



proActive

ISSUE 49 - SUMMER 2013



JON HILTON

MANAGING DIRECTOR OF FLYBRID SYSTEMS

SUMMER 2013

LOOKING AT THE STATE OF THE AUTOMOTIVE INDUSTRY

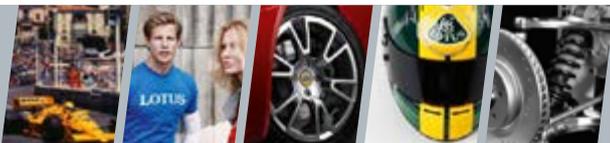




A PASSION FOR **POWER.** THE NEW EXIGE S ROADSTER

The Exige S roadster is the lightest and most powerful soft top car that Lotus has produced to date. The 0-60 mph time is an exhilarating 3.8 seconds with a top speed of 145 mph, a passion for power, and a passion for Lotus.

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Official fuel consumption, Lotus Exige S in mpg (l/100km): Urban 19.5 (14.5), Extra Urban 37.2 (7.6), Combined 28.0 (10.1). CO₂ emissions: 236 g/km.



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Lotus News



Exige S at Goodwood and in RED 2

During a fun filled day at the 2013 Goodwood Festival of Speed, Lotus Cars proudly presented the stunning Exige S Roadster to Romain Grosjean ahead of its first outing.

Grosjean took the new soft top on the famous Goodwood hillclimb to mark its first public dynamic appearance, wowing the thousands of fans who took to the sidelines.

The heat at the 20th FoS was pretty intense but it was the Exige S roadster with its gorgeous looks and superstar driver that got the crowds hot under the collar!

This summer's smash-hit movie release 'RED 2', the sequel to 'RED' (Retired Extremely Dangerous), stars a host of brilliant performers; Bruce Willis, Helen Mirren, John Malkovich, Catherine Zeta-Jones, Sir Anthony Hopkins and the Lotus Exige S.

As a special exhibit for the 2013 Goodwood FoS, one of three cars used for the movie was on display at the Lotus stand dressed in its original stunt 'costume'.

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SPEED



Rolls-Royce
Motor Car



DAYTONA
INTERNATIONAL SPEEDWAY

CITROËN



Clo



Elise S Club Racer





Making its global debut at Goodwood is the brand new Elise S Club Racer. Following the hugely popular 'Club Racer' variant on Lotus' entry level 1.6 litre Elise, the lighter-weight, enthusiast orientated package is now available on the supercharged 1.8 litre Elise S.

Achieving up to a 20 kg weight reduction over the standard Elise S, the Club Racer boasts an improved power to weight ratio delivering 240 BHP per tonne, it accelerates to 60 MPH from standing in 4.2 seconds, and

reaches a top speed of 145 MPH.

Enthusiasts can even reduce the weight of the Elise S Club Racer by a further 8 kg by specifying track-use, dealer-fit options such as a TRD air box and filter element and a sports exhaust.

The stripped-out, race inspired Elise S Club Racer benefits from both a weight-reduction initiative and the extra power of a supercharger, and is a compelling proposition for sportscar fans; quick, good looking and fun to drive!



Mixed results for Lotus F1 Team as season progresses

After a great start to the racing season, which saw a number of podium places for Lotus, disappointing races in Monaco, Canada and the UK, saw Lotus drop positions in both the drivers and constructors championships. Lotus F1 Team will be hoping that the double podium success at the German GP will be a sustainable return to form.

Kimi takes second place in Spanish GP

Kimi Räikkönen took his fourth podium finish of the season with second place in the Spanish Grand Prix, moving him to within a tantalising four points of Championship Leader Sebastian Vettel. Unfortunately, Romain Grosjean's race ended after just 8 laps following a suspension failure on the right rear of his car.

Single point for Lotus at Monaco Grand Prix

Kimi Räikkönen salvaged a solitary point on the final lap of an incident-rich Monaco Grand Prix after a late puncture forced him to pit from fifth place. Having re-joined the field in thirteenth, Romain Grosjean's race ended early following damage to his car after making contact with the rear of Daniel Ricciardo's Toro Rosso on lap 62.

P9 for Kimi at Canadian GP

Having endured a difficult Canadian Grand Prix, Kimi equalled Michael Schumacher's record of consecutive points finishes by finishing in ninth place. Romain started from the back of the Montreal grid and fought through the field to temporarily occupy a points placing, before an unexpected second stop dropped him to thirteenth place.

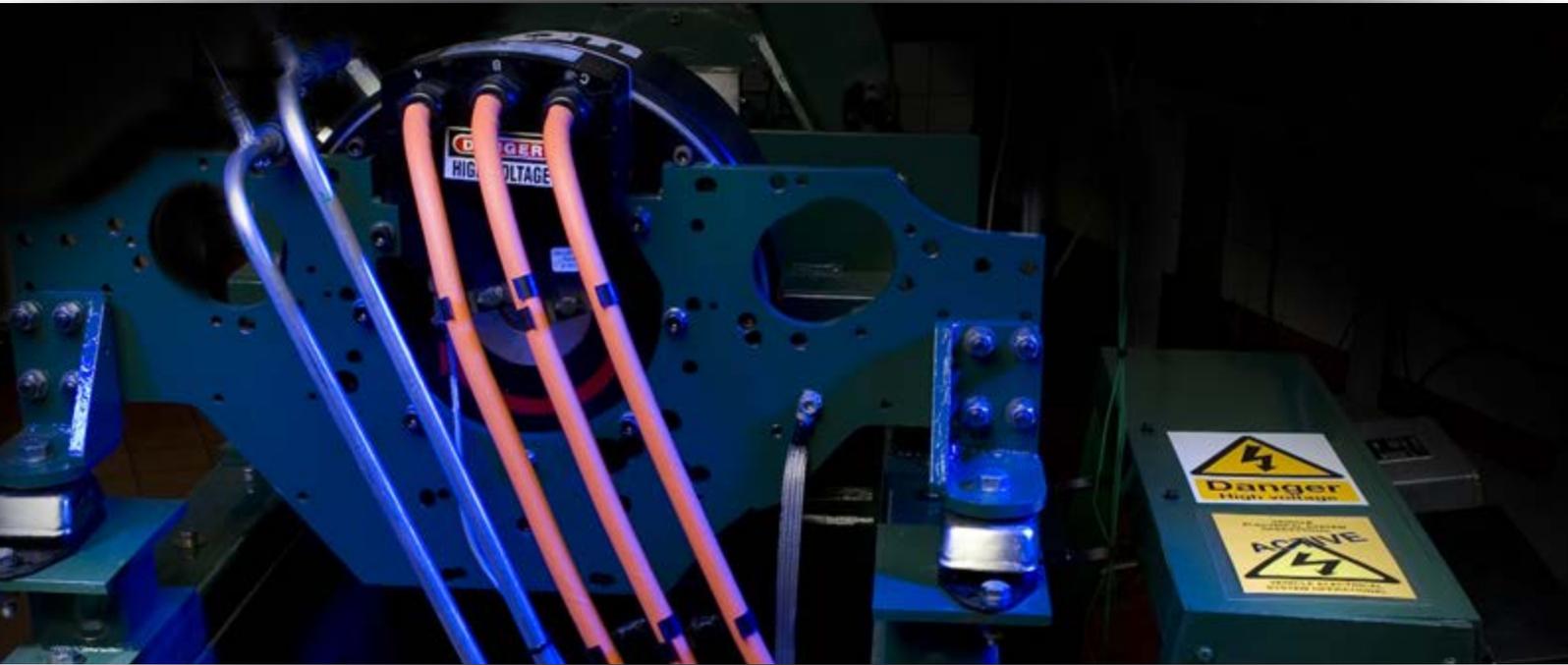
Lotus miss out on podium at British Grand Prix

Kimi set a new record for consecutive Grand Prix points placings (25) by taking a hard fought fifth position in an eventful British Grand Prix at Silverstone. The Finn ran as high as second place in a race punctuated by safety car periods and characterised by an unusual amount of tyre failures. Romain had a more difficult race, from which he retired at the end due to a front wing failure.

Double Podium for Lotus at German GP

Kimi and Romain returned to the podium with Kimi taking second and Romain third in a fast-paced German Grand Prix at the Nürburgring. Kimi remains in third position in the Drivers' Championship with 116 points and the team is fourth place in the Constructor's Championship with 157 points.





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Lotus Engineering is leading the way in the fast moving development of hybrid and electric vehicles, utilising a wide range of virtual and physical testing from component to the vehicle level, across the entire development process. Our extensive powertrain development facilities in Europe and North America are constantly expanding to meet the increasing demands of powertrain electrification.

We have over two decades of experience in building electric and hybrid vehicles. The challenges they pose are well-suited to the breadth of skills and expertise within Lotus Engineering. Our experience in control systems, electrical integration and engine design complements our 'whole vehicle' knowledge that comes from being a car manufacturer. This means we can help create practical, efficient hybrids which are viable for production.

For more information on how Lotus Engineering can help your hybrid programmes, contact us on +44 (0) 1953 608423

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Industry News

SWEDEN: Volvo Cars claims animal and pedestrian detection firsts

Geely's Volvo Car Group is claiming world firsts for animal and night pedestrian detection technology due to make its debut in the redesigned XC90 crossover due out at the end of 2014.

This, the automaker said, makes the detection and auto brake technology work effectively also when driving in darkness. It includes detection and auto brake for other vehicles, pedestrians and cyclists.

The redesigned XC90 will also get road edge and barrier detection with steer assist which detects if the car is about to drive off the road and autonomously applies steering torque to bring the vehicle back on track.

"Being able to monitor where the physical road ends is a world first. This means that the technology also works on roads without side markings," Volvo said in a statement.

Adaptive cruise control with steer assist helps the driver stay in the lane and follow the rhythm of the traffic. The new system automatically follows the vehicle ahead.

"We are introducing the first Volvos with autonomous steering to avoid accidents and make driving more

comfortable," said the automaker's senior safety adviser Thomas Broberg.

Another claimed global first is 'collision mitigation for animals' which detects and automatically brakes for animals both in daylight and in the dark. The technology, designed to help the driver avoid accidents or reduce the speed of impact, will be introduced after the new XC90 is launched.

The automaker, along with rivals like Audi and BMW, developing autonomous parking which allows a car to find and park in a vacant space by itself, allowing the driver to leave the vehicle at the entrance to the car park.

Combining autonomous driving with detection and auto brake for other objects makes it possible for the car to interact safely with other cars and pedestrians in the car park, the automaker said. The speed and braking are adapted for smooth integration in a parking environment.

"Our approach is based on autonomously driven cars being able to move safely in environments with non-autonomous vehicles and unprotected road users," said Broberg. ■



US: Ford develops new manufacturing technology to save time and cost



Ford says it is developing a new form of manufacturing technology that has the potential to reduce costs and delivery time for sheet metal parts needed in smaller quantities.

The development is based on Ford Freeform Fabrication Technology (F3T), a patented manufacturing process developed at the Ford research and innovation centre. Through this process, a piece of sheet metal is clamped around its edges and formed into a 3D shape by two stylus-type tools working in unison on opposite sides of the sheet metal blank. Similar to a digital printer, after the CAD data of a part are received, computer-generated tool paths control the F3T machine to form the sheet metal part into its final shape to the required dimensional tolerances and surface finish.

"The technology behind F3T is yet another example of Ford leading in the advanced manufacturing space," said John Fleming, executive vice president, global manufacturing and labour affairs. *"As we forge ahead with cutting-edge technologies in manufacturing like flexible body shops, robotics, 3D printing, virtual reality and others, we want to push the envelope with new innovations like F3T to make ourselves more efficient and build even better products."*

Currently, traditional stamping processes are energy-intensive, and it often takes several months for the first part to move from concept to production. While traditional

processes remain the most efficient method for high-volume stamping, efficiencies for low-volume production can be achieved with the flexibility F3T provides.

Ford says that the benefits of F3T include:

Low cost:

Geometric-specific forming dies are completely eliminated, along with the high cost and long lead time associated with die engineering, construction and machining.

Fast delivery time:

The technology aims to enable the delivery of a sheet metal part within three business days from the time the CAD model of the part is received. With the current technology, parts are delivered anywhere from two to six months using conventional methods - up to approximately 60 times longer than the potential turnaround time for F3T.

More flexibility:

Once fully developed, F3T will help to improve the vehicle research and development process, allowing for more flexibility in quickly creating parts for prototypes and concept cars. Currently, creating a prototype dye can take six to eight weeks, and developing a full prototype vehicle usually takes several months and up to hundreds of thousands of dollars. F3T could produce sheet metal parts for prototypes in just days for

essentially no cost.

F3T, Ford claims, has the potential to allow for greater personalisation options, adding the ability for buyers to customise vehicle bodywork. F3T is also expected to have broad applications outside of the automotive industry, including use in the aerospace, defence, transportation and appliance industries.

The project is part of a three-year, USD 7.04 million US Department of Energy grant to advance next-generation, energy-efficient manufacturing processes. Led by Ford, other collaborators include Northwestern University, The Boeing Company, Massachusetts Institute of Technology and Penn State Erie. Five innovative manufacturing projects were awarded a total of USD 23.5 million by the Department of Energy in March to advance clean manufacturing and help US companies increase their competitiveness.

"The F3T sheet metal forming process is one of many advanced manufacturing technologies under development at Ford," said Randy Visintainer, director of Ford research and innovation. *"We developed this process during the past four years for small-scale applications in a laboratory setting, and the DOE award enables us to scale the process for larger applications and a full prove-out for manufacturing feasibility."* ■

ITALY: Alfa Romeo 4C manufacturing processes revealed

Alfa Romeo has revealed details of how the new 4C is built at Maserati's Modena works using a mix of lightweight materials. The model weighs just 895 kg, making it one of the world's lightest cars.

Carbon fibre was chosen for the structural function monocoque that makes up the central, load-bearing cell of the 4C's chassis. The monocoque, which weighs just 65 kg, is manufactured by Adler Plastic.

So-called 'pre-preg' technology, which Alfa Romeo says was inspired by Formula 1, allows production of over 1,000 pieces per year. With pre-preg, the fibres are arranged in an optimum structural direction, thus producing a result which metal would only yield if layers were overlaid, shims differentiated, and reinforcements added.

In addition, the autoclave polymerisation makes it possible to manufacture box-section structures in one phase, whereas normally the production and assembly of various components often made of different materials is required. One example would be the door post. In its standard steel version, the door pillar is comprised of approximately six pieces attached to one another and to the car body at different stages of the manufacturing process. If autoclave polymerisation is used, the door post is a one-piece component included in the load-bearing structure.

Aluminium

Aluminium is used for the roof reinforcement cage and the front and rear frameworks. Designers replaced the traditional rectangular strut section with a newly designed section. In this way, they obtained lighter and, at the same time, safer frameworks, according to Alfa Romeo. Frameworks are manufactured using the innovative 'Cobapress' process. Cobapress joins the advantages of fusion and the benefits of forging under press

by compressing the aluminium alloy even further, thus removing any residual porosity.

Thanks to the use of seam welding processes, welding is said to be extremely precise, while the components are not deformed and the filling of the gaps is said to be excellent.

Aluminium also plays the main role in the hybrid-type front brake discs with aluminium bell and cast iron ring gear. This patented technology developed by SHW guarantees up to 2 kg of weight reduction per disc in addition to better braking. Furthermore, the sophisticated surface finishing technology by brushing increases grip and pedal feel, whereas the innovative release system between disc and bell is claimed to guarantee more comfortable and safer braking. The difference in the thermal expansion coefficients of cast iron and aluminium is compensated by specific steel radial pins which accurately transmit the braking action.

SMC (Sheet Moulding Compound)

Using SMC, a low-density and high resistance composite material, for the body has allowed a 20% weight reduction in comparison with traditional sheet steel. The 4C is said to be the first standard production car to achieve such a high percentage of low-density SMC: with a weight of 1.5 g/cm³ this material is decidedly lighter than steel (~7.8 g/cm³) and aluminium (~2.7 g/cm³), besides being more malleable. Moreover SMC is a stable material which, unlike aluminium, does not strain in the event of minor impacts, has high resistance to chemicals and atmospheric agents, and also disperses noise very well to the advantage of acoustic comfort.

Finally, low-density SMC guarantees a good functional integration of the parts; this in turn entails a reduction in the number of components and operations,





and requires shorter assembly times, thus lowering production costs.

PUR-RIM (injected polyurethane)

PUR-RIM was chosen for bumpers and wings for the same reasons described above. It is a lightweight material (weighing 20% less than steel) suitable for creating very complex design elements, such as the 4C wing, and for keeping an ideal cost/production volume ratio.

Windows

In the case of glass, lower weight was obtained by adopting a real silhouette-thinning approach: all the windows are on average around 10% thinner than the glass normally fitted on cars; this allows for an average weight reduction of 15%. The windscreen in particular is only 4 mm thick. Alfa claims this to be an extraordinary result, considering this "particularly aerodynamic shape is difficult to obtain" on such thin glass.

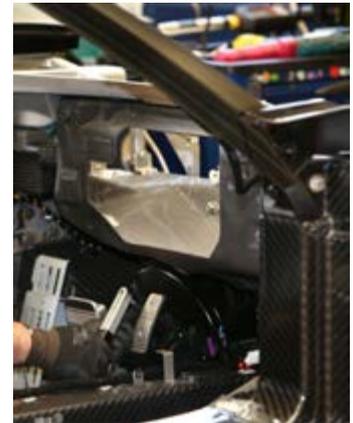
Manufacturing

The minimum takt time (the manufacturing speed needed to guarantee delivery) for the new 4C is 20 minutes. Maserati and Alfa claim that in most mass production plants, the shortest takt time is approximately 50 seconds.

Production takes place in dedicated 4C workshops: there are areas for body fitting and assembly operations, whereas the testing and finishing areas are shared with those for Maserati production.

The 4C primary structure is assembled in the body fitting area: here the first skins are applied to the newly created body in white. At station 10, operators fit the carbon monocoque on the front and rear chassis and on the crossmembers.

A little further down the line, on station 30, the vehicle cell is closed using the windscreen frame and the roof: this operation requires the use of special masks that ensure what the company terms 'the exact passenger compartment geometry'.





Finally, couplings are produced with state-of-the-art polymers and reinforced with mechanical joints.

Once the body is fitted, the 4C body in white undergoes a quality assurance check in the measuring room. Every day several sample bodies are subjected to high precision measurements. The dedicated team checks up to 400 measurement points in order to ascertain that the body is perfect from a geometric and dimensional standpoint.

The next step is painting, the only process performed outside the Maserati plant. After they have been painted, the bodies in white return to the plant.

It is claimed that the supercar is the only vehicle starting its assembly sequence with a 'disassembly' operation. Before the internal components can be assembled on station 1, the car is brought back to its primary structure by removing some of the parts that have already been painted,

such as the bonnet and the doors, and some structural parts, such as the rear frameworks and the turret bar. At this point, the car is attached to a rotating hook.

After production, delivery

In Europe the first cars are scheduled to be delivered in the second half of September, whereas the US version will be launched in November in Los Angeles, with the first deliveries scheduled for the end of 2013.

Fiat will build an initial 1,000 units of the 4C 'Launch Edition': 400 for Europe, Africa and the Middle East, 500 for North America and 100 for the rest of the world. In most European markets, the Launch Edition is priced at 60,000 euro.

After this first batch of cars is produced, availability will be limited to 3,500 cars per annum, 1,000 of which will be for European markets.



US: GM and Honda to collaborate on fuel cells, hydrogen storage

General Motors and Honda have announced a 'long-term, definitive master agreement to co-develop next-generation fuel cell system and hydrogen storage technologies, aiming for the 2020 time frame'.

The collaboration expects to succeed by sharing expertise, economies of scale and common sourcing strategies, the automakers said in a statement.

"GM and Honda plan to work together with stakeholders to further advance refueling infrastructure, which is critical for the long-term viability and consumer acceptance of fuel cell vehicles."

Honda has plenty of form with fuel cells already. In 2012, it was one of several automaker co-signers of a memorandum of understanding covering the introduction of fuel cell electric vehicles (FCEV) and hydrogen refuelling infrastructure for 2014-2017 in the Nordic countries.

Having introduced the FCX Clarity fuel cell car in 2008, Honda, also in 2012, said it would launch a new fuel cell electric model - *"which will showcase the significant technological advancements and cost*

reductions since the launch of the FCX Clarity" - in Japan, the US and Europe starting in 2015.

In 2011, Honda's UK unit opened a hydrogen fuelling station at its main campus in Swindon; this followed a similar Shell-operated facility opened by Honda's US unit in conjunction with Toyota adjacent to the automakers' campuses in Torrance, south of Los Angeles.

GM and Honda claim to be 'acknowledged leaders in fuel cell technology'.

According to the Clean Energy Patent Growth Index, GM and Honda rank first and second, respectively, in total fuel cell patents filed between 2002 and 2012, with more than 1,200 between them.

"This collaboration builds upon Honda and GM's strengths as leaders in hydrogen fuel cell technology," said Dan Akerson, GM chairman and CEO. *"We are convinced this is the best way to develop this important technology, which has the potential to help reduce the dependence on petroleum and establish sustainable mobility."*

Takanobu Ito, president and CEO of Honda Motor, said: *"Among all zero CO₂ emission technologies, fuel cell electric vehicles have a*

definitive advantage with range and refueling time that is as good as conventional gasoline cars. Honda and GM are eager to accelerate the market penetration of this ultimate clean mobility technology, and I am excited to form this collaboration to fuse our leading fuel cell technologies and create an advanced system that will be both more capable and more affordable."

GM's Project Driveway program, launched in 2007, has accumulated nearly 3 million miles of real world driving in a fleet of 119 hydrogen-powered vehicles, more than any other automaker.

Honda began leasing of the Honda FCX in 2002 and has deployed 85 units in the US and Japan, including its successor, the FCX Clarity, which was named the 2009 World Green Car. Honda has delivered these vehicles to customers in the US and collected 'valuable' data concerning real-world use of fuel cell electric vehicles.

Honda plans to launch the successor of FCX Clarity in Japan and the United States in 2015, and then in Europe. GM will announce its fuel cell production plans later.

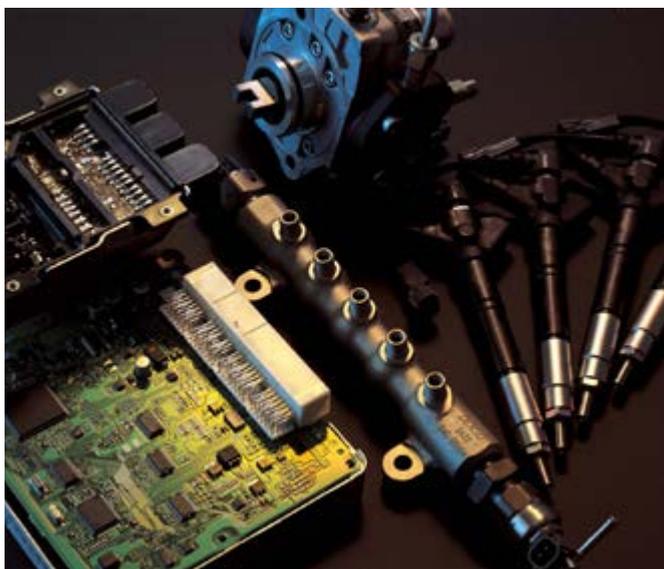
JAPAN: Denso develops new diesel common rail system

Denso says it has developed a new diesel common rail (DCR) fuel injection system with the world's highest injection pressure of 2,500 bar.

Based on its research, the company claims the new system can help increase fuel efficiency by up to 3% while also reducing particulate matter (PM) by up to 50% and nitrogen oxides (NOx) by up to 8% (compared to Denso's previous generation system).

The new DCR system will launch later this year on passenger, commercial, agricultural and construction vehicles worldwide.

"Our new diesel common rail system will help increase fuel efficiency and meet exhaust emissions standards that are becoming increasingly stringent around the world, particularly in Europe, Japan and the US," said Yukihiro Shinohara, executive director responsible for Denso's diesel engine business unit.



Improved design structure to decrease workload of fuel pump:

In a common rail system, a portion of the fuel delivered from the fuel pump to the injectors is used for purposes such as lubricating system components.

That fuel is then returned back to the fuel tank, which puts an additional load on the fuel pump, instead

of being injected into the engine combustion chambers.

By improving the design structure of the injector, fuel pump, and common rail, Denso significantly decreased the workload of the fuel pump by reducing the amount of fuel that was sent back to the fuel tank by about 90%.

Higher injection pressure:

To generate a higher fuel injection pressure, Denso redesigned components and used new materials.

These changes allowed the fuel to atomise into finer droplets, which improve fuel ignition and combustion efficiency, resulting in increased fuel economy and cleaner exhaust emissions.

Size Matters:

As automakers have limited space for component integration, Denso says it was able to engineer and manufacture a fuel pump that is similar in size but more efficient than the previous system.

- Denso was able to accomplish this by reducing the workload of the fuel pump
- Claims it was first to commercialise diesel common rail systems in 1995
- In 2002, Denso offered an 1,800 bar common rail system, the world's highest injection pressure at the time. In 2008, Denso released a 2,000 bar model into the market

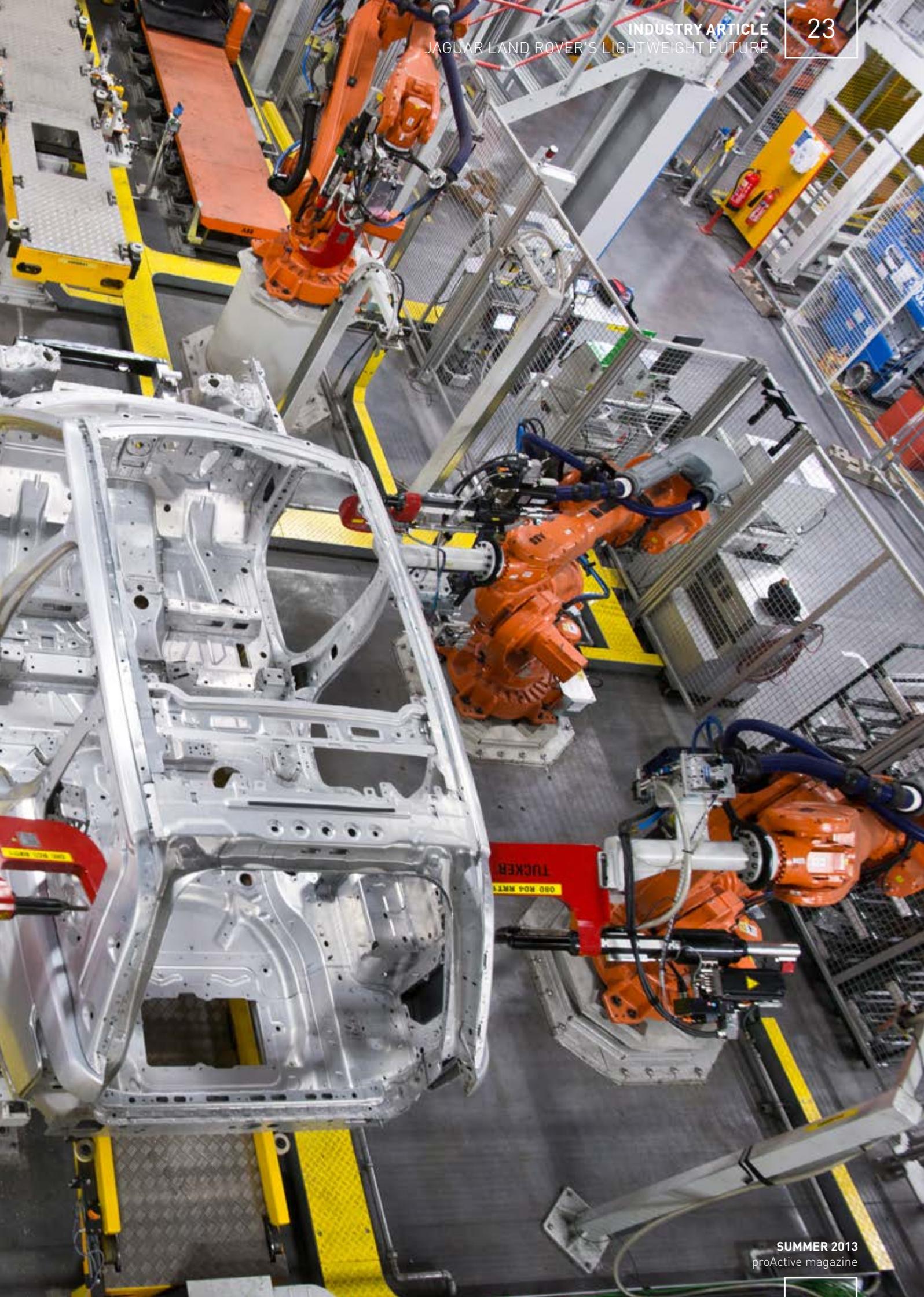
In 2012, Denso commercialised the world's first engine control system called intelligent-Accuracy Refinement Technology (i-ART), in which the injectors have a built-in pressure sensor to measure fuel injection pressure in real time and control the fuel injection quantity and timing of each injector.

Future Development:

Denso is working to develop and commercialise a 3,000 bar diesel common rail system. The company will continue to develop products and technologies that help improve the performance of diesel-powered vehicles to reduce its impact on the environment. ■

Jaguar Land Rover's Lightweight Future

Ian Adcock investigates Jaguar Land Rover's success with aluminium





Range Rover Sport
body- in white



Having just posted pre-tax profits of GBP 1,675 million, up 11% over last year, and announced an investment programme of GBP 2.75 billion, with a view to introducing eight new or refreshed products this year alone, it's challenging to recall that this is the same business that went cap in hand, unsuccessfully, to the Blair government for a bailout loan at the height of the global financial crisis in 2009.

Every press release that Jaguar Land Rover (JLR) issues seems only to trumpet yet another success, whether that be riding high in the JD Power reports that place it second only to that paragon of automotive manufacturing excellence, Lexus, or announcing manufacturing plans in China or a GBP 500 million engine plant in the UK. Jaguar, Land Rover and Range Rover, it seems, can do no wrong.

Customers are flocking to all three marques in their droves, eschewing the global ubiquity of Germany's three premier brands for a more exclusive club membership. But, underlining the design leadership of Ian Callum for Jaguar and Gerry McGovern at Land Rover there is an engineering ethos in the intelligent use of lightweight materials, specifically aluminium, that one could argue is at least equal to, and they would say privately, better than their rivals.

JLR's expertise in aluminium and, specifically, Jaguar's dates back to its time as part of the Ford empire and its Aluminium Intensive Vehicle (AIV) programme of the 1990s. In addition to the development work on aluminium monocoques that Ford had carried out in its own AIV and P2000 programmes, Jaguar also had its own reasons for going down the path it chose, rather than producing a spaceframe structure similar to Audis. It did not want to appear to be a 'me too' company following in the German's tracks.

Jaguar's breakthrough with the technology underpinned the 2003 XJ, but the saloon's conservative styling overshadowed the undoubted excellent use of aluminium structures. It really wasn't until the much sportier, and more contemporary looking, XK arrived two years later that Jaguar's pre-eminence in employing aluminium to minimise weight was truly noticed.

But there's much more to the use of this lightweight material than just minimising body-in-white mass and, of course, it shouldn't be forgotten that Land Rover pioneered the use of aluminium as far back as 1948 with the original Defender built from aluminium recycled from war time aeroplanes at Solihull.

For Mark White, JLR's chief technical specialist body structures, aluminium body structures are the outward



ABOVE: Aluminium has been used since the original Defender built in 1948

face of a new, greener, more efficient manufacturing process that stretches right across the supply chain: "Our sustainability strategy is not just focussed on the product itself, but parts manufacturing and in the plant and through our suppliers, real total lifecycle approach," and that applies equally to both Jaguar and Land Rover products.

Talking at the latest Range Rover launch, White explained that "there's a 72% increase in the amount of sustainable materials recycled over the current car, right across the whole vehicle."

He stresses sustainability and the environmental challenge. "We didn't set out by saying it had to be that, but we wanted to make the car not only appeal to the customer from a driving point of view but, also, really wanted to improve the credentials of Range Rover as a vehicle and a brand in terms of its sustainability and its outward face in terms of facing up to the environmental challenge. And we made every effort we could in all areas of the car to make it more sustainable.

"We can't just pretend the carbon problem doesn't exist, we have to face up to that and address it in a holistic way.

We want to give our customers the type of car they want to drive, we don't want to make Fiat 500s we want to make Range Rovers but we want to make Range Rovers that are truly environmentally friendly."

This strategy equally applies to Jaguar products such as the new F-Type built at Castle Bromwich, Jaguar's fastest and most modern production facility. Because no welding is involved there's a 70% saving in the amount of energy required if it had been resistant spot welded. It also means that because it's a very clean process, the body-in-white assembly can share the same facility as trim to give a very connected manufacturing process with quicker feedback during production.

Moreover, up to 50% of the metal used on the F-type is recycled, and that uses only about a tenth of the energy that prime metal requires to give the F-Type one of the lowest carbon footprints of any sports car. That's the same target JLR set for themselves with both the latest Range Rover and XJ saloon, but the group has ambitious plans to increase that to 75% recycled metal by 2020. *"That's a big walk for us,"* says White, adding *"we're working on various projects that are in pilot or research phase that will allow us to do that and the great thing is that our main supplier, Novelis has said that it's up for the challenge and has publicly stated that its goal is to get from 75 to 80 percent recycled metal supplied to us. They're on the journey as well and working with us."*

That strategy is equally applicable to suppliers like Walsall pressings, Sertec and Stadco who need to recycle their aluminium to put even more reprocessed metal into the loop. *"We've tried to apply the same mentality and rigour to the supply chain as we have done to ourselves. We've asked all of our suppliers to adopt the same joining technologies, to look at recycling the scrap they produce and make sure they've got closed loop recycling in their factories, and making sure they minimise their waste wherever [it occurs] in their part of the production phase,"* White explains.

JLR's three latest products, the Range Rover, Range Rover Sport and F-Type represent the latest stage in the evolution of its lightweight strategy, says White.

"In the past we focussed on saving body weight, I think now we're into saving weight on the whole vehicle so the obvious thing to do was to look at the sub-frames, corner geometry, knuckles, wishbones and look at how much weight we can save on them. With the added advantage that the more unsprung mass/weight you save the better it is from a dynamics point of view."

"The sub-frames are now a combination of extrusions and castings, using multi-process approach. We tried to look at how much integration opportunity can we get from

using those type of materials."

As both the Range Rover Sport and F-Type share the same production facilities as their siblings, the Range Rover and XK, respectively, it would be easy to assume there is a high percentage of shared parts, but that would be wrong.

According to the Sport's chief programme engineer, Stuart Frith, there's a 75% part count difference with the Range Rover. The most obvious are the body panels, but from an attribute perspective there are stiffer engine mounts, re-tooled suspension to deliver an eight mm lower ride height, a new magnesium front carrier that allows a lower bonnet height but still delivers Euro NCAP 5 pedestrian impact as well as a multi CAN system replacing the Range Rover's twin CAN arrangement. Both are produced at Land Rover's all-new body shop at Solihull, part of a GBP 370 million investment in the site which also includes a new paint shop. With a potential 120,000 a year capacity running three shifts there's plenty of scope for expansion to include Land Rover's burgeoning model line up that will include a radical upgrade of the Discovery which, inevitably, will follow the aluminium path at some point in the future.

Speculation would also have it that the much-rumoured Jaguar cross-over would also be assembled at Solihull, but that has been dismissed by global brand director, Adrian Hallmark. *"There are bigger and more logical segments for Jaguar to be in than cross-overs, that could be years away,"* he says.

Whilst the F-Type shares its production facilities with the XK, it too, is a significantly different beast to the larger GT says director, Jaguar programmes, Ian Hoban. *"From a structural platform perspective we refer to this as the fourth generation of our aluminium architecture so to say it's an evolution from XK is not accurate. Since the original XJ back in 2002 we've been developing and refining the architecture and the bottom line is how much stiffness can you get out of the structure in key areas for a given weight?"*

As with the Sport, the F-Type differs significantly from the XK resulting in a 10% increase in torsional stiffness over and above the XK RS. *"The best example is the work we've done around the structural castings, nodes"* explains Hoban, *"so the front suspension mounts the 'A' post castings, the base of the 'A' posts and 'B' posts castings as they're really the foundations around which the body is built. We measure it in frequency and degree per load as well. The frequency is also about measuring the noise paths back into the structure at a more specific point in the vehicle from NVH point of view."*



ABOVE: Range Rover Sport at the Solihull manufacturing plant

“As important, are the front suspension mounts and we’ve increased the lateral stiffness between those two mounts by 30% over the XK RS and that’s important because when you couple that with suspension knuckles that are 24% stiffer than the XK RS, it results in probably the stiffest open sports car on the market.”

However the challenge that Jaguar has with the F-Type, is that production is constrained at Castle Bromwich, not just in terms of manufacturing capacity, but also shift patterns. This will be addressed according to JLR’s chief executive officer, Dr Ralf Speth: *“Castle Bromwich is the next stage of investment for Jaguar. The first stage of the plan is to fill both plants and then long term build all Jaguar Land Rover models in all plants.”*

That leaves plenty of scope for forthcoming models like the Audi A4-BMW 3-Series challenger due in 2015. This, too, will employ aluminium structures that will be further developed for the next generation XF models.

The Volkswagen Group with its MQB, MLB and MSB strategy has already shown the way in which clever application of dimensions combined with a plug and play range of powertrains and key components such as heating, ventilating and air-conditioning systems, can not only drive down costs to improve profitability, but

also allow product planners the luxury of developing vehicles for narrow niches that might otherwise be only marginally profitable.

“Our goal is to make aluminium so affordable that it’s a no-brainer to make everything out of lightweight materials. Not only that, but 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,” says Mark White. Combine that with innovative powertrains, class leading styling, plus an enthusiastic work force and the prospects for Jaguar and Land Rover look more positive than ever before.

Writer: Ian Adcock

△ Writer-just-auto.com

Hydrogen Production

Without delving deep into the chemistry, atomic hydrogen is the most abundant element in the universe and is fundamental to the existence of stars and gas planets. However, it rarely exists in earth's atmosphere as molecular gas H_2 due to its readiness to form compounds with other molecules, and the fact that it is so light, that it floats above all other heavier gases.

Hydrogen is present on earth in huge amounts as it is a constituent in water, hydrocarbons and other organic compounds. So, hydrogen needs to be extracted by way of chemical reactions before being used.

Experiments by various scientists in the 17th century led to its discovery and since then, the importance of hydrogen in organic and nuclear chemistry has been increasingly understood. The by-product of burning hydrogen is water and this gave rise to its name, Greek for 'water former' and it is for this reason that hydrogen forms part of the technology roadmap for vehicles. Using hydrogen as a fuel has a zero emissions reaction at point of use however, the means to produce hydrogen are very energy reliant so sceptics use this argument to counter the 'zero emissions' aspect of hydrogen use.

There are many laboratory methods of extracting hydrogen from where it exists as part of a chemical compound but only a relatively small number have been commercialised for production on an industrial scale. This article describes the main techniques for hydrogen production.

Production overview

The main industrial method for hydrogen production is by steam reforming of hydrocarbon materials such as natural gas, oil and coal. Other methods exist on an industrial scale such as electrolysis of water; however, this only accounts for a very low percentage of overall hydrogen production. Electrolysis could become more important though as it offers a 'green' route to hydrogen production if the electricity used is from a renewable source.

Steam reformation of natural gas

This method accounts for roughly half of the global hydrogen production and is possible due to the high methane content of natural gas. High temperature

steam at around 1,000 °C is reacted with the methane to produce hydrogen and carbon monoxide. Introduction of steam in a further lower temperature stage oxidises the carbon monoxide to form carbon dioxide and yet more hydrogen.

The by-product of this process is carbon dioxide, however, as the large quantities of CO_2 are produced 'on-site' it can be captured and dealt with in a number of ways without releasing to the atmosphere.

Gasification of coal

This process is similar to steam reformation where steam and oxygen are combined with coal to produce, amongst other things, syngas, which is a gaseous mixture of hydrogen gas and carbon monoxide. It is important not to fully oxidise or combust the coal. The hydrogen can be stripped out of the syngas directly or the syngas can go through another oxidising process, like in reformation, and release more quantities of hydrogen.

Kværner process

This is a process developed in the 1980s by Kværner, whereby a plasma burner operating around 1,600 °C separates the carbon and hydrogen from a hydrocarbon material, typically methane, natural gas or biogas. The advantages over steam reformation are that the Kværner process is more efficient and doesn't produce any CO or CO_2 . The by-product of this process is pure carbon powder which has many industrial uses. It can be argued that it is a 'green' process if the energy used in the plasma burner is created renewably.

Developments of this process have led to it being useful for the conversion of municipal solid waste (MSW or landfill) into useful by-products, including hydrogen. The chemical outputs depend on what type of waste is used as the feedstock and this process also has the capability to use and convert hazardous materials, rendering them harmless. Although not yet developed on an industrial scale, this process demonstrates advantages over steam reformation and gasification; with a reduction in energy requirement and the fact that landfill waste products can be the feedstock.

Water electrolysis

The production of hydrogen and oxygen from the electrolysis of water has been well understood since the 18th century. Two electrodes placed in water are supplied with electricity and hydrogen forms at the negatively charged cathode and oxygen forms at the positively charged anode. Although the principle is very simple, it has not been a popular method on an industrial scale due to the fact that it requires a greater energy input compared with the other methods mentioned and is therefore less efficient. However, it has the potential to become more viable if the energy used comes from a renewable source and, of course, the feedstock is readily available.

Adding an electrolyte to the water will increase its conductivity and speed up the process, however, careful electrolyte selection is required to make the process effective. The choice of electrolyte also affects what gases are produced and if normal salt is used as the electrolyte, chlorine will be produced instead of oxygen. Much of the hydrogen production by electrolysis is actually as a by-product of the industrial production of chlorine.

R&D activities for other methods of production

As mentioned earlier there are many methods for hydrogen production with much going on in the research and development field. Steam reformation of bio-derived liquids (oils, alcohols and sugar based materials) is relatively straightforward and has the advantage of starting off with a renewable feedstock rather than a fossil fuel. The industry infrastructure is already there to produce hydrogen in this way so can be viewed as a near-term solution however, the bio-mass derived fuel industry requires additional development to support the process.

Photoelectrochemical hydrogen production is a straight water-splitting process. Special semiconductors are required that absorb sunlight and split water molecules in a chemical process yielding hydrogen and oxygen. The semiconductors need to be efficient and durable. Efficient in the desire to absorb light over a wide band of wavelengths and durable in that they do not adversely react with any electrolytes. This is a longer-term solution as the materials are still at the R&D stage.

Another long-term prospect is a solar thermochemical process to manufacture hydrogen in a sustainable way. This is a closed-loop process where a temperature of around 2,000 °C is produced by focussing the sun's rays by mirrors or lenses. There are

hundreds of compounds that can be reacted in such a process but one that has been identified is zinc oxide powder. The focussed solar heat dissociates the zinc and oxygen and then water is added. A further chemical reaction oxidises the zinc, releasing hydrogen from the water molecule. The resulting zinc oxide is then reused and the process starts again.

Specialised micro-organisms can produce hydrogen during their metabolism under direct sunlight. Scientists are researching this area, identifying suitable biological material such as green algae and some types of bacteria. This method of hydrogen production shows some long term merit but it is not without its challenges, one of which is that the oxygen that is also produced impedes the enzymes responsible for hydrogen production.

Summary

Industrial processes have been in place for many years to manufacture hydrogen however, they are energy intensive. There is also a challenge to cost-effectively get the hydrogen to its point of use. For these reasons, there are opponents of the idea of a hydrogen economy, citing the energetics of the hydrogen economy just not working out.

Potential solutions include substantial uses of renewable energy although this in itself requires investment. There is also the question of how to transport hydrogen from where it is made to its point of use. A solution for this could be to localise hydrogen production where some of the industrial processes could be scaled down to have small reformation plants on site at vehicle refuelling stations.

ITM Power and Hydrogenics are two companies that produce small scale electrolyser and hydrogen storage and delivery systems that would suit localisation in this way. There are a number of examples of onsite reformers including one based in Nevada by Air Products.

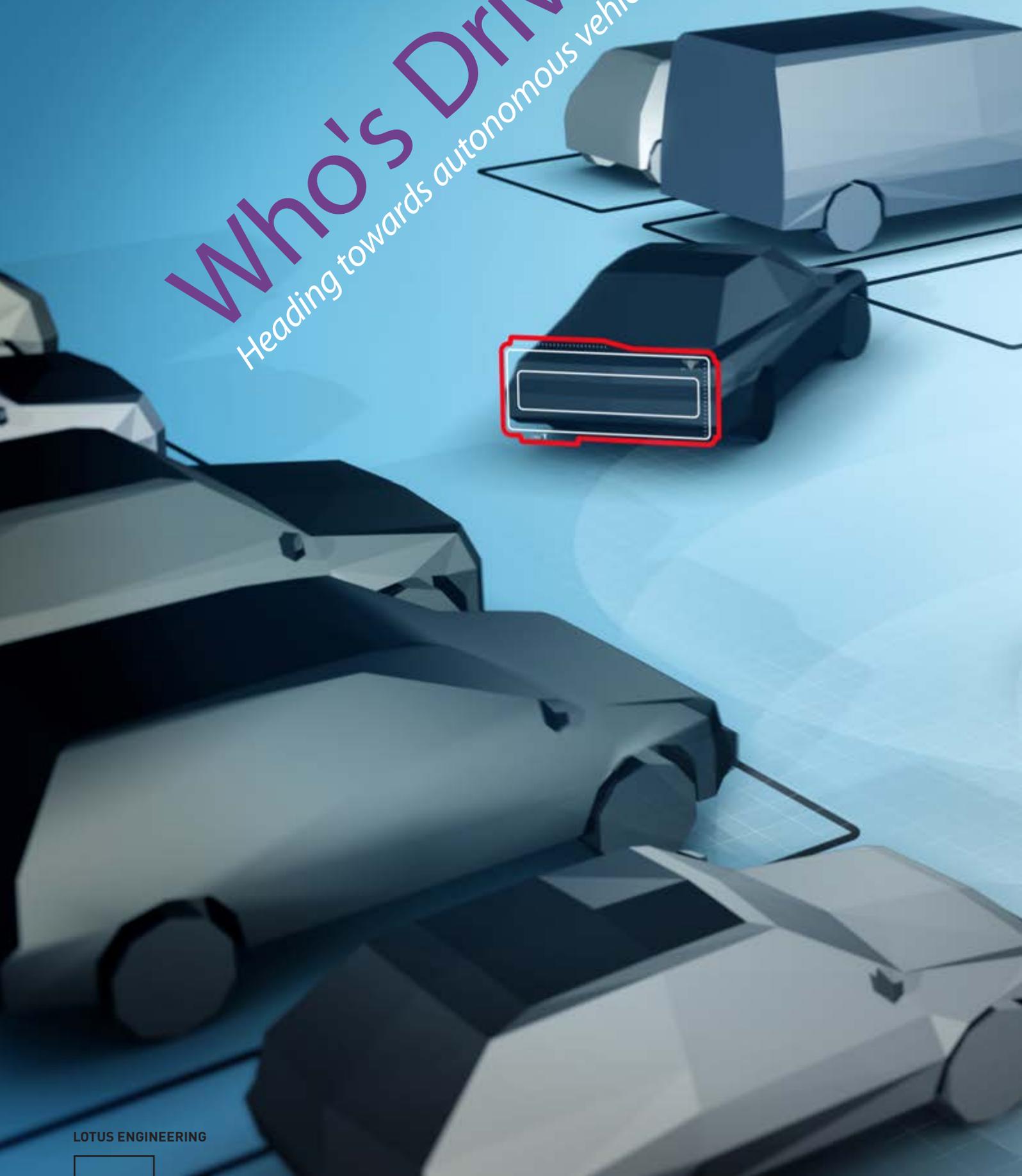
Legislation is driving vehicle emissions to be cleaner than they have ever been before and so car manufacturers are developing solutions that use hydrogen either as a combustible fuel or with fuel cells for electric drive systems. These factors are pushing the hydrogen production industry to come up with solutions that move towards a hydrogen economy although there is still a lot of work to do to make this a viable alternative to liquid fuels. ■

Writer: Phil Barker

△ Chief Engineer Hybrid and Electric Vehicles, Lotus Engineering

Who's Driving?

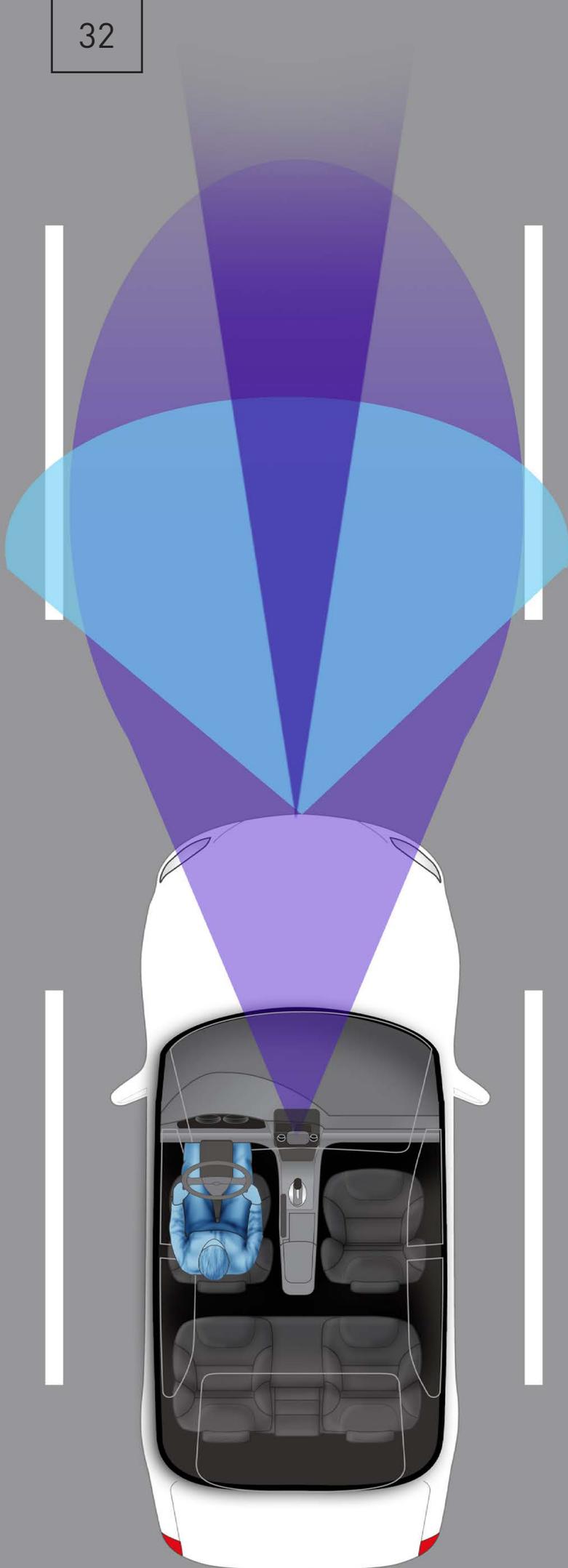
Heading towards autonomous vehicles...





AUTONOMOUS DRIVE





Do we need assistance while driving? While some people believe we can't do without it, others disagree. Yet recent research has shown that driver error is one of the most common causes of traffic accidents. Matthew Beecham reports on how driver assistance technologies are edging us towards the autonomous car.

Autonomous or driverless cars have been talked about for decades. The earliest representation of such a car appeared way back at the 1939 World's Fair. Here, an exhibit sponsored by GM depicted electric cars powered by circuits embedded in the roadway and controlled by radio. Driverless cars have featured on the big screen, too. Remember how the Batmobile drove itself to Batman's location? Holy smoke, that vision is almost a reality.

Over the past decade or so, momentum for autonomous driving has gathered pace to the point where a driverless car is no longer science fiction. Among those development projects which have hit the headlines recently is one supported by Google. For some time, Google has been testing a fleet of almost fully autonomous hybrid cars. The company claims its cars have travelled more than 300,000 miles without an accident while under computer control.

Backed by private and publicly funded research, a number of other projects are pushing back the technical boundaries to driverless cars. The common vision, however, of a fully autonomous vehicle is one capable of sensing its environment and navigating without the need for driver intervention. Such vehicles sense their surroundings using techniques such as radar, lidar, GPS and computer vision systems.

Do we need autonomous vehicles?

Those in favour of autonomous driving are quick to point out a number of benefits, such as fewer accidents (thanks to its 360 degree sensors), reduced traffic congestion, improved fuel efficiency and, of course, relieving the occupant of driving, parking and navigating the vehicle (something we all might especially appreciate as we live for longer).

An autonomous car is also an attractive

option when out on the town, serving as a designated driver.

But not everyone likes the idea of driverless cars running around on our roads. A sudden malfunction could leave you frighteningly powerless. And does the car's algorithm cover the simple but unexpected rolling football on the road? Aside from who is to blame if something goes wrong, it will take some time for the public, drivers and pedestrians alike to feel comfortable with such technology.

Meanwhile, some people argue that driverless cars could increase congestion and reduce fuel efficiency. For instance, an autonomous car left to locate a parking space could go round and round the block endlessly. And what then? Does it drive itself home leaving you to call it back thereby using more fuel in the process? Furthermore, instead of opting for public transport we could see more people opting to take their autonomous car therefore adding to congestion. There are issues of privacy, too. Whether you like it or not, such cars will record your every move.

And then, of course, there are many of us who just like driving cars. So the last thing we want or need is some geeky technology doing it for us.

Whichever way you look at it, driverless cars are coming to a road near you. Lawyers will be among the first group to benefit, too. We suspect that there will be one or two spectacular debacles in the early years of their use as unforeseen kinks are ironed out.

Are they legal?

As autonomous technology advances, legislation is catching-up. In June 2011, the state of Nevada was the first to pass a law concerning the operation of autonomous cars. Since then, two more states, Florida and California have passed laws allowing driverless cars.

More recently, in June 2013 the National Highway Traffic Safety Administration (NHTSA) unveiled new guidelines for self-driving cars. The new guidelines urge that such cars be used only for testing and that safeguards ensure they can be taken over by a driver in the case of malfunction. Again, as politicians pave the way for self-driving cars, the thorny issue of liability in the event of such a malfunction remains.

Partial autonomous driving technology is already with us

Although fully autonomous vehicles are not yet available to the public, there are increasing numbers of models offering assistance to the driver as standard. These include adaptive cruise control, lane keeping assist and parking assistance (see below). And these features are just the tip of the iceberg among production cars.

For example, the 2014 model year Mercedes-Benz S Class has the option of autonomous steering, braking, parking, lane guidance, accident avoidance and driver fatigue detection. Meanwhile, the BMW i3 has the capability to autonomously steer, accelerate and brake in traffic jams at up to 25 MPH.

Israel's Mobileye told us that they expect to release self-driving autonomous technology in the third quarter of this year. Looking further ahead, Google expects to release its autonomous car technology by 2018. And by 2020, Volvo expects accident-free cars and 'road trains' in which individual cars are guided by a driver in a lead vehicle.

Driver assistance technologies aim to make the vehicle capable of perceiving its surroundings, interpret them, identify critical situations, and assist the driver in performing driving manoeuvres. The object is, at best, to prevent accidents completely and, at worst, to minimise the consequences of an accident for those concerned.

While the possibilities to 'assist the driver' seem endless, is there a risk of information overload? We reckon that as driver assistance systems are designed to help a driver in potential emergency situations, any warnings given by the system must be clearly understandable in order to allow them to react quickly and correctly in a potential high-stress situation. The design of the human machine interface is the key as more and more information becomes available. Driver feedback is critical. The worst outcome would be to annoy the driver with constant alarms and warnings.

Technology cascading down the segments

While autonomous driving technologies are appearing across the premium segments, they are starting to appear in less expensive cars.

For example, Nissan recently announced that it is to include advanced safety systems on the new Note and is claiming that it is first-in-segment. Described as the Nissan Safety Shield, the company claims that it is the first to include such systems: blind spot warning, lane departure warning and moving object detection as well as Nissan's 'around view monitor' on a small car.

The fact is that multi-function cameras have already penetrated down to mass market C-segment vehicles in Europe, and are expected to migrate further downwards in the next five years driven by Euro NCAP and future regulations. While the smaller A and B segment cars are the most price-sensitive, these same smaller and lighter vehicles are most vulnerable in a crash and can benefit the most from accident avoidance technologies. So we could expect to see automakers using this as a safety differentiator in these segments.

Adaptive cruise control (ACC)

In order to gauge the stage we are at with the semi-autonomous car, let's now take a closer look at which models are offering assistance to the driver.

Today's adaptive cruise control relies on radar or laser technology to track a vehicle ahead and maintain a safe gap. It lets the car hold a speed but adjusts to changing traffic conditions with automatic braking and acceleration.

Although it is mainly the large and luxury vehicle models being equipped with ACC, the technology is not exclusive to these segments. For example, ACC is being offered on the Ford Focus as well as the upper trim level of the Ford Taurus, Toyota Avalon and Hyundai Genesis.

The fact that the Ford Focus now offers ACC represents a milestone in the market. We expect others to follow as there is no reason to consider driver assistance as a luxury status symbol.

Each automaker has a different name for ACC: Infiniti refers to it as Intelligent Cruise Control, Toyota calls it Dynamic Laser Cruise Control, Hyundai's name is Smart Cruise

Control while BMW refers to it as Active Cruise Control.

Lane-keeping assist

Advanced driver assistance system (ADAS) technologies are also becoming increasingly common in the European mass-market C and D segments. For example, a lane keeping assist system is offered in the Lancia Delta hatchback and ACC radar system in the VW Passat but do not yet appear in the A and B segments. We expect to see a wider rollout of ADAS technology in European C segment vehicles in the next 2-3 years, as new forward-looking radar products continue to drive down the cost of ADAS technology.

Now that the NHTSA has made collision warning and lane departure alert part of the New Car Assessment Programme (NCAP) requirements for a five-star safety rating, we can expect the market for such technology in North America to grow.

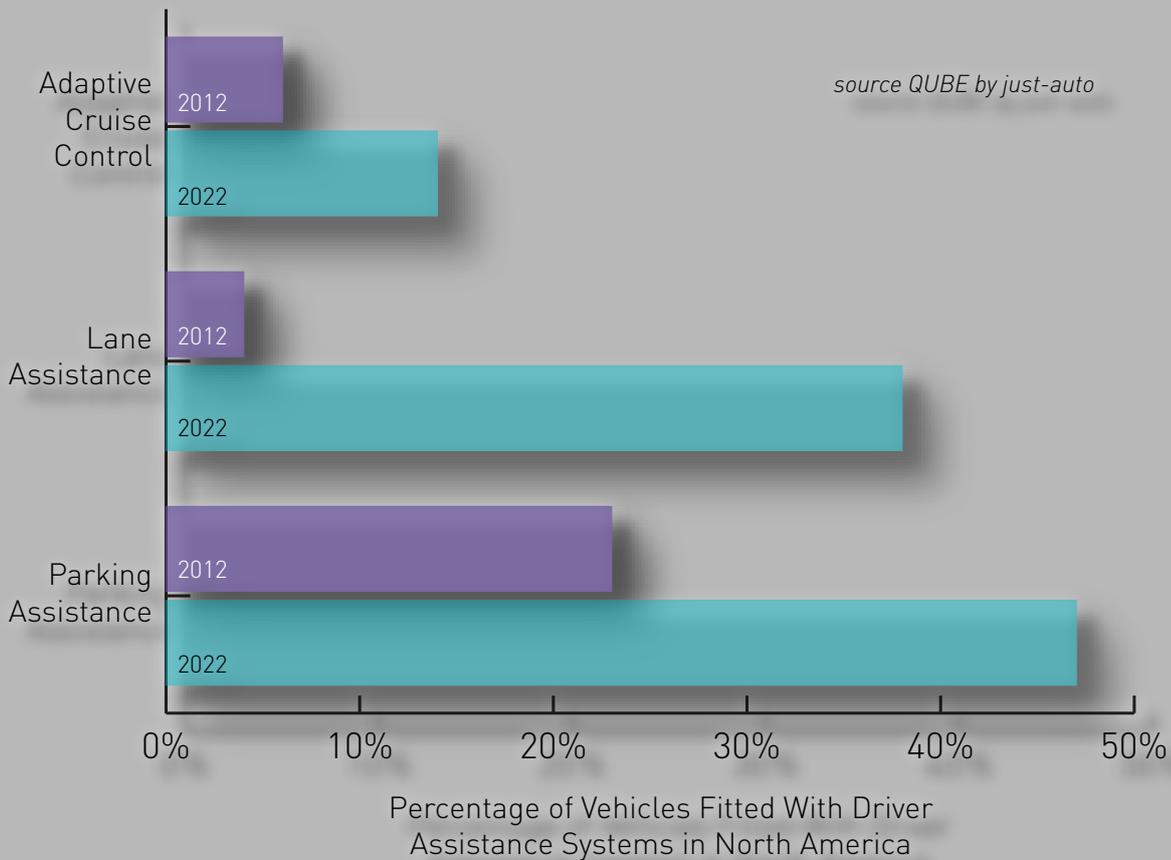
While NHTSA has helped drive this market, there are other market forces playing an important role in their popularity. Insurance companies dotted across Europe offer price reductions for vehicles with these features, and we expect insurance companies in the US to follow suit, although more conservatively.

Meanwhile, consumer awareness of these collision mitigation features is increasing. We are seeing more TV advertising from a number of automakers, and buyers are developing an expectation that such advanced safety features be 'built in' to their vehicles as standard.

Parking assistance

For sure, parking assistance systems are becoming increasingly popular but the market is still in its infancy. This feature is more popular on SUVs which typically have restricted rear visibility and more difficult to park.

As we would expect, luxury automakers Lexus and Mercedes are offering parking assistance. Lexus models being offered with parking assistance include the LS460L and LS460L AWD while it is fitted as standard equipment on the LS4600hl hybrid. Meanwhile,



Mercedes-Benz offers Active Park Assist on a number of models, including the CLS550 and CL563 AMG as well as the M Class. And BMW offers auto parking on the 3, 5, 6 and 7 Series sedans.

Like ACC and lane assist, parking assistance is not the sole preserve of the luxury classes. For its part, Ford made available its active park assist way back in mid-2009 on the Focus, Explorer, Escape, Flex, Lincoln MKS and Lincoln MKT. Those Ford models offered with automatic parking today include the Focus, Fusion and Taurus. Lincoln also offers it on the MKS and MKZ.

How fast is the market growing?

Just-auto's QUBE service estimates and forecasts certain OE driver assistance systems fitted to newly-assembled passenger cars and light vehicles across 14 of the world's largest light vehicle markets which collectively account

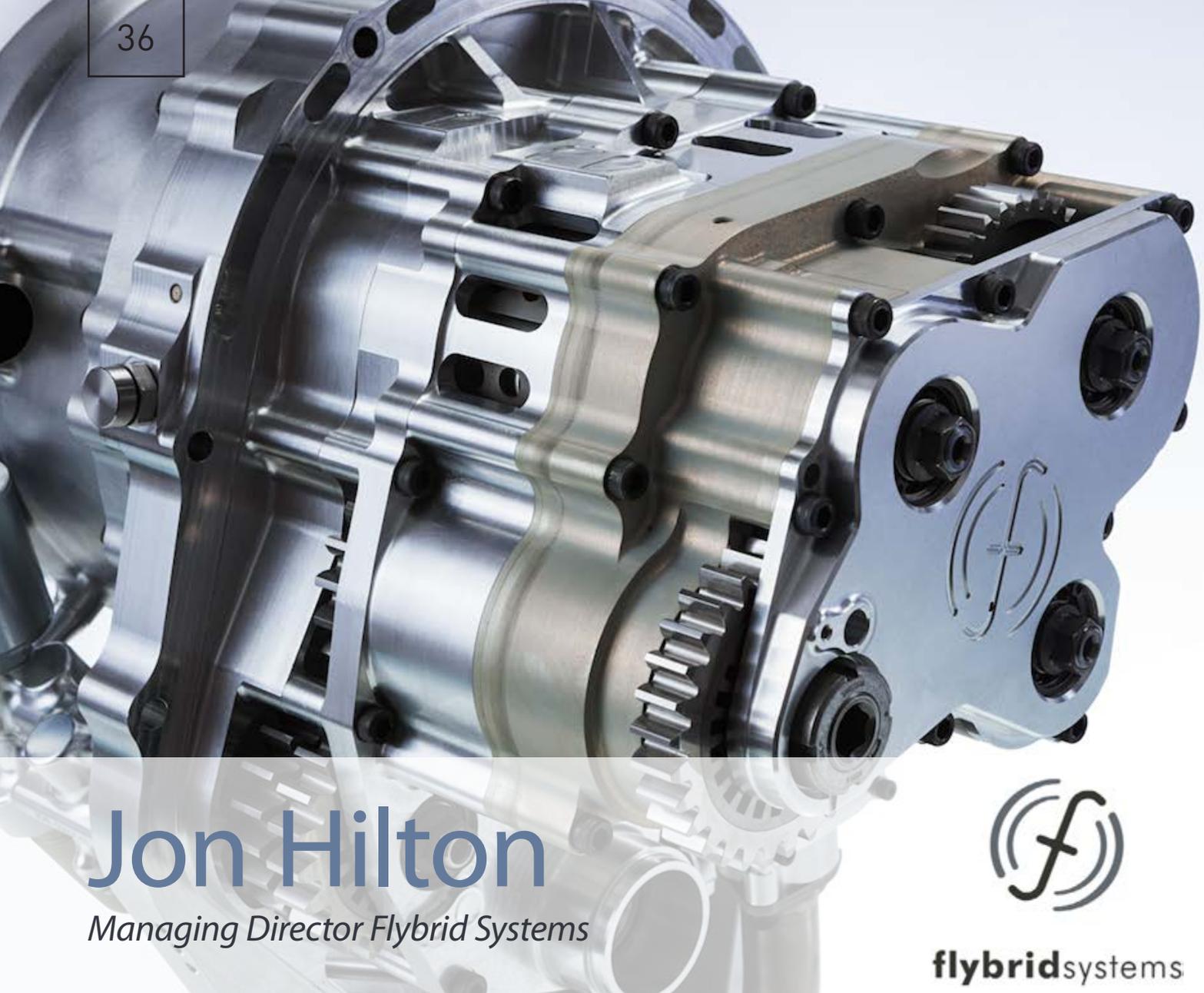
for more than 98% of world light vehicle production.

To illustrate, the table above sets out our estimates and forecasts of the percentage of OE ADAS fitted to newly-assembled passenger cars and light vehicles in North America, starting with how the market looked last year and how each product application could grow by 2022.

On balance, radar-based safety technologies such as advance collision warning and blind-spot detection are becoming commonplace as optional equipment on new C-segment vehicles. While we have seen multi-function cameras on the high-end and medium segment cars for some time, such technology is indeed permeating down to the low-end in Europe and North America.

Writer: Matthew Beecham

△ Writer - just-auto.com



Jon Hilton

Managing Director Flybrid Systems



flybridsystems

Flybrid Automotive Limited's core product is a high-speed flywheel based Kinetic Energy Recovery System (KERS), which it claims is a superior alternative to electric hybrid systems for cars. Road car applications for the technology (also seen in Formula 1) are coming, Flybrid says. Dave Leggett spoke to co-founder Jon Hilton about the company, its technology and the latest developments.

What are you busy with right now and can you describe the main elements and responsibilities that come with your role?

I'm managing director here at Flybrid and this job has changed quite a lot in the last couple of years. Until a couple of years ago I was responsible mainly for sales and marketing.

We decided about a year and a half ago to promote a group of our guys to management. Doug and I, the two business owners, gave the day-to-day running of the business to this group of managers in order to free

our time up to look for finance.

That was something of a priority, we had to raise finance in order to do all the things that we wanted to do. That's been pretty successful; we received substantial investment from Torotrak in March of this year and now my role has changed again, as we no longer have to look for money.

Now I have a bigger picture to concern myself with, particularly the future growth of our business and how we move on to manufacture our products for clients.

There's also Tier-1 licensing for mainstream cars with clients like Volvo Cars looking to buy the product in 2017, so I'm out there trying to find Tier-1s to make it for them.

Can you describe the main activities of the company and the resource base?

We're in the field of kinetic energy recovery systems (KERS) and all of our work is in that area. And we do many things related to that, so while we started off



just with the flywheel, we've ended up making the transmissions and the hydraulic and electronic control systems, creating software and there's also product support out in the field. So we're doing everything from buying steel bar to selling complete systems running in vehicles.

We have twenty people in the company on two adjacent units on the Silverstone Technology Park and we are just at the point of expanding.

You manufacture yourselves?

We do a proportion of the manufacturing inhouse, such as the flywheel hub, we make about 20% of the parts in-house at the moment and we are just about to invest in more machinery to enable us to make more ourselves.

What are the key advantages, as you see it, of your flywheel based KERS over equivalent battery based systems?

The key advantage is cost. We are about a third of the cost of an equivalent power electric system. We are also more efficient, capable of a wider [operating] temperature range and we have a long life. We can do the full bus life, for example, and around six million full charge-discharge cycles in a bus life, perhaps a million kilometres of use. Buses can't do that on batteries, they change them after around five years and that would be two battery replacements at maybe GBP 25k each during the life of the bus.

The benefits of our system are cost and performance.

The electric battery is basically very expensive and they are not going to be more than a niche product in our view. And the emission test drive cycles are changing with the move, from 2017, to the World Harmonized Light Vehicle Test Procedure (WLTP), from the current NEDC standard in Europe.

It will suit us, but it will mean a harsher duty cycle than the existing one and it gets very difficult for the cheaper end of the electric systems where you need more power, 30-40 kilowatts on a normal-sized car.

You just can't get that sort of power out of the low voltage electric systems. And as soon as you go to the full electric hybrid where you have to separate the earth from the chassis of the car, above 60 volts.

With a secondary electrical system, it becomes much more expensive because you are carrying high voltage, at that point, our system looks even better.



ABOVE: Jon Hilton, Managing Director of Flybrid Systems.

And the cost and performance benefits you describe for flywheel-based KERS are becoming widely accepted in the industry?

Yes, I think so, and more widely accepted as time goes by. It's always reassuring to potential clients to see other people in the same space, doing the development work and developing flywheel based hybrid products. As more clients and users of our system break cover, the level of confidence goes up. Nobody asks us now whether it works; we've done enough high profile programmes for people to be able to see that it works. And we've done much more work in the private domain than the public.

The performance aspect is important and that's something that Volvo likes. Our system provides high power with a small amount of storage. We can capture a lot of the braking energy and in real-world use, we're even better than the test cycle.

I guess everyone is aware of the F1 application, but how useful was that experience?

The original Flybrid Kinetic Energy Recovery System (KERS) was a small and light device designed to meet the FIA regulations for the 2009 Formula One season and the development work was very useful, even though our system wasn't actually used by our client in the end (Honda pulled out from F1 before racing with it).

Without that we would have struggled to get as much product development work done as quickly as we did; it was quite well funded.

The Formula 1 rule-makers did a really good job of setting a specification that was sensible and the product we developed, the storage and power levels meant that it was about the right size. In fact we went on to use very similar flywheels and transmissions in things like the Jaguar demonstration car and later on in the Volvo.

Commercial vehicle applications also seem significant. What are the benefits of the flywheel KERS that have attracted bus operators?

The key thing with commercial vehicle operators is that it has to be affordable with a payback over a reasonable period of time. With electrical systems the payback can be over ten years. We're half that and once we have mature volumes out there it's coming down to three years or less, at which point it's a no-brainer to fit our system.

And frequent stop-start operation is particularly important to energy recovery?

This is an interesting one. The energy recovery will still be very significant on a vehicle braking just a few times, but braking from speed. It's about kinetic energy

and how fast you are going when you decelerate to stop. We have looked at a variety of drive cycles and journeys. For example, a colleague has a journey to work that is mainly dual carriageway but when he does brake, it's typically from a relatively high speed to, say, negotiate a roundabout and then there will be a few more accelerations and braking, so there's actually quite a big energy saving to be made.

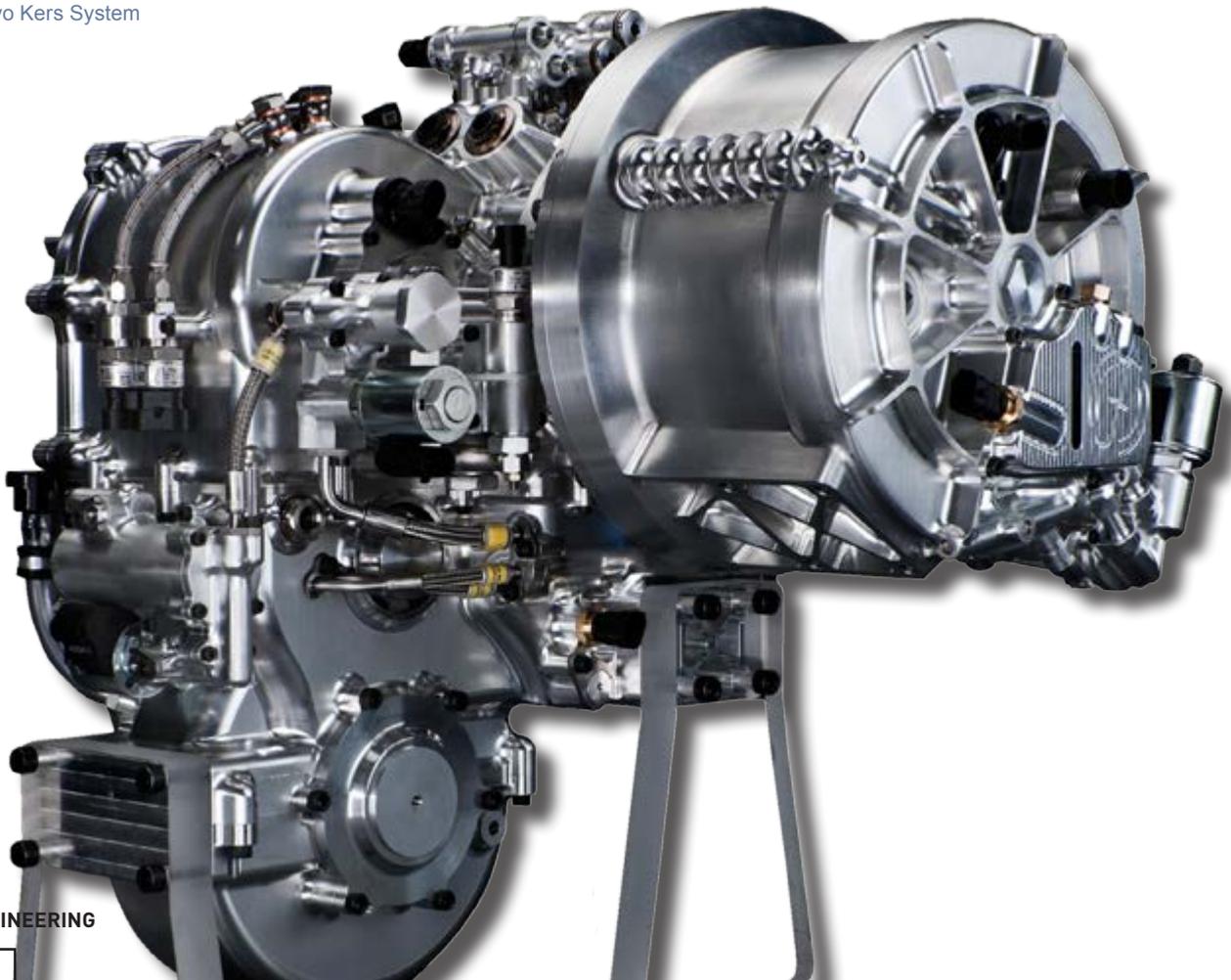
It's not the case that you will only get the benefit on frequent stop-start driving cycles. In fact, if they are very stop-start they may be a bit slow, like refuse trucks. We can get 20% savings on refuse trucks, but they're not as good as you might think because they are very slow. It's all about half the mass times velocity squared and that v^2 element is obviously very important.

How about reliability and the vacuum-seal housing for the flywheel?

It's not as difficult as you might think. On the shaft are two lip-seals and in between is a quantity of oil-based fluid. The pressure of that oil-based fluid is just above atmospheric so that the air cannot get in. From the fluid into the chamber is just over 1 bar, so you're sealing oil and not air.

There's a little bit of seepage across that seal, but

Flybrid Volvo Kers System



every time the vacuum pump runs, it sucks up any liquid that's leaked into the chamber and puts it back in the tank, so it's a closed loop system. We can manage it pretty easily. The seals are like a crankshaft seal on a typical engine and because the seal diameter is very small, the speed is not that scary. We can't break them, despite hundreds of hours on the test rig at accelerated speeds.

They're looking really good to do whole vehicle life, no problem.

So manufacturing and scalability are not difficult issues?

On the manufacturing side, it's very important to balance the flywheel extraordinarily accurately and we have had to invent our own balancing machine to do that because no balancing machine we could buy was good enough. We have invented that now and it works reliably and will scale up okay. We can do 25,000 flywheels a year on one machine.

Turning to road car applications, what's the state of play of the Jaguar led demonstrator project?

That is finished now. It was sponsored by the UK Technology Strategy Board, so government funded, and it illustrated a 22.4% fuel saving on a real world driving cycle including the benefit of stop/start. The programme was aimed at CO₂ reduction technologies so we didn't do any performance work as part of that.

However, we have had the car back at Flybrid over the past year and we have been doing some performance work, because to get the best out of the system you have to show both economy and performance.

Our push is to downsize the engine a bit and put it back to original performance with the KERS boost and take the fuel consumption saving on top of that. Volvo talked about a 25% fuel saving versus a car of equivalent performance and that's a very sensible way of putting it, in our view. That's where we like people to be pitching it.

Do you think Jaguar will pick up this technology on a production vehicle?

We hope so and they certainly remain interested in the programme. The key for them will be pricing and Tier-I involvement and that's also where we are with Volvo. We need to make a license arrangement with a Tier-I supplier that is capable of manufacturing in mass volume for these sorts of companies. Neither is prepared to fund the programme all the way to



The Flybrid KERS is integrated into the gearbox of the car

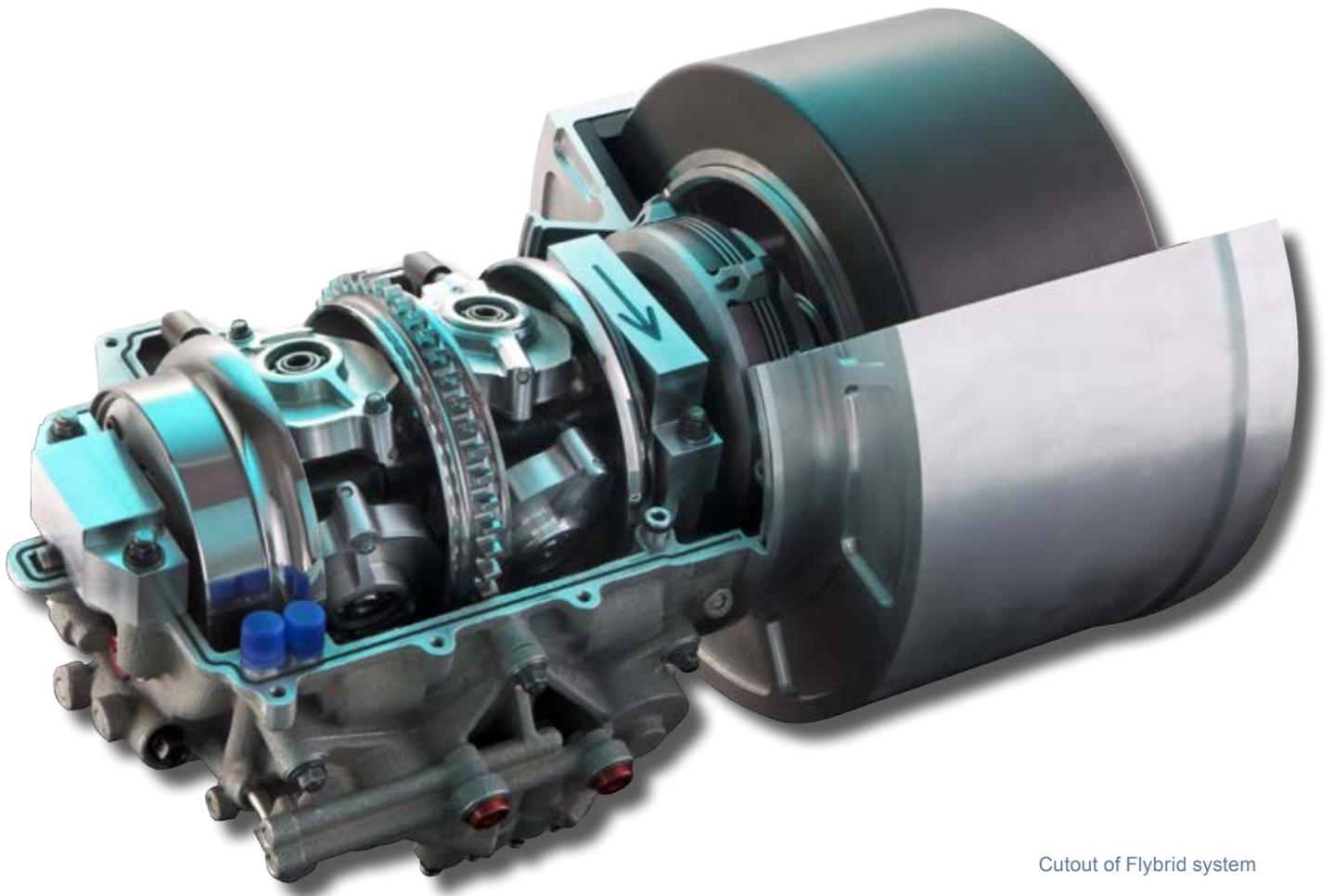
production, with things like design for manufacture, design for assembly, setting up an assembly line and tooling on their own numbers alone. They really want to share that.

So that's the big commercial challenge for you right now?

Yes. We need to license to a Tier-I in order to get this technology into production for mainstream cars. Volvo have been really helpful to us, they want a Tier-I involved, with things like press coverage. I can say that we have a lot of interest from a large number of Tier-I's and it's an interesting challenge from our point of view. We have to know who is best to license to. None of the Tier-I's supply everybody. Some of them, for example, know Volvo very well and they might seem like obvious choices. But maybe they don't know Jaguar so well or some of our other clients who are not yet in the public domain. Finding one company that can service all of the requirements is difficult.

And Volvo is the lead OEM amongst your clients?

Yes, that's probably a fair way to put it.



Cutout of Flybrid system

What Volvo model would, potentially, be first for this technology?

They have made space on the new platform they call SPA for it in the rear of the vehicle, connected to the rear wheels. That platform will cover everything from Volvo's 40 series cars to 60 series, most of what they make.

And there's already a trial vehicle...

That's right, the current S60 saloon.

So when could we see your flywheel in a production Volvo car?

Volvo are asking for 2017 and we'd be delighted to do that and we are pushing to achieve that. We need to get the Tier-I side of things resolved over the next year.

The tie-up with Torotrak is an interesting one, another technology development company. What synergies does that tie-up provide?

We've been a Torotrak licensee since 2007 and we have been using their variator in our KERS product, so we know their product and we know them very well. The Volvo demonstrator vehicle uses a Torotrak CVT.

We share a lot of high speed and rotating things,

precision stuff; there are also very similar control systems. We developed a control system to control their CVT and developed that same thing for clutches and other things that we need in our device. We are working with the same kinds of electronic control units, valves, sensors, fluids.

And we're both at a similar production stage regarding production for mainstream. They have done their license deal for main vehicle transmission with Allison. And they could be a partner for us, maybe...

Torotrak has been through the same kinds of processes we are going through. We have gone about things a bit differently but we are arriving at a similar place at a similar time and we face a number of similar challenges, particularly in the manufacturing area where we are getting ready to make our product in low volume for the bus application in particular.

We are wanting to invest in factory, line, machine tools and so on, and they are in the same position with their variable supercharger product. There could be an opportunity to combine our requirements, do the work only once and potentially build one machine shop to make both sets of bits. The machines involved are pretty similar, we're talking hard steel round and turned and milled bits that go on the same machines.

And the 20% stake that Torotrak took was also important?

Yes, absolutely. The money raised has been vital to keep the low-volume bus project going at a timescale that we needed to hit. Torotrak understands what we are doing and where the technical risks are.

Could you do an IPO?

We could have done that, but we don't really need to do that now. If Torotrak take the remaining 80% equity by the end of this year, which we think they will do, we'll be okay for funding.

How do you see the future for Flybrid over the next five years?

I think you'll see a big change. We'll get into the market at low-volume at first, extending on that timeframe to production cars. I think what we have is going to go absolutely massive. Back in 2007 we looked at the alternatives [to our technology] that were available and concluded they were all rubbish.

Here we are, six years later and the alternatives have not significantly improved. Our technology really does work. The alternatives are poor and they are not fixing that, despite the talk. Batteries are not getting cheaper and technology is being added to address the fundamental issues of power capability and longevity.

Another important point is that the regulatory landscape is moving in our favour. The EU targets for CO₂ emissions in 2025 are very ambitious, 68 to 75 grammes of CO₂ per km, and we have a solution that is mechanical and avoids high voltage electrical to get there. We have proper long term future-proof solutions that really work and avoid the complications and cost that come with electric solutions.

Overall, I think we are sat in a really good place. With the right Tier-1 support it could really fly and in five years' time, we could be swimming in car programmes. The issue for us will be managing the high growth that could be ahead.

Writer: Dave Leggett

△ Editor - just-auto.com



Founders Jon Hilton FIMechE CEng and Doug Cross MIMechE CEng have a strong racing background and their last 'real jobs' were working for the Renault F1 Team where Jon headed up the UK based Engine Division as Technical Director.

Between them they have approaching 25 years' experience at the top level of world motorsport.

Jon has a long record of success in motor racing going back to Michael Schumacher's first F1 Championship victory in a Benetton powered by a Cosworth V8 for which he designed a number of parts. International Touring Car Championship victory with the Opel Calibra and Manuel Reuter in 1996 signalled his first major wins as Chief Engineer of a whole engine programme, and after five seasons at TWR Arrows and four seasons at Renault F1 his achievements were capped with a fantastic back to back double victory for Renault F1 and Fernando Alonso in 2005 and 2006.

Doug Cross shared the Renault victories and as Design Manager of the UK based Engine Division played his part in the significant engine performance improvements that helped to secure them. Previous employment at Toyota F1 and Ricardo Consulting Engineers gave Doug a strong engineering background combined with commercial understanding.



Summer 2013

Dave Leggett takes a personal look at the automotive industry



The macro landscape for the auto industry does not seem to have changed much lately. Europe remains a troubled region. North America continues to show growth, with steady recovery on track to deliver a market over 15 million units this year. We're getting back up towards pre-crisis markets again. The US economy may not be quite firing on all cylinders, but it's ticking over quite nicely.

China is also still looking pretty good for around 10% vehicle market growth this year. One key variable to look at there is the money supply, which tracks car sales pretty well. I'm told the money supply is looking buoyant. The last thing Beijing wants is for the economy to run out of steam and for any kind of popular protests, as we have seen lately in Turkey and Egypt, to gather momentum on the streets.

Things in Europe, of course, remain rather dire, even if the market is showing signs of bottoming.

The trend to sales in Western Europe in the first half of the year show that the underlying running rate of sales has stabilised at around the same low it was last at during the low spot of the early 1990s. A degree of stabilisation in terms of overall demand will be welcomed by many in Europe's beleaguered auto industry. However, the position for the industry and

some OEMs in particular, and the need to address overcapacity, claw operations back to profitability, remains deadly serious.

It now looks like the German car market will dip a little below 3 million units this year, not a disaster (especially when you look at some other European markets, like Italy where the market has been halved) and the German OEMs are pretty busy meeting orders elsewhere anyway.

The UK car market, meanwhile, continues to defy gravity, propelled by private buyers who are attracted to replacing their cars for new under their personal contracts and with interest rates at near zero percent. When, I wonder, will the UK car market run out of momentum, or can this continue for a while yet, a structural change with many people permanently changing their cars for new on shorter cycles than used to be the case?

Britain's car industry is maintaining a positive sheen. Total vehicle output increased 8% last year to 1.58 million units, the highest level since 2008. A number of OEMs are showing a substantial commitment to increase UK car production, most notably Nissan and Jaguar Land Rover (JLR). Output could be heading for 2 million a year within the next five years and there are clearly opportunities for UK suppliers ahead, too.

Things still look worse on the Continent. Something I picked up in the news recently seems very apposite regarding the situation in Europe. German Chancellor Angela Merkel has apparently become fond of a rather crude English language term that is becoming so popular in Germany that it has now been inducted into their equivalent of the Oxford English Dictionary, the Duden. The word? Ahem, get ready for it: 'shitstorm'. German language experts voted it 'Anglicism of the year' in 2012 and the eurozone's economic crisis seems to have propelled the word into wider usage in Germany.

Certainly, German consumers seem to be retrenching, worried about eurozone bailouts and where the eurozone's economic crisis is heading, where it might leave Germany, the de facto guarantor. German car sales in the first half were 8% down on last year. Some southern European countries are once again having trouble making austerity budgets stick (surprise, surprise). The EU is not at all popular in Spain where unemployment stands at 25% and is nearer 50% for young people. Welcome Croatia, the latest addition to the EU club and its dysfunctional family.

There are rumours that PSA Peugeot-Citroen and General Motors could be getting closer and, if they do, consolidating European manufacturing would be an obvious thing to look at. Obvious, that is, in a business sense. Politically though? Ah, tricky. With the European economy on its knees and worries over low growth and unemployment very much on politicians' radars, axing employment-intensive car plants doesn't look very politically astute. It's not exactly a winner at the ballot box. There are elections later this year in Germany.

Not so long ago a bankrupt General Motors was looking at selling Opel/Vauxhall. With almost three quarters of the companies employees in Germany, the prospect of a sale and conditions for that sale created a quite a political fuss in Germany. Now, GM is busy talking about repositioning Opel/Vauxhall as more upscale than Chevrolet. It sounds good on paper, but Chevrolet has been mighty successful and makes good cars at a (for the consumer) very good price. As Opel/Vauxhall continues to lose money, the European headache for GM continues. Some sort of consolidation in Europe involving PSA might look like a way out. It would not be popular though. As Angela Merkel and many of her compatriots would no doubt concur, the eurozone's 'shitstorm' has certainly not passed over yet.

The changing consumer...

In any business, knowing your customer and meeting their needs is an essential first principle. That's as true in the car business as any other. Many people in the auto

industry are wondering how the customer, and market demand, is changing and how they need to adapt to best meet the changes. There's a lot of talk about the growth of cities and urban mobility, the challenges ahead that are being shaped by environmental pressures, pressures of population and rapid advances in connectivity.

There are signs of changing attitudes. Young people, especially in cities, are not as attracted to getting on the car ownership rung as they once were. Cars are costly to run and maintain. Lifestyles are increasingly dominated by the emergence of cool brands like Apple and the devices that come with that. The costs of motoring: insurance, fuel and maintenance can look daunting for young people. In Germany in the last few years there has been a 25-30% decline in new car driving licenses issued to the under-25s. People are applying for driving licenses much later in their lives.

'Peak Car' some argue, has passed. Distances travelled by motor vehicle in mature automotive markets are going down. The reasons may be complex, but there is a sense for some of an industry that may be past its heyday or that some consumers are fundamentally changing their attitudes to transport. The auto industry needs to listen and adapt.

Renault's entry range programme director shared his thoughts in respect of low-cost brands at a recent conference. Arnaud Deboeuf said that Renault's low-cost Dacia brand "*is one of the symbols of the new consumer trend in metro markets*", appealing to an emerging market group that is not motivated by traditional automotive product strengths.

"For many years automotive companies have planned to increase their turnover, to expand lineups, add content and raise prices," he said. *"The underlying idea was that we could raise the costs of the cars because we could increase the customer's willingness to pay. The car was a symbol of status and achievement. More recently things have changed.*

"We have seen the emergence of a large portion of car buyers who no longer show their pride in the most recent or expensive car model, but [they] would rather invest in high-tech, leisure...and they are no longer looking for status when they buy their car. They are looking for a 'good enough' offer, a 'good enough' level of feature, a 'good enough' level of comfort."

In many cities around the world, car sharing is widening its reach and appeal. The savvy young consumer can rent a car when he or she needs it, by the hour. They can also use other modes of transport as appropriate and not be burdened with the cost overheads that come with outright car ownership.

About David Leggett

David Leggett has been editor of just-auto since 2000. He has been analysing the auto industry for over 25 years in analyst, forecasting or B2B publishing roles. He is frequently asked for media interviews or to present at industry conferences.

David also plays a leading role in the development of just-auto's expanding research portfolio.

He joined just-auto from the Economist Group's Economist Intelligence Unit (EIU) where, as director of automotive forecasting, he played a key role in the integration and development of forecast-orientated automotive data to the EIU's electronic product portfolio.

Formerly, he was director of forecast services at CSM Europe, the European arm of US-based auto industry analysts CSM Worldwide, where he developed the European Light Vehicle Forecast Service for automotive clients across the world.

Previous appointments include senior associate with Global Insight (then DRI) and senior economist with the UK's automotive trade body, the Society of Motor Manufacturers and Traders (SMMT).

While at Global Insight in the mid-1990s he led the company's expanding analysis of automotive emerging markets, especially in East Asia.

David holds an honours degree in Economics from the University of East Anglia, Norwich, UK.



LOTUS ENGINEERING

Smart phones and apps that provide real-time updates are supporting this drive towards the increasingly fragmented consumption of transport modes. If sustainability is your thing, there's an app that can help you optimise your travel plans to reduce your CO₂ footprint, as well as apps that will minimise your journey time. Car clubs look like they are here to stay as a part of the urban transportation landscape. Another point is that they offer up to date models, something that plays well to the brand aware and technologically conscious priorities of smart 'Generation Y' consumers.

Several vehicle manufacturers are now getting involved in car sharing projects and businesses. The smarter ones recognise that they need to be able to adapt their business models to suit changing market needs. Initially we saw the premium OEMs getting involved, but volume players are now starting to get active in this area. Ford, for example, has now got into car sharing with FORD2GO which is a project to provide car sharing across all Ford dealerships in Germany. We are also seeing more leasing companies getting into the car sharing business.

The digital dealer

Another key trend is the rapid evolution of digital technologies in the urban environment, the emergence of 'lifestyle retailing', such as that offered by Audi with its 'City' outlet in London. Potential buyers can configure cars on large screens, an experience suited to city living and that uses up less space than the traditional dealership. It's more of a lifestyle kind of retail concept, like Apple, and means that you can have a retail point in the centre of the city, rather than in the outskirts where land is cheaper. Audi has only three cars in the whole showroom, but the advanced digital technologies mean that you can see any car you want on the wall, put options on, you can gesture control and so on.

Who's driving?

As technology develops it can aid the driver, enhance the driving experience or turn the driving experience into something else. ABS is a simple example of electronics intervening to make braking better. Such interventions from vehicle systems have proliferated to things like collision avoidance and lane departure warning. As the interventions multiply, the position of the driver is changing, perhaps subtly, with more responsibility taken by advanced electronics. The ultimate expression of these advanced technologies can be seen in the autonomous car, such as that produced



by Google.

Autonomous driving is something that is beginning to attract much more attention, even if the fully driverless car remains some way off as a commercial proposition rather than an experimental car. We might not see significant autonomous driving before 2020 but we will see certain features of autonomous driving such as valet parking and traffic-jam assist. With traffic-jam assist, if you are caught in a traffic jam, the car will drive itself up to a speed of, say, 30 MPH. You can take your hands off the steering wheel, check your email or read a book...

Another intriguing development is intelligent transport systems. Cars that can communicate with each other and with roadside infrastructure can produce real-time data flows that can serve to optimise traffic flows. The traffic lights become much more dynamic. It's a nice vision of technology helping to reduce traffic congestion.

And here's a thought. If cars are communicating with each other and advanced systems mean that they never crash, then why bother with passive safety systems that add weight? There's probably no need for airbags if the chance of a system failure and subsequent crash is about the same as being struck by a meteor.

Advanced technology may reshape the car and the driving experience radically and it may also impact our emotional feelings about motor vehicles and the brands that come with them. Can driving be fun? Of

course it can. Many of us enjoy the driving experience, the sense of control, man and machine in harmony on a twisty country road on a sunny day. But a long commute in heavy traffic and in pouring rain? That may be an instance when you would rather read your newspaper than negotiate the driving. Maybe flip a switch to autopilot. Is this the car as a pod? You get in, enter the destination on a screen and then sit back, get on with something else while the car seamlessly takes you where you want to go? A good scenario or a bad one? Or would you like access to a 'pod', as well as a more conventional car when you need it? Would that be two cars, engineered for different experiences, or would both experiences be available in one vehicle? If you have travelled in the pods at London's Heathrow airport, you'll perhaps feel that there is a place for the autonomous pod in the transportation future.

Meanwhile, the car companies and suppliers are working on cars in the near future that will be geared to helping you check your email and keep in touch while in your car. There is no need to be incommunicado and fancy electronics will gradually mean that you don't have to pay as much attention to driving as you do now. That's right. Do something else in your car. You can, instead, be engaged in much more socially productive activity such as checking your Facebook friends' news or watching dancing cats on YouTube.

YouTube, by the way, is updated every six days with more content than has been delivered by the BBC throughout its entire history. There's plenty of demand for new forms of media content out there and the car companies can't just ignore that.

There's a lot to be resolved and the car needs to continually adapt to changing societal needs and preferences. It's ultimately a question of what the customer wants and where the regulators draw lines.

Being part of the solution, not the problem

As the world's population grows and the migration to cities continues, moving around the big mega-cities in a manner that minimises environmental harm, maximises economic growth and makes cities agreeably liveable spaces will become a rising challenge. The auto industry can manoeuvre to be part of the emerging solutions, rather than the problem. And that's the way the smarter companies are already thinking.

Writer: Dave Leggett

△ Editor - just-auto.com

V2X

Vehicles to everything

This article was originally intended to be about charging vehicles and what were the implications to the electricity grid however, it became obvious that there is a wider picture that interlinks vehicles to infrastructure.

The industry has started to use common terminology for this V2x. V2x is the combination of vehicle to grid/infrastructure/home/vehicles communication technologies discussed below.

One thing to point out is that the communication isn't one way, another is that the deployment of V2x will benefit conventional vehicles as well as H&EVs. In some cases the benefits are the same but there may be additional benefits for H&EVs when it comes to energy consumption and intelligent control strategies.

Vehicle to grid (V2G)

Vehicle to grid covers the connectivity, via a smart meter, of the vehicle to the electricity grid. The use of a smart meter would allow time-based data to be collected including charging rates, time of day, number of vehicles connected at any one time. This is valuable data for the energy and utility sector to be able to help plan energy supply and demand. Smart charging could be bi-directional where the grid could use the energy storage of a population of EVs to balance peaks and troughs in electrical supply.

Vehicle to home (V2H)

The Toyota City Project is an ongoing research project on smart grid technology supported by Japan's Ministry of Economy, Trade and Industry.

The trial investigates the possibility of using the energy stored in a plug-in vehicle to power the home in times of emergency blackouts or power outage. Nissan have also announced their work in this field and have suggested that a Nissan Leaf with its 24 kWh battery pack could power a home for up to two days. Given the aftermath of the 2011 tsunami, it's clear to see why Japan is keen to explore using energy in this way.

Vehicle to infrastructure (V2I)

Telemetry and sensor technology enables vehicle connectivity to the Infrastructure and this is where things get really interesting with benefits at all levels. If the infrastructure knows where a vehicle is, intelligent traffic management allows for so-called 'green waves' of traffic flow where the amount of slowing down and speeding up is reduced.

Whether it is an individual or a fleet operator the benefit to the road user is improved fuel consumption and energy use; the benefit to the road operator is increased mobility. Traffic lights will form part of 'junction management' and could be easily retrofitted with sensors for V2I communications.

As well as mobility improvements there will be benefits to road safety. Some vehicles already exhibit driver assistance technologies like lane departure warning; emergency brake assist and radar cruise control. These systems could intervene to prevent an accident occurring. There are a number of stages leading up to a road traffic accident totalling a 'time to collision'.

Firstly there is the awareness of an up and coming risk. Road signs, signalling and driver awareness make up this first phase and some vehicles already in production have things like road sign recognition and driver warning systems. If nothing is done (if the driver hasn't responded correctly to the risk) the second phase is a warning phase where the vehicle systems could provide audible or visual warnings to the driver. Additionally force feedback could be used by tightening the seatbelt, pulsing the brake pedal or other means.

If the driver still does nothing, the vehicle systems controls could intervene and alter the vehicle speed, direction or both. If the accident is inevitable, vehicle systems could be 'primed' to operate. Intelligent airbag firing could be deployed as could seatbelt pre-tensioning.

It's true that these passive safety systems already exist but what's new is the V2I being able to control them, in order to manage the accident in a way that

could lessen damage or injury compared with the deployment alone of the passive safety systems. Post-accident, the vehicle could automatically contact the emergency services and give out information such as vehicle location, accident severity and driver condition.

The idea of this eCall system was proposed in 2001 and the European Commission is targeting 2015 to be when a fully functioning eCall system will be operable throughout the EU.

Issue 48 of proActive included an article on ISO26262 and functional safety and this is directly implicated with V2x and the (semi) automatic control of driver assistance and other safety related vehicle systems.

Specifically, for H&EV users, intelligent control strategies could optimise the control of the vehicle systems by using the infrastructure or environment information. This could be as simple as using the satellite navigation system not just for intelligent journey planning for the shortest journey but additionally controlling the strategy to use the least amount of energy. 'Cloud-based' information such as traffic and weather conditions would also allow optimised energy usage.

Vehicle to vehicle (V2V)

A vehicle knowing its position in relation to other vehicles in the locality has the ability to improve road safety to another level by creating an autonomous collision avoidance environment.

Building on the development of V2I systems and the environment infrastructure makes V2V a possibility.

Accurate sensing and wireless communication technologies will allow a vehicle to build up a picture of its surroundings which will enable the control of driver assistance devices to be managed accordingly.

Summary

V2x is used to combine the above, particularly V2I and V2V. It should be pointed out that there are no technological barriers to V2x from a technology

standpoint, everything that is needed for V2x already exists today.

As recently as June 2013, Mercedes Benz announced that by the end of 2013, its newest vehicles will include the fitment of technologies enabling V2x communication. The systems will also be available to be retrofitted to some vehicles. GM, Ford and Honda are already fitting systems and using downloadable apps to enable elements of V2x.

So, the technology is there however, there may be other aspects that could be barriers to the adoption and use of full V2x capabilities.

The typical industry 3-year timescale for the design, development, verification and certification of automobile systems makes the EC eCar roll-out date of October 2015 appear challenging. Having said that, the major OEMs have large elements of on-board V2x systems in place already.

Legislation and standardisation typically lag behind the development of the technical solutions so there is an element of designing 'in the dark'. The trick is to design the hardware and software to be 'future-proofed' so it could be adapted to any communications standards for example. Protocols, interoperability and compatibility all need to be considered for V2x as does ISO26262 and functional safety of vehicle systems.

As V2x moves into the realms of autonomous driving, it must be made clear where the boundary is set for liability. Where and when does the liability transfer from the driver to the OEM when systems intervene and alter how the car behaves on the road?

Finally, as V2x is very much data driven, data management must be in accordance with data protection, human rights and privacy laws. OEMs and fleet operators are putting a lot of effort into the legalities of data collection and usage. ■

Writer: Phil Barker

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