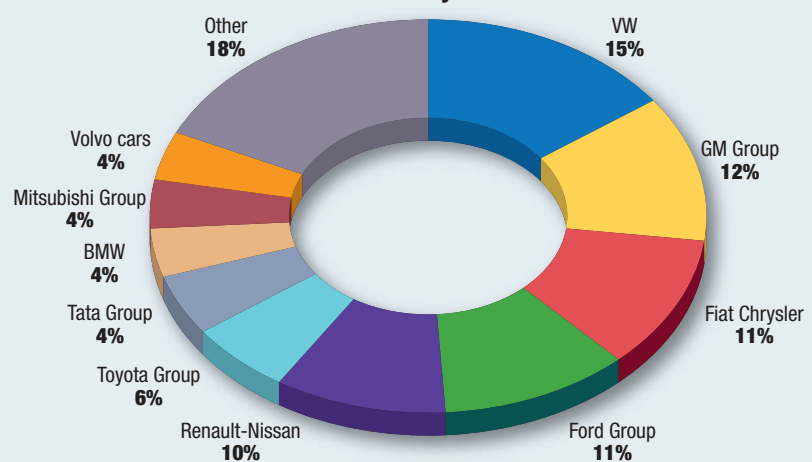
With its origins traceable back to 1759 and the birth of the Industrial Revolution, GKN has constantly gone through change and it appears that, with Rob Rickell leading the technology strategy, it could be about to undergo an industrial revolution of its own.

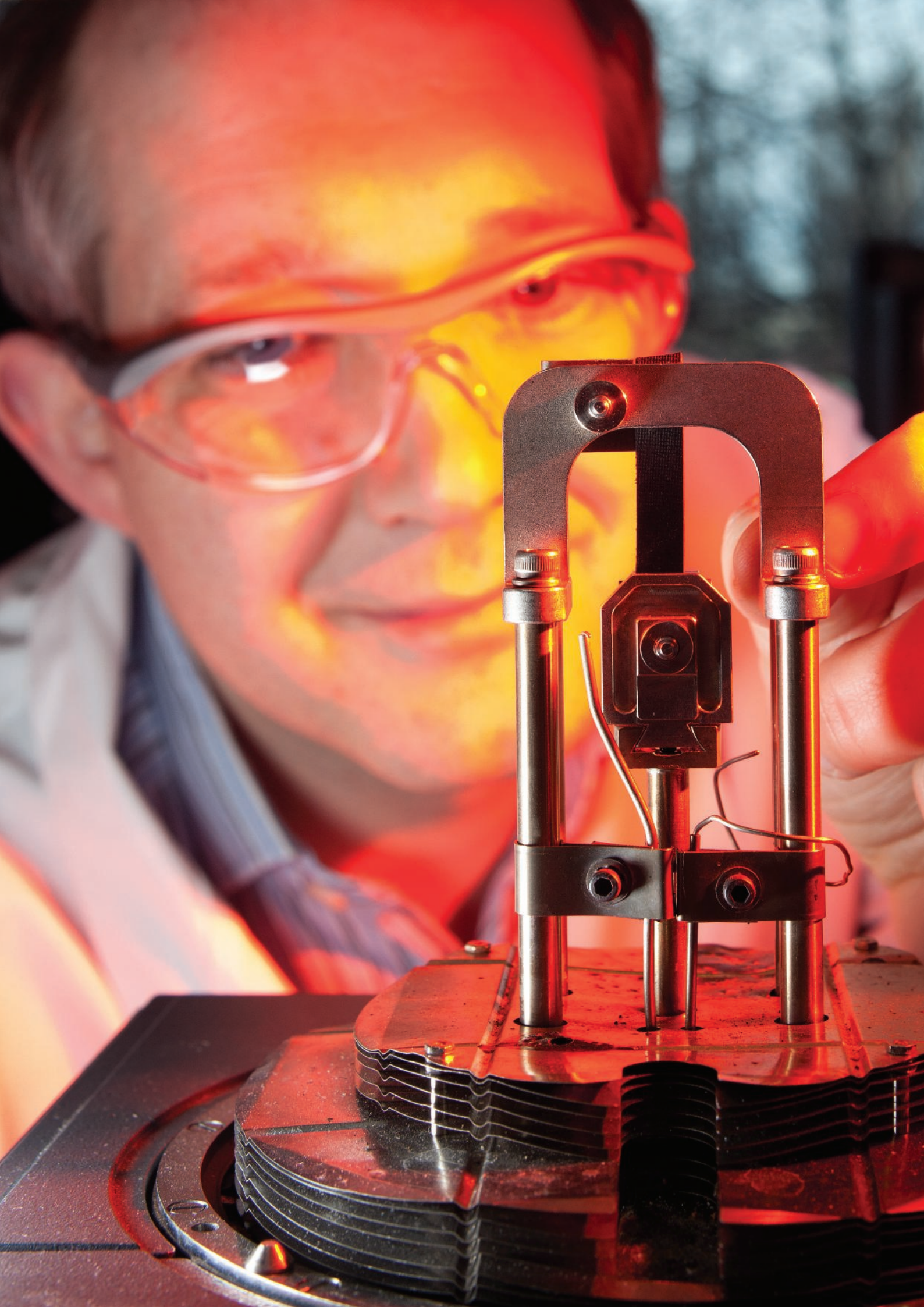
GKN Driveline sales by product 2013



CVJ systems eDrive systems
AWD systems Other
Trans-axle solutions

GKN Driveline sales by customer 2013





GRAPHENE SUPREME

Ian Adcock discovers what role graphene is likely to play in the vehicles of tomorrow

It is 11 years since Nobel prize winners Andre Geim and Konstantin Novoselov first isolated graphene from carbon, even though it had been known about by modellers and theoreticians since the 1960s. In the intervening years, it has been touted by the popular media as a wonder material that is at one and the same time: strong, flexible, opaque, transparent, waterproof and repellent, breathable, yet a barrier to helium, and conducts electricity and heat. In fact, there doesn't seem to be a property the atom-thin material doesn't possess or a material it can't improve – apart from curing baldness, although it wouldn't be a surprise if someone patented a hair restorer containing graphene, claiming it did just that.

"There's a danger in it being oversold," Ian Kinloch, professor of material science at the University of Manchester tells me, adding: "The simplest thing is to think of graphene as a layer of carbon atoms arranged like a chicken wire in hexagons. If you remember your school day chemistry, whenever you drew a hexagon atom you included a little circle within, it symbolising that the electrons were free to move. So, if you imagine that graphene is a whole series of those hexagons

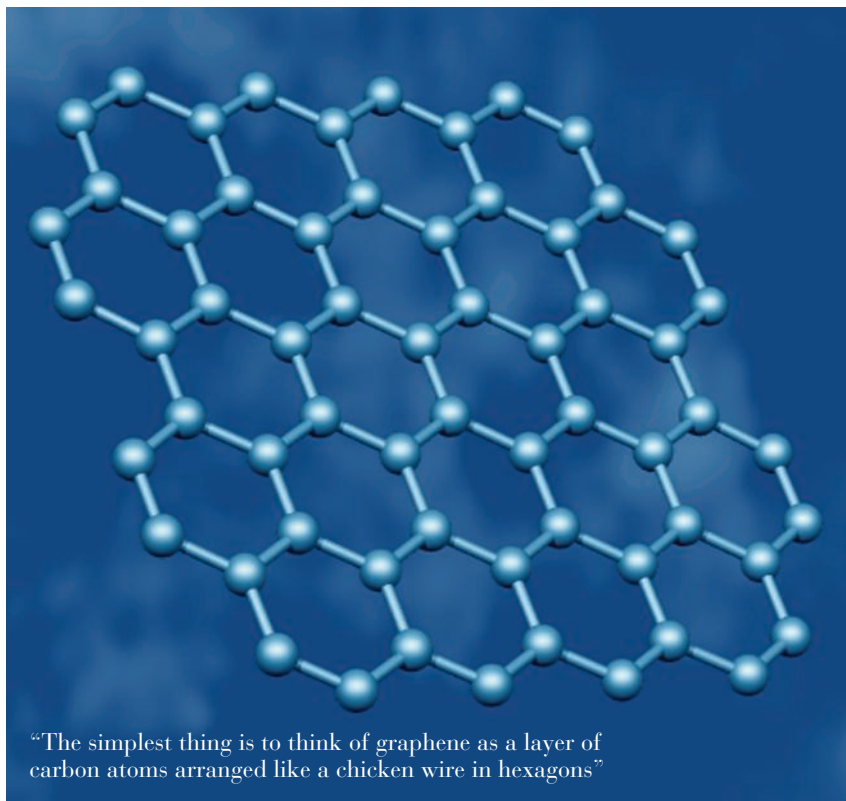
containing circles, it means that the electrons are free to move within that sheet, giving it conductive properties."

One of the properties that led to the physics Nobel prize was the discovery that the electrons in a single layer of graphene are moving close to the speed of light, described by Kinloch as "very exciting, because there's a whole branch of physics that describes quantum particles moving at high speeds that you can then prove experimentally. That caused a big hubbub in the physics community and from there everyone started looking at what potential this material had".

"Like carbon fibre, graphene's take-up – especially in the automotive sector – will be dictated by price, and driven by the second and third tier material suppliers before it reaches the tier ones and eventually the OEMs"

Ian Kinloch

Photo: Dean Smith, Camera Crew



Its modulus is very high – in tera Pascals, about 3-4 times stiffer than the carbon fibre used in Airbus – but warns Kinloch: “That’s partly because the materials people have been looking at are very small and unlikely to have any critical defects.” And he continues: “The electrical properties of a mono layer are unique, in terms of the way the electrons move close to the speed of light, and that’s due to graphene’s symmetry, which is quite particular to that structure.

“Then you have good thermal conductivity, so it’s good for taking heat away and, being so thin, it’s transparent, with 2.3% light going through. It also has a very high surface area, which is important for battery and super capacitor applications, and that’s because, when you have only one atom, each atom is on two surfaces and counts twice when you calculate surface area. At 2600 m² per gram that makes it the highest theoretical area from a material.”

“Graphene is the first of a new class of materials called layered materials, or van der Waal solids, because of the interaction between them. The idea is like building a deck of cards with different layers of materials inserted in a controlled manner to build up the stack”

As with aluminium and steels, there is more than one grade of graphene, and the number of layers stacked up will influence its stiffness, conductivity and how much light penetrates... “the thicker it is, the more light it absorbs”, while a perfect sheet won’t even let helium

through, making it ideal for use in paint and anti-corrosion finishes.

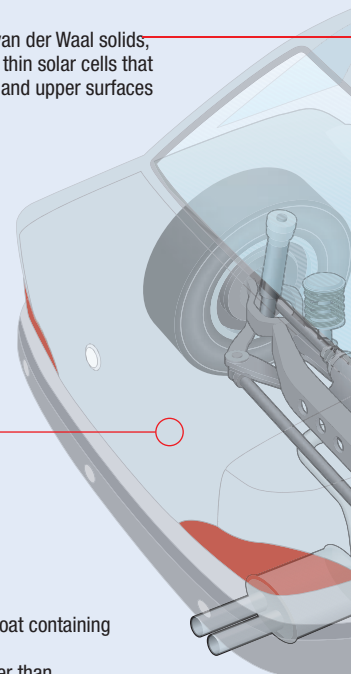
Change graphene’s surface chemistry and it can be made hydrophilic or hydrophobic. “There’s a tuneability there, which is when you give it to the chemists to get it to behave the way you want. But,” warns Kinloch, “all the challenges and properties described so far are with a perfect piece of material, in a laboratory on a very small scale. The challenge for the engineers and material scientists is: how close can we get to those perfect properties when we put it into a real material?”

Graphene – How it makes its mark

Its flexibility and ability to provide haptic feedback when used with polymers means instrument displays and centre stacks could be contoured into 3D shapes with touch-sensitive controls

Layered materials, or van der Waal solids, create microscopically thin solar cells that could coat a car’s roof and upper surfaces to generate power

Body-in-white undercoat containing graphene would be a more effective barrier than conventional paint. Because of its platelet format, graphene creates frustrated pathways, which, in theory, makes it impenetrable to moisture, road salts and other corrosive elements – only one coat required, saving more weight, as well as achieving a better ‘A’ class finish.



Cover story

Kinloch likens the timescale to that for carbon fibre. "That's been around for 30-40 years and it took three decades to get into the first commercial plane – and it's only just beginning to get into what you might class as production cars with BMW's i3. There's a lag, but I am sure the new materials will be quicker, because there's a trend towards lighter cars."

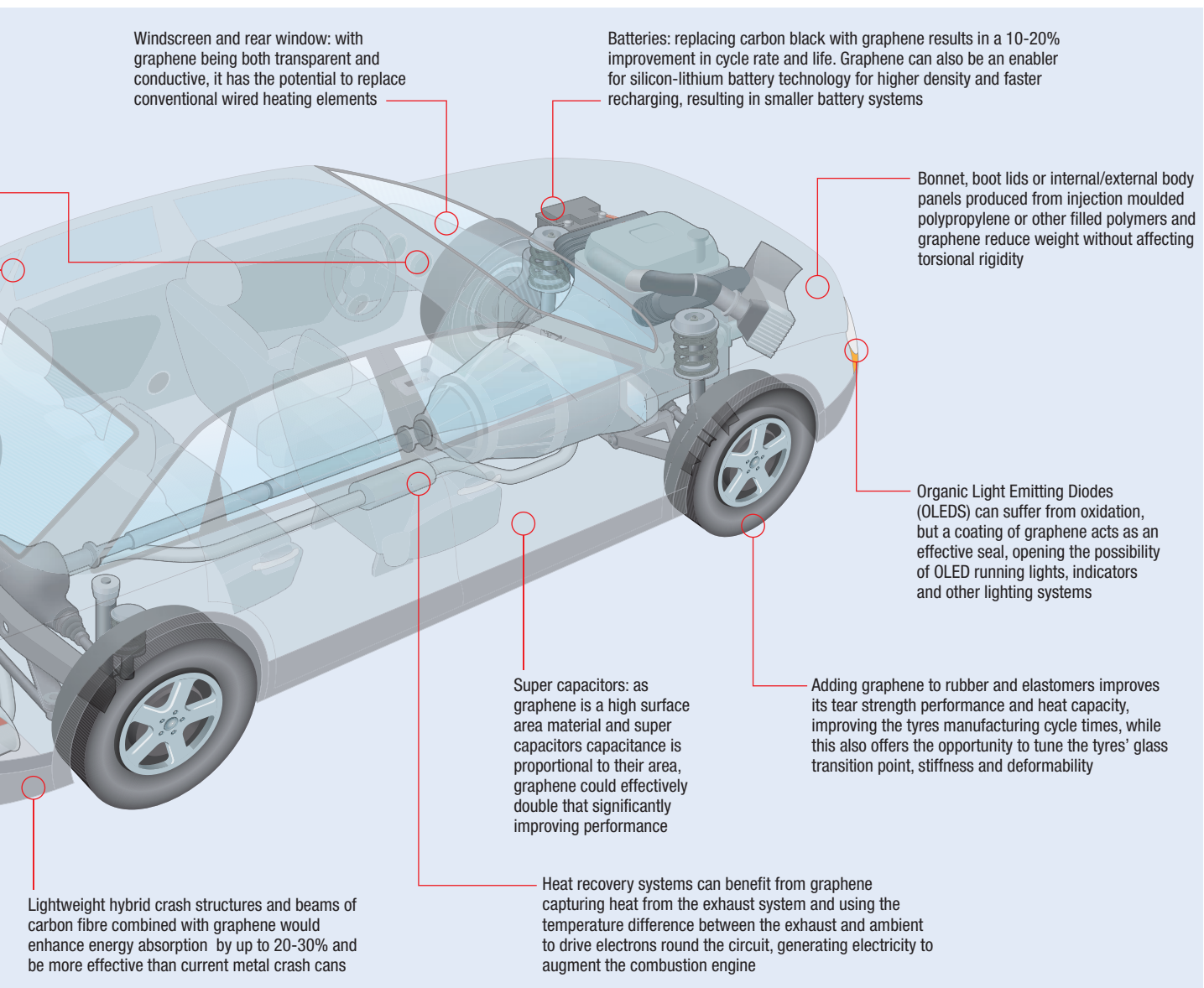
Like carbon fibre, graphene's take-up – especially in the automotive sector – will be dictated by price and, predicts Kinloch, driven by the second and third tier

material suppliers before it reaches the tier ones and eventually the OEMs. "There are probably 100-plus companies globally claiming they make graphene: different grades of graphene, with different price/performance points. The most available of the ton scale is nano graphite and that is probably 30 layers, so it has stopped behaving like a unique nano material and behaves like small lumps of graphite. That doesn't give the same performance as true graphene, however, where \$10s per kilo for nanographite is being predicted; the

fewer the layers, the more expensive it becomes, with \$30-100/kilo being forecast.

"The issue is knowing what you have and building up your level of understanding – that's where we are now. Because each manufacturer has a different plate size, option content and dispersivity, you need to start matching the grade of graphene to the application and that's what people are now beginning to understand, so production ready is probably five years away."

The resurgence in interest of fuel cell-powered cars could also be



Cover story

accelerated by using graphene in the membrane. "That's the big technical challenge and we have a project running here in Manchester to see if graphene is the key to unlocking the fuel cells potential," notes Kinloch.

UKplc, he says, is "up at the front", along with the USA, China and Singapore, not only in terms of manufacturing graphene with companies such as Thomas Swan producing "kilos a day", but also joint projects between themselves and companies like Morgan Advanced Materials that has invested £1 million to commercialise a different flake size. Then there is the £60 million

"Mankind has been through many ages and revolutions, from stone to the industrial revolution. It looks as if future generations will look back on the first half of this century as the dawn of the graphene age"

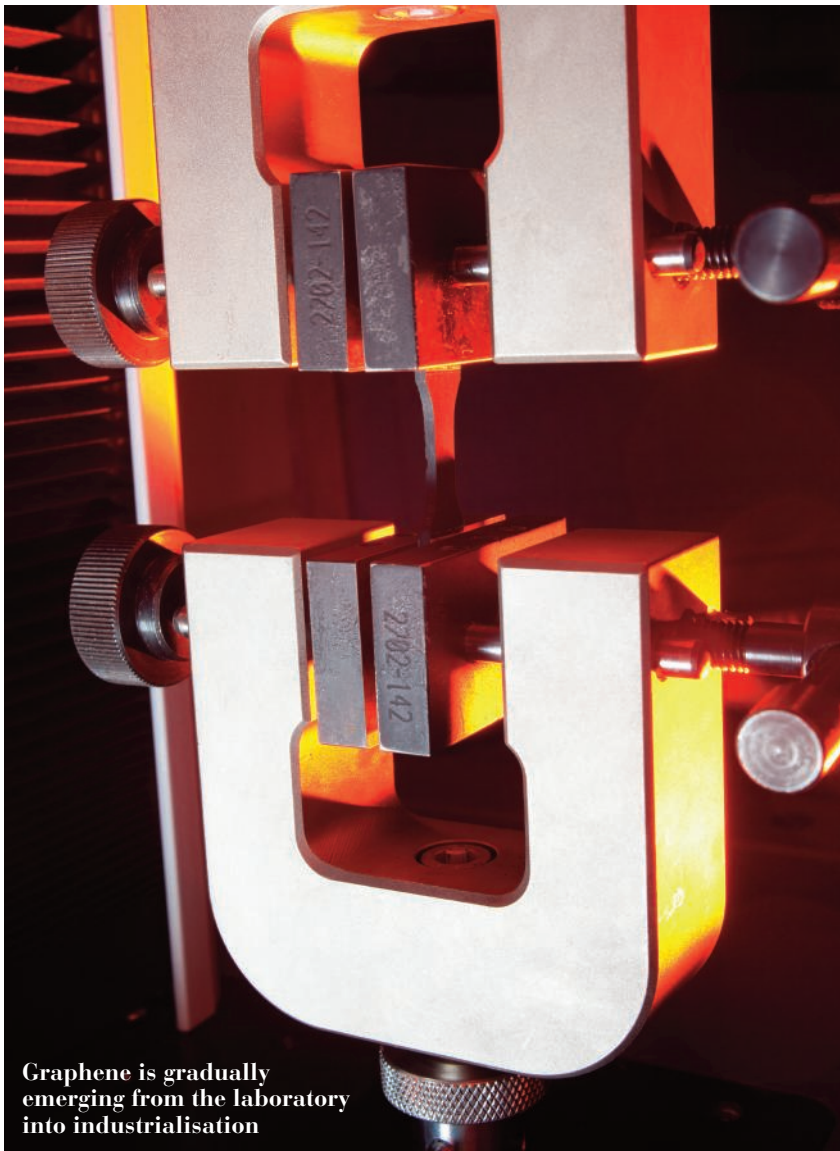
investment into Manchester's Graphene Engineering Innovation Centre (GEIC) that will open shortly and house over 200 scientists researching and developing graphene and other 2D materials.

With graphene barely out of the starting blocks, though, isn't it a little premature, I ask Kinloch, to be talking about a whole new series of materials that are beyond graphene? "Graphene is the first of a new class of materials called layered materials, or van der Waal solids, because of the interaction between them. The idea is like building a deck of cards with different layers of materials inserted in a controlled manner to build up the stack. Graphene is the enabler for this new generation of materials, such as molybdenum disulphide tungsten disulphide and boron nitride.

"Ultimately, 15 to 20 years down the line, we could have layers of graphene sandwiching a layer of tungsten disulphide, acting as a semi-conductor to create a solar cell seven atoms thick, which would be reasonably efficient. The key thing is that it conforms to the car's contours and could augment or recharge its battery pack. It's a long way off, but it's the type of thing people are beginning to look at. Graphene has its limits; but, by adding it to other materials, you end up with different properties in each layer, resulting in a microscopically thin device."

It's early days in graphene's development, never mind its potential applications in automotive technology, but as manufacturers strive to meet increasingly stringent impact, emission and efficiency legislation, then the OEMs will be driven to employ any material that will assist them meet those targets.

Mankind has been through many ages and revolutions, from stone to the industrial revolution. It looks as if future generations will look back on the first half of this century as the dawn of the graphene age.



Graphene is gradually emerging from the laboratory into industrialisation

Engine management & connectivity



Two megatrends affecting the automotive industry are the regulatory push for cleaner transportation solutions and consumer demands for the comfort, convenience and entertainment functionality of their homes to be offered in their cars. Recent market research provides some insight into the current state and future trends in these two high-value and strong-growing areas of automotive electronics technology: engine management and connected vehicle technologies.

The automotive engine management system market is expected to be worth \$197 billion by 2019, according to MarketsandMarkets. The company's report analysed the market from passenger car to heavy commercial vehicle and highlights growth opportunities in the coming years.

North America will be the fastest-growing market for engine management systems between 2014 and 2019. Increasing NOx levels in the environment, stringent fuel emissions regulations, demand for higher fuel efficiency and the need for better performing vehicles are factors driving the demand. In addition, there is a need for improved feedback from the engine for response to the actuators and motors.

In Europe, the engine management

system market is projected to record a stable growth rate during the period. The market holds a technological advantage, due to factors such as the promotion of green vehicles, stringent emissions and fuel economy rules, along with increasing concerns regarding global warming. The region has become a testing ground for new and advanced automotive engine management systems.

The Asia-Oceania region is also projected to show favourable growth, because of fast-growing production volumes and the growing need for better performing and highly fuel-efficient vehicles. More stringent emissions regulations and growing acceptance among consumers of technologically advanced systems are also propelling growth there.

The report lists the major engine management manufacturers, including Bosch, Continental, Delphi, Denso, Hella, Hitachi, NGK and Mitsubishi Electric.

Another huge slice of the automotive electronics space will be the connected car market, which is



expected to reach \$141 billion globally by 2020, with a compound annual growth rate just north of 32% during the period from 2014 to 2020, according to Allied Market Research. Its report forecasts that the availability of faster communication networks, advanced connectivity solutions and user-friendly interfaces should drive the global connected car market. Favourable regulations around the world will also fuel market growth.

Integrated connectivity solutions are expected to surpass embedded solutions in 2016. Navigation and infotainment services together held almost 80% of the market in 2013 and are expected to maintain steady growth during the forecast period. North America and Europe are projected to be the most lucrative markets, in terms of revenue generation, whereas the Asia-Pacific market will grow fastest.

North America currently garners a major market share and is expected to maintain the position throughout the forecast period. The relatively mature market was an early adopter of the technology and the US National Highway Traffic Safety Administration could mandate further M2M (machine to machine) connectivity solutions in vehicles.

focus@sae.org



What lies beneath?

***Automotive Design* looks into chassis developments designed to ensure local preferences are catered for globally**

Increasingly, cars are nowadays designed globally for local markets, meeting different demands from drivers according to regional requirements, whether they are driving styles and tastes or road conditions.

To ensure local preferences are catered for, OEMs rely on the supply chain to deliver suspension, steering and other chassis components that have been developed to suit those wants.

struts, dampers, as well as entire axle systems.

SMiCA (Sheet Metal integrated Control Arm), for instance, offers a lightweight solution requiring no rivets or screw connections, resulting in up to 23% weight-saving over a conventional sheet metal control arm. Moreover, it requires less installation space and allows for more flexibility when designing the chassis.

Close to volume production are ZF's lightweight aluminium damper and lightweight steel suspension strut. The monotube damper for the rear axle is an aluminium/plastic hybrid design, achieving weight savings of

up to 25%, while the lightweight steel suspension strut for the front axle includes both a hybrid spring plate made from steel/plastic and a hollow piston rod, as well as outer tubes with varying wall strengths.

The material is reinforced where required and other areas of the outer tube are kept as thin as possible for a 20% weight reduction.

Tenneco is another systems supplier whose suspension technology is going on a diet, using plastic spring seats, as well as top mounts produced from plastic or aluminium, together with new monotube technology and composite springs under development with a third party, which are imminent.

What started at the first passenger car axle assembly location in Duncan, USA, with production-synchronised supply of front axles for the BMW Z3 Roadster, is now standard practice on every continent: at 15 plants in eight countries, ZF has already assembled approximately 27 million ready-to-install axle sets, individually tuned to the respective vehicles – with annual sales of almost €2.8 billion and rising, with nearly four million complete front and rear axles. Over 50% of sales are generated in the Asia-Pacific region and approximately 30% in America.

WEIGHT-SAVING

Alternative materials, as well as new designs and production methods, save weight; materials, such as aluminium, carbon fibre reinforced plastic (CRP) or glass-reinforced plastic (GRP) are used in conjunction with advanced production processes to manufacture tie rods, suspension



ZF's lightweight SMiCA control arm (left) and, above, Nexteer's ceps steering assembly

Focus on Chassis Systems



The challenge with all these lightweighting strategies is achieving a price point that is attractive to the OEMs, which is very dependent on the sector the vehicles are designed for. A mass-produced car destined for the A, B or C sector, for example, could only withstand a price increase of €2-5 per kilo saved, simply because of the narrow margins achieved with these cars, whereas a premium product would be able to withstand higher cost per kilo saved.

THE EV FACTOR

Furthermore, there is a trade-off between investing in powertrain development or lightweight materials to achieve fuel savings and CO₂ levels

in the future, as these are usually passed on to the end buyer.

One sector that arguably flies in the face of this is electric vehicles (EVs). With their inherently higher purchase price, the higher costs of weight-saving is more acceptable, as a lighter vehicle requires fewer/smaller battery packs to power it, with a subsequent price saving.

It is also essential to minimise cost during the development process. Nexteer regards itself as a leader in developing best practices for documenting design processes and techniques, supported by repeated testing until proven improvements in production are seen by using standardised design processes and high quality mechanical computer aided design (MCAD) data to effect improvements to product cost and delivery.

This approach, Nexteer claims, eliminates a common problem in traditional CAD departments, where up to 50% of design and engineering time can be spent in rework. Moreover, its standardised system with advanced interoperability encourages effective collaboration.

LEAN BY DESIGN

Nexteer Automotive's Lean Design Methodology (LDM) takes the proven principles of lean from the factory floor to the product development process, and consists of both product design and manufacturing process

design methodologies.

This process, which goes beyond software applications, enables instant, controlled propagation of design changes throughout the global enterprise, supporting a 'lean' approach to product design and a highly efficient change-management process.

Actual time studies carried out have shown that Nexteer Automotive's Lean Design Methodology delivers industry-leading productivity improvements. For example, in typical product development scenarios customers may experience:

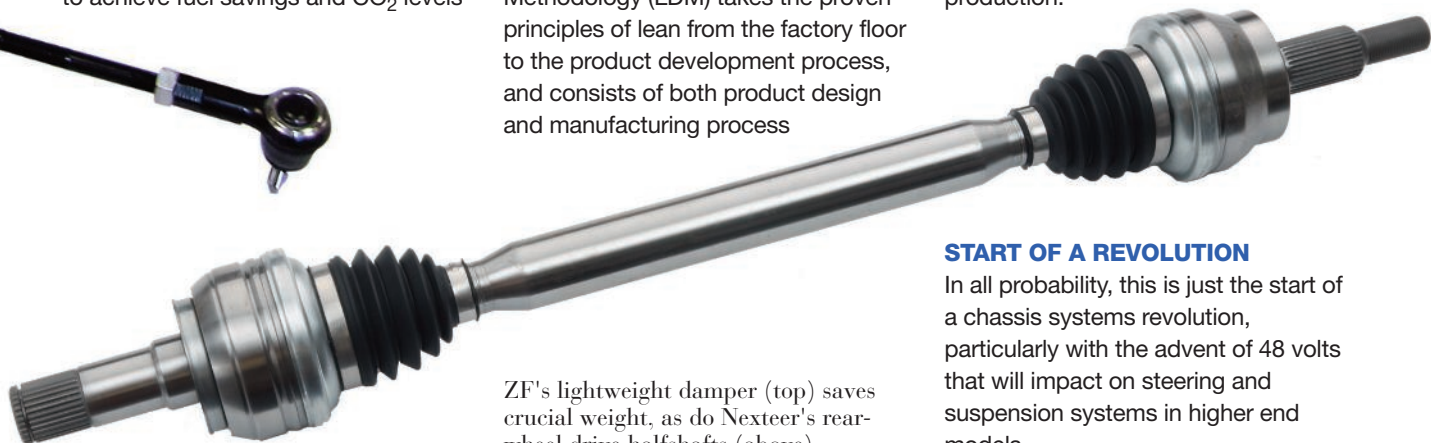
- **50%** reduction in time needed to create product design and manufacturing process models
- **65%** reduction in time spent editing models
- **75%** reduction in total project time
- **100%** reusable designs in downstream applications
- **50%** reduction in staff and resource requirements.

At the same time, other advantages include:

- Supports lean design and Six Sigma quality manufacturing practices
- Optimises use of CAD licences and workstations
- Accelerates time to market through the integration of design and production.

START OF A REVOLUTION

In all probability, this is just the start of a chassis systems revolution, particularly with the advent of 48 volts that will impact on steering and suspension systems in higher end models.



ZF's lightweight damper (top) saves crucial weight, as do Nexteer's rear-wheel drive halfshafts (above)



Wheels and tyres are becoming more technically adept, as *Automotive Design* discovers

Getting a GRIP on the future

Ford's most powerful Mustang, the Shelby GT350R, caused a bit of a stir at the Detroit show at the beginning of the year when it rolled into view on carbon fibre wheels. These lightweight 19-inch rims save 5.9 Kgs of unsprung weight per wheel, while offering higher levels of stiffness than equivalent aluminium wheels. Produced by Australian specialists Carbon Revolution, it is the first time these rims have been used by a mainstream producer, rather than a supercar specialist or after-market application. And although perhaps not an everyday car, Ford's use of these lightweight rims points the way towards reducing mass at every single opportunity.

Even more radical is Michelin's X Tweel airless radial tyre for commercial applications. After a decade of development that brings together the tyre and hub into one assembly, it has finally gone into

production in South Carolina, though it is still too early to predict if this unique solution will make the transition from its current low-speed industrial applications to the everyday demands of automotive applications.

EVERGRIP TECHNOLOGY

Making the transfer from the North American market into Europe, however, is Michelin's EverGrip technology unveiled in January last year. Made from a proprietary chemical compound containing high amounts of silica to provide the bonding strength needed to keep the treads on the road and deliver high traction, even in wet conditions, it is also infused with sunflower oil for greater flexibility at low temperatures to improve cold weather grip.

Additionally, it has a revolutionary design of rain grooves that widen as they wear down, supported by a special set of more than 150 grooves hidden beneath the surface that emerge as the outer layers wear. The

result, claims Michelin, is a tyre that continues to channel water away at an incredible rate, even as the grooves become shallower.

Super computer modelling has enabled Sumitomo Rubber Industries (SRI) subsidiary Falken to develop its latest SN832 Ecorun tyre by simulating real-world conditions that a tyre experiences to identify heat build-up and how to minimise it, as increases in temperature result in higher rolling resistance and worse fuel economy.

Falken has also developed a new run-flat tyre that it believes takes this technology to a new level altogether. There has been considerable criticism of run-flats deteriorating a car's ride, due to the additional stiffness of the side walls.

NEO-T01 MANUFACTURING PROCESS

By adopting its new NEO-T01 manufacturing process developed by SRI, the computer-controlled



Focus on Wheels and Tyres

punctures occur on average every 3000Kms, compared to 75,000Kms in Europe. In the longer term, this could be applied across all markets and tyres, with the added benefit that OEMs could then eliminate spare tyres once and for all, freeing up space in the car and reducing weight.

Burgeoning sales of electric vehicles (EVs) also present tyre producers with a unique set of challenges: the tyres tend to be taller and narrower to reduce wind resistance, while they must also have lower rolling resistance throughout their life to help maximise the EVs' range and, simultaneously, transmit less noise into the cabin.

'OLOGIC' TECHNOLOGY

Bridgestone claims to have achieved this with its 'ologic' technology, as fitted to BMW's i3 EV: combining a large diameter with a narrow tread pattern has several advantages. While the tread on smaller diameter tyres is typically inclined to excessive movement or 'deformation' during driving, the larger diameter and higher belt tension significantly reduces tyre deformation and, therefore, conserves energy that is

otherwise lost through internal friction – which helps to reduce rolling resistance. By the same token, the narrow tread concept improves aerodynamics. These improvements, it is said, do not involve a trade-off, in terms of safety. The tyres long contact patch (relative to its narrow width), revolutionary tread design and compound still ensure outstanding grip in both wet and dry conditions.

A second feature is the unique 'Multicell' compound that contains microscopic bubbles and tubes, which clear water rapidly from between the tyre and ice or snow surface and assure a proper contact with the road. As the water is cleared, the 'bite' particles come into contact with the ice surface, improving the grip even further.

With the prospect of multi-compound tyres filtering down from high-performance cars and developments like Bridgestone's intelligent Contact Area Information Sensing based system that can monitor in real-time tyre wear and tread depth, then the advances in this sometimes overlooked area of vehicle development appear to be coming thick and fast.

systems can, in theory, produce tyres within a tolerance of 0.01mm, enabling the engineers to design a tyre with 70% improvement in high speed uniformity and a 10% weight reduction on rival run-flats.

Also, the Azenis FK453 features a dimpled sidewall that helps to disperse heat, allowing the tyre to run at speeds up to 80Km/h for 80Kms, despite the side wall being 20% more compliant than rivals.

An alternative to run-flat is Michelin's Selfseal technology that is being targeted at emerging markets, such as the Association of Southeast Asian Nations (ASEAN), where

MICHELIN TECHNOLOGY IN ACTION

2 As the tyre wears, rain grooves widen, in order to maintain wet weather grip

3 As the tyre wears, grooves open up to evacuate water



1 On a microscopic level form a finer, tighter grid that distributes key additives more evenly, maximising wet traction

4 The tyre delivers safety, performance and durability



APPLIANCE OF

With more materials used in vehicle structures, *Automotive Design* reports on the challenge that this then sets when it comes to recycling

A product's green credentials are now an essential part of its brand image and sales appeal. Whether it's the refrigerator in the kitchen or the light bulbs in the lounge, any device that consumes power is coming under increasing scrutiny as to just how efficient, or otherwise, it might be.

Perhaps more than any other sector, it is the automotive industry that has been at the forefront of the march towards a greener future. This isn't just about tailpipe emissions, which is a simple and – some would argue – misleading way of illustrating just how environmentally friendly, or not, a given vehicle is. It is about the complete manufacturing process: from mining the ore that is turned into the metal the car is built from, to the complete manufacturing process, to its usage and, finally, its disposal at the end of life.

UPFRONT IMPACT

Life Cycle Analysis (LCA) has become a science in itself – the ability to model upfront what impact over its lifetime a given vehicle will have, in terms of CO₂ emissions. Historically, the vehicle's 'use' phase has accounted for some 85% of CO₂ emissions.

But, as engines have become more efficient, reducing both fuel

consumption and exhaust gases (ironically, at the same time as vehicles have tended to get bigger and heavier), that percentage has dropped to around 63% in the 'use' phase, with the balance of 27% accounted for by manufacturing, according to Jaguar Land Rover's technical specialist for whole vehicle sustainability, Jamie Shaw.

“Any device that consumes power is coming under increasing scrutiny as to just how efficient, or otherwise, it might be”

“For something like a Range Rover, that's one out of 61-62 tons of CO₂ created during its 10-year, 200,000 Kms life cycle that we base our calculations on,” says Shaw, “although many last longer and cover a higher mileage.” Where the car spends its driving life can also impact on that figure.

Typically, a Range Rover would

have 36,000 lines of data to analyse that would include the entire bill of material and the manufacturing impact of each component. That figure was arrived at by analysing a genuine car specified by a customer; adding or eliminating various options, Shaw points out, makes practically no difference.

MASS APPEAL

The biggest gains to be had in LCA are through weight reduction, because the less mass you're dragging around, the greater the impact on the 'use' phase of a vehicle's life. Typically, taking 100Kgs out of a car results in a 2% improvement in fuel efficiency, while employing recycled materials has a lower impact than using virgin materials; none more so than when aluminium is used for vehicle structures and body panels.

Even though virgin aluminium is power-intensive, recycled aluminium requires 95% less energy, because its melt point is relatively low – hence the industry's drive towards greater use of recycled aluminium.

To ensure you get back 'like for like' from the recycling process, says Adrian Tautscher, responsible for sustainable aluminium strategies at Jaguar Land Rover, aluminium grades, whether cast or sheet, should be segregated. “We've

LCA SCIENCE

achieved that in manufacturing with process scrap going back to Novelis to be melted into automotive sheet and that's been running for several years, with no loss of quality."

Steel, he concedes, is more tolerant of being mixed, but then loses out with a melt temperature twice that of aluminium.

The ultimate aim would be to use 100% recycled aluminium, but, with its consumption expanding across all sectors, production will have to increase three-fold by 2050 to satisfy projected demand and that won't be satisfied by recycling alone.

SLOWLY, SLOWLY

Part of that is due to the lag in recycling technology and the sporadic timing that cars go for recycling. Not all XJs or Audi A8s will be scrapped at the same time, while the shredding and sorting technology will need to be improved, although it's difficult to persuade the operators of the need for investment today for products they might not see for another decade or more.

The vision of the 100% totally recycled car is unlikely to be realised in the 'foreseeable' future. However, as LCA matures and recycling becomes more sophisticated, the closer the industry comes to creating a closed loop economy: a manufacturer builds a product, the customer uses it and, when they're finished with it, it is taken back and recycled into the next generation of products. And that could be any product from any industry.

Weight for it... MagiZinc is here

Aluminium isn't having it all own way by any means when it comes to lightweighting and LCA.

Steel giant Tata has developed MagiZinc, which incorporates a small percentage of magnesium and aluminium in the coating that reduces weight by 30% over conventional G1100 steel, resulting in a 14% reduction in its carbon footprint.

In the fabrication process, there's a 3.3% improvement in press shop yield and upwards of 3.6% in life cycle carbon footprint. An optimised body structure would save a kilo with extensive use of MagiZinc, delivering a reduction in use phase-related emissions of 4 kgCO₂e.

For a B-segment car, add to that the 12kg CO₂e carbon footprint saving from manufacture, fabrication and end of life recycling results to give a total life cycle carbon footprint saving of 16kg CO₂e.



MagiZinc offers press shop and carbon footprint benefits.

Ryan Gehm looks ahead to this year's SAE World Congress & Exhibition, where the theme, 'Leading Mobility Innovation', heralds what SAE International sees for automotive as...

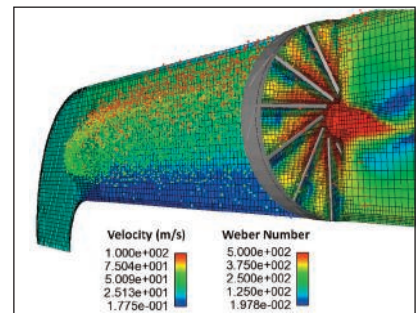
THE DAWNING OF A NEW DAY

cEngine system analysis

Software Cradle has announced that its SC/Tetra Version 12, scheduled for release in June 2015, will introduce several new features, including the coupling of SC/Tetra CFD software with Gamma Technologies' GT-Power software for engine system simulation, allowing more accurate and detailed calculations for enhanced analysis and development. A GT-Power 1D simulation of the intake manifold could be replaced, for example, by an SC/Tetra 3D model, including compressible flow and mixing gas analysis.

This is particularly important for exhaust gas recirculation (EGR) simulation, according to Software

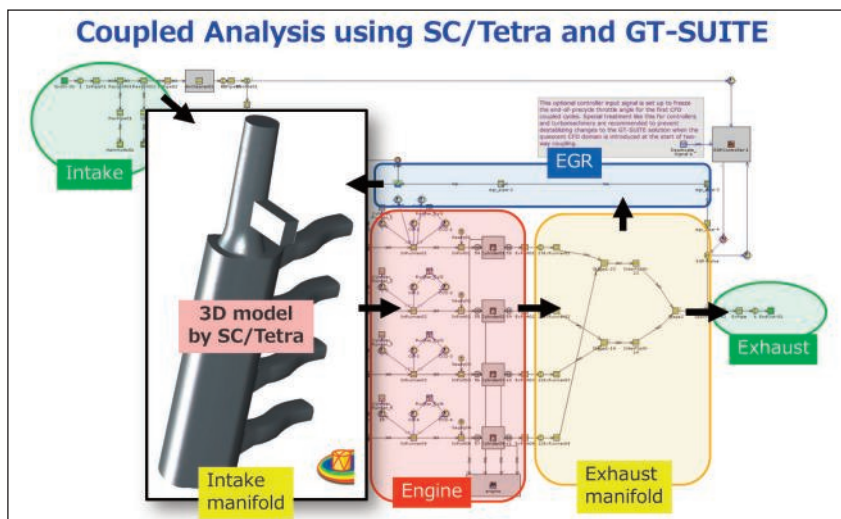
Cradle, where a feedback is needed from the exhaust to the intake manifold. Performing the entire simulation in 3D is too expensive, while a 1D simulation cannot fully resolve the effects of 3D phenomena in the manifold. The coupling is set up using extensions to the standard, user-friendly SC/Tetra Condition Wizard, which lets the engineer systematically define the relationships between inflow/outflow conditions and chemical species in the two software packages. SC/Tetra can be employed for the design and analysis of engine systems, aerodynamics, climate control, acoustics and numerous other automotive applications.



Aftertreatment system

To achieve Tier and Euro emissions compliance, with minimal impact on efficiency, system size and maintenance, Convergent Science has developed an aftertreatment simulation approach for on- and off-road urea/selective catalytic reduction (SCR) systems that combines spray, wall-interaction, chemistry and heat transfer models with automatic meshing.

Built for in-cylinder simulations, this is suited for urea/SCR systems with transient sprays that impact mixers, potentially producing liquid films resulting in solid urea deposits. Convergent's approach gives designers the flexibility to change geometry and exhaust system layout to improve performance. The use of computer simulation and code reduces aftertreatment system design time; in-cylinder combustion modelling timeframes are shortened by replacing user-defined meshing with the automated mesh generation process.



Virtual road traffic

A model for traffic and environment simulations from dSPACE supports the testing of advanced driver assistance systems (ADAS). ASM Traffic 3.0, part of the Automotive Simulation Models (ASM) library, simulates active safety systems, including autonomous emergency braking and emergency steering assistance, allowing users to test and demonstrate ADAS capabilities early in development.

With the ASMs, developers can simulate test vehicles, urban and rural road networks, other vehicles, pedestrians and traffic signs in real



time. Virtual sensors detect the objects in the simulated environment and signal ADAS to take appropriate action. Simulated collision risk scenarios can be used regressively to test the functionality of active safety and driver assistance systems. Engineers can also import road information from other mapping and simulation tools.

Heat-resistant steel casting

Hitachi Metals offers Hercunite-S heat-resistant steel casting for exhaust systems to improve fuel economy and reduce CO₂ emissions. With increasing demand for heat-resistant casting that withstands high-temperature exhaust gases from turbochargers, the Hercunite-S Series is a next-generation, downsized design that also meets higher fuel economy standards. Applications include exhaust manifolds, turbine housings and exhaust manifold-integrated turbine housings.

The series operates over a wide



temperature range, up to 1050°C, and provides the correct shape for casting, using the company's computer-aided design and rig-burner test systems. Castings contribute to improved fuel economy and cleaner exhaust gases, and are geared toward high-temperature combustion of engines with low-alloy, heat-resistant cast steel.

High-capacity shock system

Intertek recently acquired an ETS Solutions 115,655 Nm vibration and mechanical shock system that will enable the company to double its existing capacity on high payload testing to up to 862 kg. The shaker is the largest in Intertek's network and will allow the company to test both heavier components, as well as multiple smaller components in a single run. The ability to test heavier and/or multiple components will potentially reduce testing time and ensure the durability of products in both the design and production validation stages. The system is installed at Intertek's lab in Plymouth, Michigan.

In-cylinder gas analysis

LaVision's internal combustion optical sensor (ICOS) product family provides a series of techniques for the measurement of quantitative, in-cylinder, transient engine-relevant



values, such as air/fuel-ratio, temperature or the exhaust gas recirculation (EGR) rate. Systems are applicable in petrol or diesel experimental or production engines; do not require a gas sampling system; and measure contactless without a time delay.

The ICOS-Fuel system provides a technique for air/fuel-ratio analysis for crank angle resolved investigations, such as cold start. The system measures the cycle-resolved internal and external EGR rate directly inside the cylinder, with consecutive cycle variations at different engine conditions, and accurately compares



injection systems. The ICOS-Temperature system analyses time-resolved in-cylinder temperatures in internal combustion engines.

Media converter

Intrepid Control Systems offers a rugged, pocket-sized RAD-Moon media converter that interfaces conventional Ethernet with BroadR-Reach. Powered by USB, the device allows communication between a PC and an automotive Ethernet electronic control unit (ECU). Features of the converter include single port BroadR-Reach PHY (BCM89810) connected directly to one port of 4-wire 10/100 Mb physical layer (PHY); master/slave auto-configuration; activity Link LEDs for both PHYs; Molex Mini 50 connector for BroadR-Reach PHY; and RJ-45 connector for 10/100 Mb PHY. Part of Intrepid's complete line of automotive Ethernet tools, the RAD-Moon features a small, rugged enclosure suitable for portability.

Land Rover's latest Discovery packs a lot of space into a compact vehicle. Paul Cleaver explains to Ian Adcock

It would be fair to say that the Land Rover and Range Rover brands have a dilemma when it comes to balancing vehicle attributes: on the one hand, the brands both carry 'The best 4x4x4' tag lines, yet to achieve their peerless off-road performance naturally leads to a compromise in on-road dynamics. While that might not necessarily be an issue with the more utilitarian nature of Land Rovers, Range Rovers have moved so far upmarket that some models can now, rightly, be classed as luxury rivals bordering on Bentley territory. And for most of their owners, the nearest they get to off-roading is parking with two wheels on the kerb outside a fashionable restaurant.

Yet any dilution of that capability would be to deny their heritage and the reason why people buy them: because they like the idea of being able to rough it off-road one minute and then turn up at an opera house, complete with tuxedo, the next. But they never do. It's the same with Ferrari, how many owners fully exploit their cars' capabilities? A tiny



VOYAGE of

percentage, but the aura of F1, Vettel, Raikkonen and Ferrari's folklore is bestowed upon the owners.

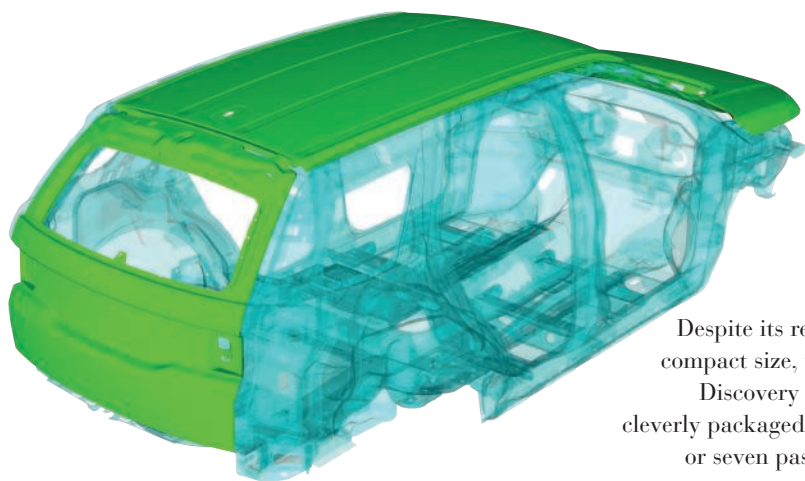
RIVAL CLAIMS

And, of course, while Ferrari has few rarefied rivals, the same cannot be said for Land/Range Rover, which has seen every Tom, Dick and Harry in the motor industry jump on the

SUV/Cross-over/4x4wagon, including fellow marque Jaguar. But, in most instances, these rivals are faux 4x4s: greater ride heights and a nod to the occasional 'off-roading' across a field at a county show. But they drive, ride and handle more like the saloons from which their owners have migrated.

Such has been the challenge for Range Rover engineers and now, it seems, also for those responsible for the Land Rover badge; the latest product bearing the green oval is not just the Discovery replacement, but the Discovery Sport. The 'Sport' bit is important, because it is targeting the upstart 4x4s from German OEMs, in terms of on-road dynamics, combined with the mud-plugging, rock-climbing sand-shifting capabilities of a traditional 4x4. Oil and water, you might think.

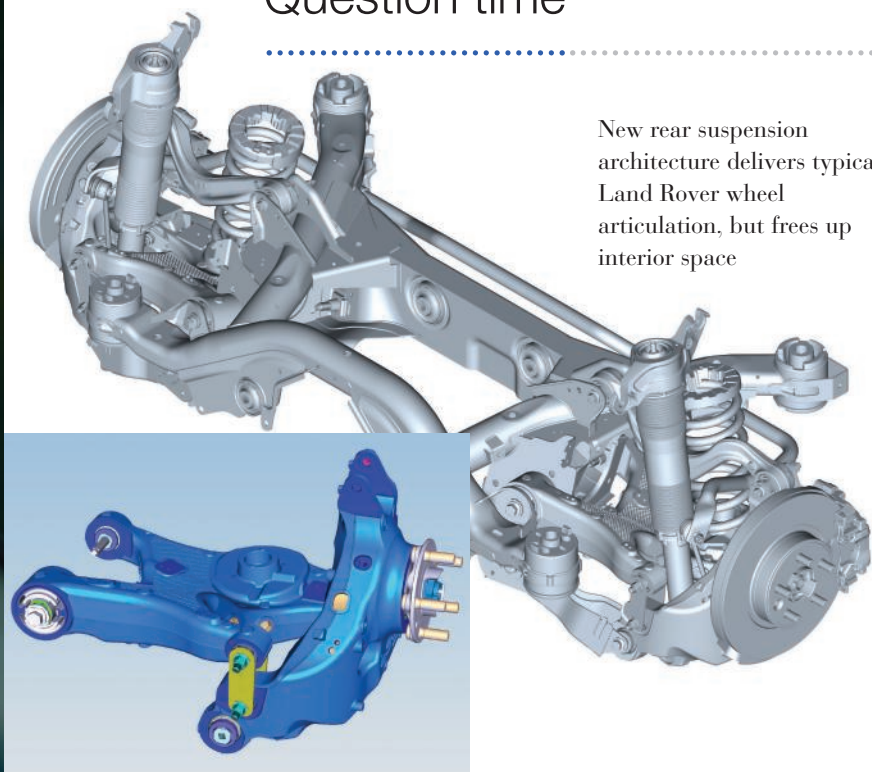
Vehicle programme director for the Discovery Sport, Paul Cleaver, would disagree: "Wheel articulation is as good as Freelander and Evoque, with



Despite its relatively compact size, the new Discovery Sport is cleverly packaged for five or seven passengers

“While Ferrari has few rarefied rivals, the same cannot be said for Land/Range Rover, which has seen every Tom, Dick and Harry in the motor industry jump on the SUV/Crossover/4x4 wagon, including fellow marque Jaguar”

Question time



New rear suspension architecture delivers typical Land Rover wheel articulation, but frees up interior space

DISCOVERY

340mm of travel; off-road capability is sacrosanct in any Land Rover. The approach, break over and departure angles, suspension articulation, wheel travel and wheel envelopes all drive the other components to fall into the packaging envelope.”

SPACE CHASE

The multi-link rear axle is developed from that which made its debut on the Range Rover Sport and scaled down for this application – which, says Cleaver, “is a little bit more expensive” than rival technologies for this class of vehicle, but the absence of turrets intruding into the rear luggage area delivered the additional packaging Land Rover wanted. “It saves, probably, in the region of 20-30mm in Z height, and that allowed us to clear out the rear environment and maximise the width of the load space,” he explains.

Adopting this new suspension strategy, which is likely to be used in

other Land Rover products in the future, meant the engineers could develop two rear-end solutions for the five- and seven-seater configurations; that for the five-seater allows a full-size spare to be located beneath the load floor, while the seven-seater’s spare is stowed under the vehicle.

“That was a challenge, given the proportions, and clearly, for us, we want short front and rear overhangs to deliver the off-road geometry needed.”

It also led Land Rover to engineering two exhaust systems: a twin muffler design that sits up around the spare on the seven-seater and a transverse muffler on the five-seater.

SEATING ARRANGEMENTS

Land Rover worked with its usual seat suppliers, Brose for the structures, and Johnson Controls for trim and as overall integrator. Again, they are based on those used in the Range Rover Sport, suitably modified and redesigned for the Discovery Sport.

The second row of seats has a class-leading 160mm of fore and aft movement, with the 60:40 split allowing independent adjustment and with the centre seat folding flat, providing good forward visibility for the third row occupants, packaged primarily for 50th percentile children and occasional adult occupants.

In five-seater models, the rear seats flip and fold with a single control. “We wanted a very easy to use operation to drop the head rest and seat back in one movement via a strap on the back of the seat, which drops it into the load space,” Cleaver adds. “From the outset, we wanted the car to be no longer than 460cms, which, for a plus two seater, is pretty aggressive for overall length.

“It needed to be versatile, so it had to have plus two seats, but we were also very mindful of not compromising anything on the interior occupant package, given the compact exterior we had.”

Harald Schoepp, leader development team SmartCore technology, Visteon

Convergence: visions for the future

“There’s a big vision for convergence in cars. On the one hand, there’s the complexity of the system, with head up displays, instrument clusters and infotainment competing with cloud activity and driver assist all coming together. The user interface has a complexity where the average human has issues coping with this level of information. You cannot be overwhelmed with ever increasing amounts of information and interaction whilst the car is not fully autonomous.

“The other driver here is coming from the infrastructure side, with systems increasingly having to interact and communicate with each other. Added to that, we now have dual core, quad core even eight core micro processors on a single piece of silicon.”

Schoepp says there “are good reasons” to keep safety and security systems separate from infotainment or the connected cloud and, whilst drivers might want those regularly updated as on their Smartphone, other things, like the instrument panel clusters, change very little.

“The highly innovative power in SmartCore is to keep the separation where necessary, at the same time fully opening the convergence of different functional domains, resulting in lower costs, better performance and improved driver usability.

“Ultimately, it’s in the hands of the OEMs to what extent they want to allow open or closed systems. In our system, one partition could be owned by Android, for example, but we are agnostic and the system we have been building can potentially use four different operating systems for each domain. This broad capability is a particular strength of our system.

“There are two other very important aspects to this system: the computing horsepower and the graphics horsepower. Systems you find in cars like the BMW 7-series and Mercedes-Benz S Class will have migrated down to entry-level cars, like the I-series or A-class, by 2018. What we’re working on now is I2-inch high definition screens that have the same resolution as a 50-inch television screen of today.”

These powerful new screens, predicts Schoepp, will result in a major rethink in dashboard and instrument cluster design when combined with HUD. “As they become more powerful, information can be brought to the driver and passengers in a much more convenient display, making the central instrument display obsolete in some cases.

“We support all control methods, from touch displays – which Asian customers prefer – to classic haptic devices – which you find in a lot of German cars – through to voice input and output.”



“What we’re working on now is I2-inch high definition screens that have the same resolution as a 50-inch television screen of today”



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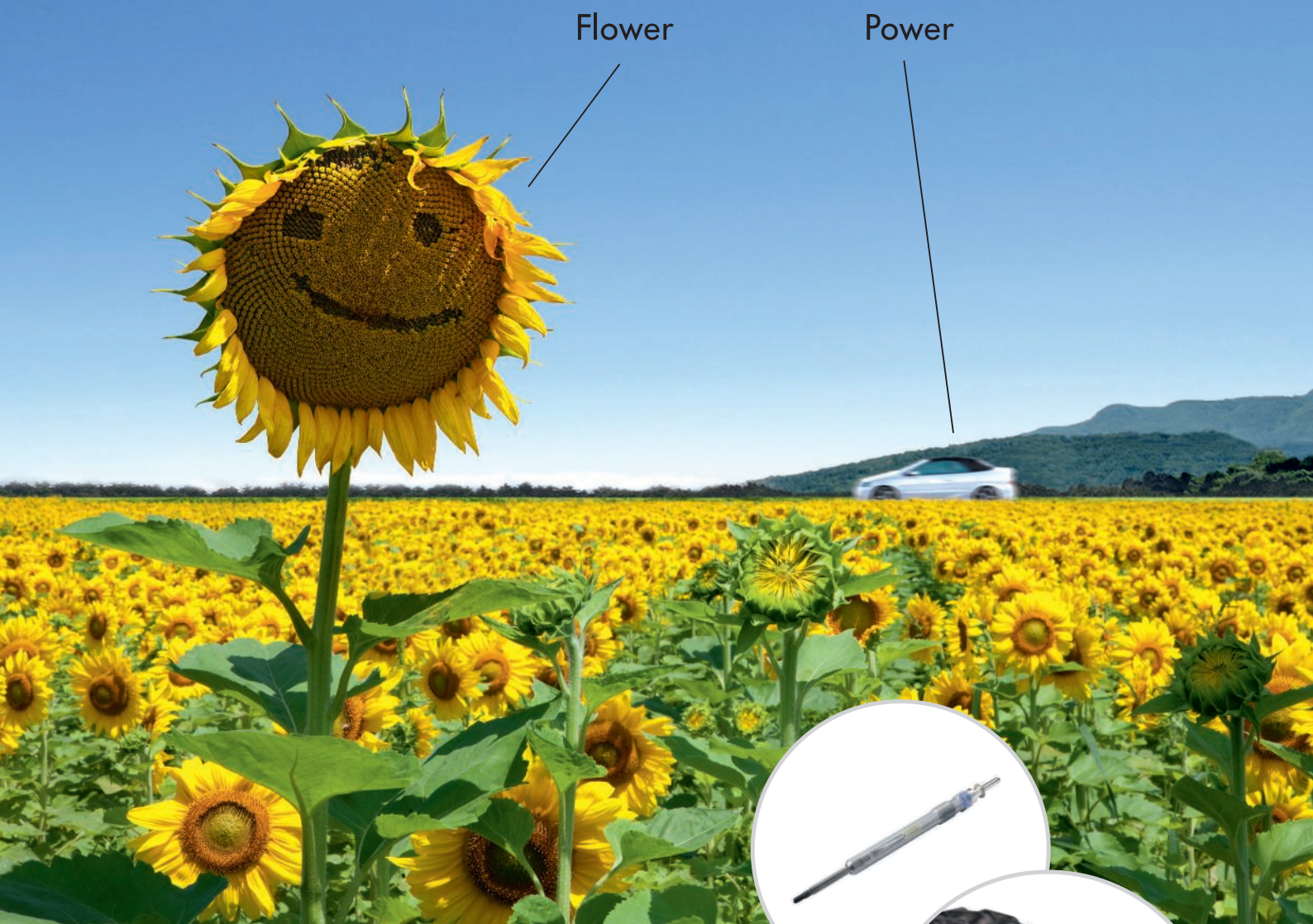
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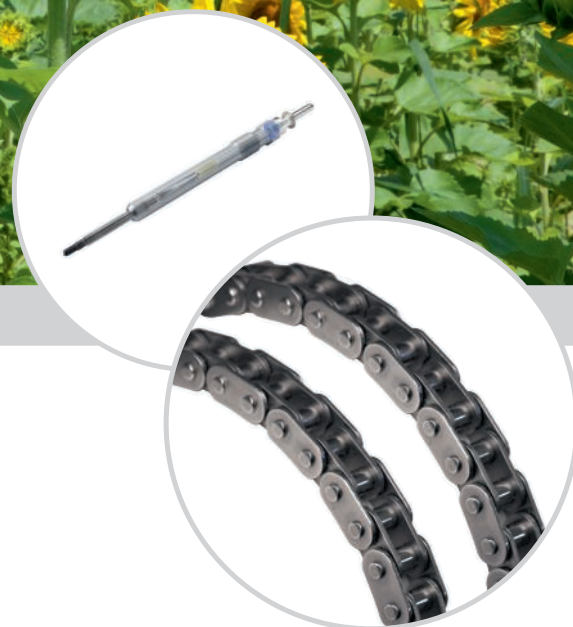
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