



ENGINEERING

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ISSUE 40 | **SPRING 2011**

**LOTUS ENGINEERING PROVIDES**  
ELECTRICAL INTEGRATION EXPERTISE  
FOR ULTRA LUXURY VEHICLE

**THE SIGHTS AND SOUNDS OF GENEVA**  
– NEW TECHNOLOGIES FROM LOTUS  
ENGINEERING

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TO START WORK ON ONE OF THE UK'S  
MOST EXTENSIVE ELECTRIC VEHICLE  
RECHARGING NETWORKS



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## WELCOME

**Having been at Lotus Engineering for over a year now it is great to be able to say that we are on track with the five year plan and going from strength to strength.**

Over the last year we have expanded the headcount across our global engineering teams and have been joined by a new Head of European Sales, Martin Elbs and a new General Manager in China, Hui Zhang. We have huge expectations for China over the next five years. A new office in Germany will be opened in the coming months as part of our continuing strategy to increase our presence in important markets.

More recently we have just had a very successful Geneva motor show, with high levels of media interest in Lotus Engineering. This year at Geneva we unveiled

the cutaway 414Evolution series hybrid technology demonstrator. The new exciting technology on this car included the production design Range Extender engine that has been developed with our partners Fagor Ederlan and also our latest pedestrian safety system using the HALOsonic active noise control technology integrated with a camera-based driver assistance system.

Generally confidentiality means that we cannot talk about the third party projects we undertake, though we are proud to be able to make public our recent work on the 102EX Rolls Royce Phantom Experimental Electric unveiled at Geneva. Lotus Engineering designed and developed the full electric drivetrain for this vehicle and the project exemplifies our technical expertise in Electrical and Electronic Integration.



This Phantom Experimental Electric has been a great advert for Lotus Engineering and we now have to continue to build on all our successes of last year and further grow our business. I am incredibly excited about the year ahead. >

Dr Robert Hentschel  
Director of Lotus  
Engineering

## INDUSTRY NEWS

JUST-AUTO EDITOR DAVE LEGGETT REVIEWS SOME OF THE LAST QUARTER'S NEWS HIGHLIGHTS

### **THE FRIDAY STORY: Thieves nick BMW Detroit show transport**

The New Year kicks off in traditional fashion with the NAIAS, otherwise known as the Detroit Motor Show. Our roving reporter tells us that the atmosphere around the show halls is pretty upbeat. Yes folks, Mo'town has got its mojo back. There is plenty on display from a confident industry, so maybe there is good reason to believe that things are really on the up. Downtown Detroit, locals will tell you, is still a place where you need to have your wits about you. An unfortunate valet is left with some explaining to do over a disappeared BMW 7 Series. 'I just left it on the street for a second, engine idling...I looked back and it was gone...'

[Read more](#)

### **QATAR: VW unveils new super efficient concept**

Volkswagen unveils its new XL1 Super Efficient Vehicle (SEV) concept at the Qatar motor show.

"Pioneering construction techniques, an advanced plug-in hybrid drivetrain and innovative packaging all play a part in allowing the XL1 to return 313 mpg on the combined cycle while emitting 24g/km of CO<sub>2</sub> to set a new benchmark for vehicle efficiency," the automaker claims.

[Read more](#)



### **GERMANY: ZF developing nine-speed autobox for transverse use**

ZF says it is developing a nine-speed automatic transmission for transverse engine installation that will be produced in Greenville, South Carolina, US. "With its nine-speed automatic transmission for vehicles with transverse installed engines, ZF will once again establish a benchmark in terms of fuel consumption. Compared to today's standard six-speed automatic transmissions for front-transverse design, ZF's new nine-speed automatic transmission clearly improves both driving performance and fuel economy.

[Read more](#)

### **JAPAN: Daimler in carbon fibre JV with Japanese textile firm**

Here's a sign of the growing attractiveness of carbon-fibre reinforced plastic (CFRP) in the auto industry. Japanese textile maker Toray Industries and Daimler announce that they will jointly set up a company in Germany to make and sell automobile parts using CFRP. The joint venture will start supplying carbon fibre components for Daimler's Mercedes-Benz passenger vehicles to be launched in 2012.

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# DAIMLER

### **SWEDEN: First demonstration of SARTRE vehicle platooning**

It's a mind-boggling thought. Just cosy up to other cars at high speed on the motorway and read the newspaper or take a power nap. Meanwhile, save on fuel and do the environment a favour due to slipstream benefits. 'Platooning' may be the new way of travelling on motorways in as little as ten years time – it is claimed – and the EU-financed SARTRE project has carried out the first successful demonstration of its technology at the Volvo Proving Ground close to Gothenburg, Sweden. Clever stuff, but I can see a whole load of practical obstacles that need to be overcome.

[Read more](#)

## INDUSTRY NEWS

JUST-AUTO EDITOR DAVE LEGGETT REVIEWS SOME OF THE LAST QUARTER'S NEWS HIGHLIGHTS

### CHINA: Changan to open Detroit R&D centre

Here's a sign of the growing maturity and international presence of Chinese companies. Chongqing Changan Automobile Company reportedly says it will establish a presence in America by opening a research centre in Detroit.

[Read more](#)



长安汽车

### US: Chrysler considering natural gas engines for Ram truck brand

It's perhaps a lesser known synergy for exploitation between Fiat and Chrysler. It emerges that Chrysler is exploring the possibility of adding compressed natural-gas powered engines to its Ram truck brand. Fiat is the market leader in Europe for engines using compressed natural gas, or CNG. It is estimated to have an 80% share of CNG-powered cars. Not a lot of people know that.

[Read more](#)

### GERMANY: BMW's i3 to offset battery weight with carbon fibre use

BMW claims that its use of carbon fibre reinforced plastic (CFRP) in its i3 electric vehicle will save around 300kg in weight following the start of production in 2013.

[Read more](#)



### BELGIUM: EU mandates car and small van daytime running lights

New European Union (EU) regulations mandating daytime running lights (DRL) come into force. They mean that all new types of passenger cars and small delivery vans will have to be equipped with the lights, while trucks and buses will follow suit in August next year. DRL uses lamps which automatically switch on when the engine is started and are claimed to have a low energy consumption rate compared with existing dipped-beam head lights.

[Read more](#)

### US: High-end audio technology helps Terrain get top MPGs

It is claimed by GM that the technology that makes high-end noise-cancelling headphones coveted by frequent flyers and iPod audiophiles is helping GMC Terrain owners save gas. Active noise cancellation does double duty on Terrain, GM tells us.

[Read more](#)



## INDUSTRY NEWS

JUST-AUTO EDITOR DAVE LEGGETT REVIEWS SOME OF THE LAST QUARTER'S NEWS HIGHLIGHTS

### GENEVA PREVIEW: Porsche to recreate 'Semper Vivus' classic hybrid

Porsche reminds us that hybrids have been around for a while as it recreates its first functional, full hybrid car in the world, the Semper Vivus, 111 years after its World Premiere in 1900. Nice pic.

[Read more](#)



### GENEVA: Mazda 'will double fuel efficiency' with G2 Skyactiv

Mazda says that it is working on second generation 'Skyactiv' (no, nothing to do with your TV) technology which will double the efficiency achieved by the first generation which arrives this year. This, it says, will be achieved by applying lean-burn technology to the engines – something not done with the first generation – while continuing to reduce vehicle weight and improve transmission efficiency.

[Read more](#)



### UK/France: JLR and Dassault Systèmes announce technology partnership

Jaguar Land Rover and Dassault Systèmes, a specialist in 3D and Product Lifecycle Management (PLM) solutions, announce that they have entered a 'strategic partnership that formalises future cooperation and collaboration between the two companies'.

[Read more](#)



### THE FRIDAY STORY: Petrol-sniffing spider prompts Mazda recall

And finally, an unusual reason for a Mazda recall in the US gets worldwide coverage – a spider likes the smell of petrol so much it chooses to build its webs in emission control systems. You couldn't make it up.

[Read more](#)



### US: Spiders also like Honda Accords – paper

But the yellow sac spider that likes to make a home in certain Mazda 6 cars in the US may also be partial to the occasional Honda Accord.

[Read more](#)



## LOTUS NEWS

### LOTUS ENGINEERING PROVIDES ELECTRICAL INTEGRATION EXPERTISE FOR ULTRA LUXURY VEHICLE

**Lotus Engineering, a company with over 20 years of EV and HEV experience, has been responsible for all aspects of the electric drivetrain integration for 102EX, the Rolls-Royce Phantom Experimental Electric. This includes the largest battery pack fitted to a road car, together with an innovative 7kW induction charging system. These components and the electric drivetrain have been integrated by Lotus Engineering into the existing Phantom electrical systems, giving an efficient electrical propulsion control strategy and retaining full vehicle functionality.**

Lotus Engineering has a broad expertise in vehicle design, manufacture and development. For the Phantom Experimental Electric project Lotus Engineering provided engineering services in the

areas of: drivetrain layout, vehicle simulation, Computer Aided Engineering (CAE), component specification, vehicle build, control strategy, control integration, procurement, commissioning and development testing. This project highlights the technical competence in Electrical and Electronic Integration and the capability and range of consultancy services offered by Lotus Engineering.

The Phantom Experimental Electric has two electric motors to replace the 6.75 litre V12 engine. These electric motors each produce 145kW of power to provide a total 290kW and torque of 800Nm giving a 0 - 100km/h time of under eight seconds and a top speed limited to 160km/h.

In the conversion of a Phantom into an electric vehicle a study was conducted to ensure that the optimum layout of the electric

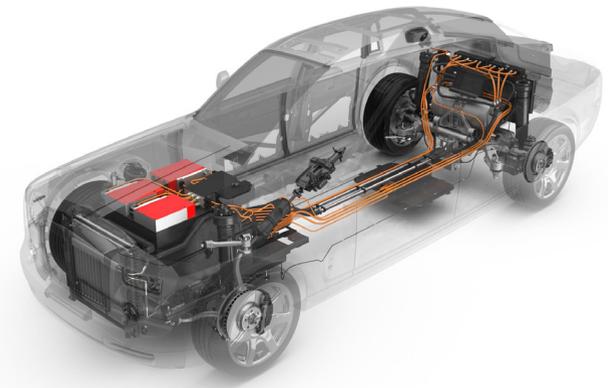
drivetrain and ancillaries was achieved with no intrusion into passenger compartment. Following an iterative design study the 71kWh, 640kg lithium ion battery pack was placed under the bonnet where the engine had been. The two motors, gearbox and inverters were located behind the rear seats in the original fuel tank bay, with power cables running longitudinally between the converters and the battery. This has enabled the Phantom Experimental Electric to retain its 50:50 weight distribution and characteristic Rolls-Royce driving experience.

The Rolls-Royce Phantom is a complex vehicle with many advanced electrical systems. The integration of the electric drivetrain and ancillaries with the existing vehicle control unit provided the greatest challenge for the project. To compound

this the Phantom Experimental Electric features the additional complexity of a 3 mode charging system (single phase, three phase and the inductive power transfer) together with a two level driver selectable regenerative braking system.

Dr Robert Hentschel, Director of Lotus Engineering, said "The Rolls-Royce Phantom Experimental Electric is an extremely advanced vehicle. I am delighted that Rolls-Royce

Motor Cars has recognised Lotus Engineering's world class engineering capability and chosen us to be a part of this project. We have taken a great deal of pride working for such a prestigious ultra luxury brand and I believe that this project illustrates the technical competency of Lotus Engineering in Electrical and Electronic Integration and the capability to apply our expertise to a wide range of applications and types of vehicle". >



The chassis and powertrain of the 102EX, the Rolls-Royce Phantom Experimental Electric

## LOTUS NEWS

### LOTUS ANNOUNCES PLANS FOR FIRST STAGE HETHEL SITE IMPROVEMENTS

#### **New Motorsports Centre and improvements to the Lotus Test Track show that the New Era of Lotus is well underway.**

For 43 years the legendary test track at Lotus' Hethel headquarters in Norfolk has been used to develop and test Lotus' innovative road and track

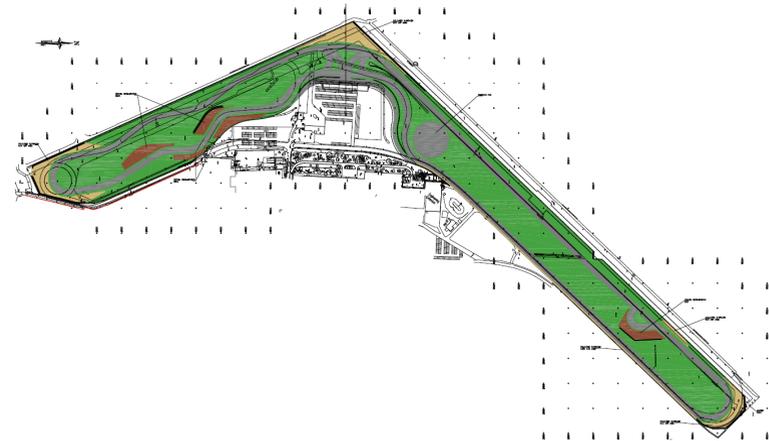
cars. Now the much used track is set to receive a well deserved facelift bringing it in line with rigorous FIA safety standards. The revised and improved test track will continue to be used for the testing and development of current and future Lotus cars and as an important tool in Lotus Engineering's global consultancy

product and services portfolio. Commenting on the development Group Lotus CEO Dany Bahar said: "Our test track is a vital part of the development of all our cars, both road and track. These improvements will ensure that all Lotus cars and those of our Engineering clients' will continue to be developed in Norfolk. A

better test track will mean even better Lotus cars in the future."

To accompany the improvements to the test track, Lotus has also submitted planning permission for a new Motorsport Centre, with a first floor viewing area based around a beautifully landscaped "Champions Square".

This new Motorsports Centre will be home to the popular Lotus Driving Academy driving experience and will also contain a number of engineering facilities which will enable Lotus to make running changes to cars under development within close proximity of the test track. >



## LOTUS NEWS

### LOTUS CUP: ALL FOR ONE AND ONE FOR ALL!

#### Popular Lotus Cup Race Series gets a global makeover

Over the years, the Lotus Cup Race Series has developed into one of the most successful race series brands in the world, often with capacity grids of Elise, Exige, 2-Eleven and Europa race cars racing and jostling for position. Previously operated from several countries in Europe and Japan, the Lotus Cup has

now expanded considerably to include the USA, UK and Eastern Europe.

Not only has the Lotus Cup grown in size, the organisation of the series has been consolidated. For the first time this year, drivers will now race to one set of rules, regulations and formats in championships around the world including:

- Lotus Cup UK
- Lotus Cup Europe
- Lotus Cup Italy
- Lotus Cup USA (West Coast)
- Lotus Cup USA (East Coast)
- Lotus Cup Eastern Europe
- Lotus Cup Japan

Lotus sports car racing is one of the most popular forms of accessible motorsport in the world, both at a spectator and participant level. Now these championships are being brought under the Lotus umbrella, to ensure consistent look and feel to the competition. This will benefit the current drivers and encourage new racers, ensuring that the cars and components remain good value

and the competition retains its accessibility.

Lotus will provide increased support and investment for these race series and will also ensure that the new Cup Championships retain the community feel and friendliness that an enthusiast based race series needs. >



## LOTUS NEWS

### LOTUS ENGINEERING RECRUITS FOR MAJOR EXPANSION OF GLOBAL OPERATIONS

**Lotus Engineering is delighted to announce two key appointments as part of its five year strategic plan to double the size of the engineering consultancy business.**

Hui Zhang joined Lotus Engineering in September as General Manager – China Operations with responsibility to generate growth in third party business in China and to improve the Lotus Engineering local delivery service structure. Hui Zhang joins Lotus Engineering from Kiekert with a wealth of international business experience and specific expertise in the European and Chinese Automotive industries.

Martin Elbs joined Lotus Engineering as Head of Sales for Europe on the 1st February 2011.

This role will focus on developing the sales organisation to generate increased consultancy business in Europe and to manage the opening of a Lotus Engineering office in Germany.

Martin Elbs has joined Lotus Engineering after 15 years at the German engineering company ETAS GmbH. He has an engineering background, strong international management credentials and brings an impressive breadth of experience to the role.

2010 signalled the third successive year of third party sales growth for Lotus Engineering, in line with the company's five year business plan to grow revenue from external clients. >



Hui Zhang joined Lotus Engineering in September



Martin Elbs joined Lotus Engineering as Head of Sales

## LOTUS NEWS

### LOTUS ENGINEERING SCOOPS TWO TROPHIES AT THE ENGINEER AWARDS

**Project Omnivore wins first place in the Automotive, Rail and Marine sector while the Fuel Cell Hybrid Taxi triumphs in the Energy category**

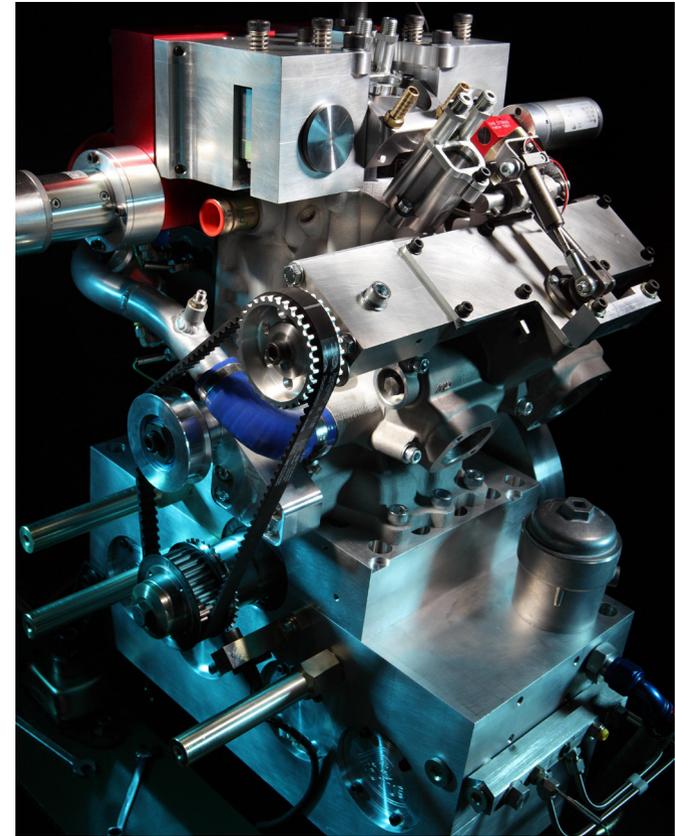
The Engineer – Technology and Innovation Awards 2010 is the annual competition of the highly regarded magazine celebrating the year's best engineering projects across a wide range of engineering fields. These prestigious awards recognise the expertise and world class research at Lotus Engineering in the areas of advanced powertrain and hybrid vehicles.

It is not difficult to see how the judges were impressed by Project Omnivore. It is an innovative two-stroke engine that will run in Homogeneous Charge Compression Ignition (HCCI) operation on a range of

fuels. The research engine will not only run on gasoline, diesel and alcohol fuels, but it also offers a 10% increase in fuel efficiency compared to stratified direct injection engines. Lotus Engineering was lead partner on Project Omnivore, working with Jaguar Cars, Orbital and Queen's University Belfast, with sponsorship from the Department for Environment, Food, & Rural Affairs (DEFRA), the Department of Energy and Climate Change (DECC) and the Department of the Environment – Northern Ireland through the Renewables Materials LINK programme.

The Fuel Cell Hybrid Taxi is a zero emissions series hybrid vehicle that has received extensive attention. It retains the iconic styling of a conventional London taxi, but it is fitted

with an advanced hydrogen fuel cell and hybrid drivetrain, giving a range of 250 miles and a top speed in excess of 85mph with zero tailpipe CO<sub>2</sub> emissions. The consortium for the project comprised Lotus Engineering, Intelligent Energy, TRW Conekt, LTI and the UK Technology Strategy Board. Lotus Engineering has designed and built the taxis, including the integration and control of the full drivetrain system. >



## FEATURE

### THE SIGHTS AND SOUNDS OF GENEVA – NEW TECHNOLOGIES FROM LOTUS ENGINEERING

**The 81st Geneva International Motor Show ran from March 3-13 2011 and attracted the top marques from the automotive industry to display their latest cars, automotive technology and concepts. The prestigious event was spread across some 80,000 square Meters, with 260 exhibitors representing more than 700 brands from 31 different countries.**

An enhanced development of the HALOsonic active noise technologies for enhanced pedestrian safety and the new production Range Extenders were made public for the first time, highlight of the continuing advanced research and development at Lotus. These new technologies were displayed in an interactive cutaway hybrid Evora 414Evolution exhibit on the stunning Lotus show stand.

The Lotus-designed series hybrid drivetrain of the 414Evolution incorporated the latest production Lotus Range Extender which is an extremely compact, lightweight, low-cost engine and generator, designed specifically for hybrid electric vehicles.

The initial concept engine was fitted to the Jaguar Limo Green research vehicle and this new version has been redesigned by Lotus Engineering and Fagor Ederlan Group to optimise performance and develop the engine for series production.

The Lotus Range Extender offers a fast route to market for vehicle manufacturers requiring a dedicated range extender for hybrid vehicles and will be offered in two versions with the top of the range 50kW supercharged variant on show in the hybrid Evora 414Evolution. The 1.3 litre, three cylinder Lotus

Range Extender engine offers high efficiency and low mass, which will enable the downsizing of expensive batteries, whilst maintaining vehicle efficiency and driving range of hybrid electric vehicles.

The supercharged version of the engine uses a belt driven centrifugal supercharger to produce its 50kW peak electrical power at 3500rpm, with the naturally aspirated version producing a maximum 35kW. The engine is optimised to generate power at engine speeds between 1500 and 3500rpm allowing a lightweight simple 2 valve per cylinder engine architecture and eliminating the need for a complex 4 valve per cylinder design.

Designing the engine specifically for hybrid applications has provided a number of



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### THE SIGHTS AND SOUNDS OF GENEVA – NEW TECHNOLOGIES FROM LOTUS ENGINEERING

opportunities to significantly reduce the mass of the engine. This mass optimisation has resulted in an engine weight of 58kg for the supercharged version and 51kg for the naturally aspirated variant.

Further weight reductions have been achieved through the design and use of an Integrated Exhaust Manifold, and an innovative new Integrated Intake Manifold that not only gives a significant reduction in weight but also in the overall package size of the Range Extender. Along with these innovative manifold solutions the generator that has been supplied by Fagor Automation, is driven directly off the crankshaft which helps to further reduce weight, package size and cost.

The engine, generator and power electronics on the Range Extender are controlled using

a Lotus controller which helps to improve communication and efficient running of the systems. The engine architecture and engine management system have been designed to offer flex-fuel capability to allow the engine to run on renewable alcohol fuels.

The 414Evolution was also fitted with Lotus Engineering’s latest pedestrian safety system that was developed using the HALOsonic active noise control technology integrated with a camera based driver assistance system.

Lotus Engineering and HARMAN Automotive joined forces to develop a sound synthesis system for electric vehicles that now forms part of the HALOsonic suite of sound technologies. Lotus Engineering saw an opportunity to further enhance the system into a more intelligent pedestrian warning system by



integrating a camera based driver assistance system. This development offers enhanced pedestrian warning while minimising sound generation and energy use when possible.

The forward vision system integrated with the HALOsonic

systems uses a single camera to determine the distance, trajectory and speed of pedestrians and other road users, calculating the risk of collision by comparing this information with the car’s path. The HALOsonic system uses this data to actively control the

volume of the External Sound Synthesis to warn pedestrians of the vehicle’s location, thereby improving pedestrian safety and by running at a lower level of sound for the majority of the time reducing perceived noise pollution. Under certain conditions the system will also

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### THE SIGHTS AND SOUNDS OF GENEVA – NEW TECHNOLOGIES FROM LOTUS ENGINEERING



generate an audible and visual warning inside the vehicle using the Internal Sound Synthesis and instrument panel to alert the driver to potential danger.

The new active system is optimised to operate in urban environments where there is the greatest risk of a collision with a pedestrian. It is calibrated to actively control the volume and

pitch of the sound synthesised, continually evaluating the risk of a pedestrian collision and operating in an area up to 60 metres ahead of the vehicle. All of the HALOsonic systems are

designed to use low levels of power and with the new active version there will be less power consumed as the system will only increase the volume when there is risk of an impact.

This innovative new active safety system is integrated into the HALOsonic range of products, which includes: External Sound Synthesis, Internal Sound Synthesis, Road Noise

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### THE SIGHTS AND SOUNDS OF GENEVA – NEW TECHNOLOGIES FROM LOTUS ENGINEERING

Cancellation and Engine Order Cancellation. The HALOsonic range has been designed by Lotus Engineering and HARMAN Automotive and offers a production-ready technology as a stand alone or integrated ICE system solution.

The latest active video HALOsonic system is the most advanced system on the market and meets with all the proposed legislation worldwide. HALOsonic is the global benchmark pedestrian safety system of this type and is receiving a lot of attention from large vehicle manufacturers keen to meet the upcoming legislation in the US and Japan. >

John Lamb  
Lotus Engineering

#### **National Highway Traffic Safety Administration (NHTSA) study into the dangers of ‘quiet vehicles’**

The dangers of ‘quiet vehicles’ was emphasised by a recent National Highway Traffic Safety Administration (NHTSA) study in the USA that measured the increased risk of silent vehicles through accident data and found that “for one group of scenarios, those in which a vehicle is slowing or stopping, backing up, or entering or leaving a parking space, a statistically significant effect was found due to engine type. The HEV was two times more likely to be involved in a pedestrian crash in these situations than was an ICE vehicle.”

Following this research governments around the world have acknowledged the

increased risk posed by almost silent vehicles such as EV and HEVs and are in the process of drawing up legislation to compel car manufacturers to equip vehicles with pedestrian warning systems like the HALOsonic system. In many regions around the world noise legislation concerning electric and hybrid electric vehicles is deemed to be inevitable.

In the US, President Barack Obama recently signed a bill mandating pedestrian warning devices on ‘quiet vehicles’ and Japan has published sound generation guidelines pushing for a voluntary adoption of exterior sound generators ahead of legislation. In Europe, legislators are planning to adopt guidelines similar to Japan in the near term, with legislation likely in the future.



## FEATURE

### A BRIEF HISTORY OF CARBON FIBRE COMPOSITES AT LOTUS

**A composite is a material consisting of two or more ingredients that possesses better properties than the individual constituents possess in isolation. Some examples of natural composites include wood, celery, bones, teeth, plant leaves and bird feathers.**

In vehicles, arguably the most important composite is the tyre, a combination of steel and nylon reinforcing fibres in a rubber matrix. This composite provides our entire connection between the car and the road surface with a contact patch no bigger than your hand on all four corners of the car. However, when we think about composites in automotive applications it is usually in the context of Glass Fibre Reinforced Plastics (GFRP) and Carbon Fibre.

Glass fibres were first discovered by the ancient Phoenician and

Egyptian civilizations over 5,000 years ago, however they used the coarse material for decoration unaware of the potential that lay within them. It was not until 1936 that glass fibre, as we know it today, was developed and patented by Owens Corning, and then combined with plastic matrices in the early 1940s to form GFRP.

Carbon Fibre was first used by Thomas Edison, back in 1879, as a filament in his early light bulbs. These early fibres were made out of cellulose from cotton or bamboo, being highly tolerant of the heat but lacking the high tensile strength of today's carbon fibres. It was not until the late 1950s that high tensile carbon fibres were discovered.

The use of composites at Lotus fits well with our design philosophy of performance through light weight and parts

integration. We have been using composites at Lotus ever since the introduction of our first production model in 1957 – the Lotus Elite – which was the world's first composite monocoque production car.

Lotus first used carbon fibre to design and develop a technology demonstrator performance car of the future for General Motors (GM) in 1987. Carbon fibre was used for both the primary and secondary structures as well as the floorpan. A filament wound carbon/epoxy torque tube was also employed. This vehicle was also the first where Lotus utilised composites, especially carbon fibre, for crash protection. This fully road legal 200mph supercar also used state of the art 4-wheel-steering as well as 4-wheel-drive.

In July 1992, the British cyclist Chris Boardman, riding the



**British cyclist Chris Boardman riding the unique Lotus monocoque bicycle**

unique Lotus sport black and gold monocoque bicycle, set the world buzzing, as in the space of just four days, together they smashed world records and dominated the 4000m pursuit event at the 1992 Barcelona Olympics. Never before had a cyclist and his machine made so many headlines world-wide. The bicycle was developed and tested in secret during early 1992 with dramatic improvements in its rider's times being recorded.

Before 1992 Western teams had struggled to challenge the supremacy of the East Europeans, but together, bike and rider, were able to achieve an unprecedented victory and setting a new fastest time for the event to add to the Gold Medal. Later that summer, bike and rider went on to set a new 5000m world record beating the old one by over 12 seconds.

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### A BRIEF HISTORY OF CARBON FIBRE COMPOSITES AT LOTUS

The bike was an all-composite monocoque with aerofoil cross-section, formed in two halves and bonded together, from a combination of unidirectional and stitched carbon fibre in an epoxy resin matrix. The two halves were hand laminated and vacuum bagged to draw out excess resin in order to reduce weight. The same process was adopted for the aerofoil cross-sectioned monoblade. Back then pre-preg was only processable in an autoclave and resin infusion had not yet been developed, so processing options at Lotus were limited as we didn't have access to an autoclave.

In 1998 AML and Lotus worked together to develop the Vanquish which was built for the Federal and European markets. It utilized a 50% volume fraction dry carbon fibre/epoxy Resin Transfer Moulded (RTM) transmission tunnel bonded into an Aluminium

chassis. The tunnel and the carbon reinforced RTM crash structure were moulded for AML by Lotus for the 8 year life of the vehicle.

GM was also keen to raise its profile in Europe and back in 1999 used Lotus to design and assemble the Vauxhall VX220/ Opel speedster at Hethel. This vehicle was based around a slightly modified Elise chassis with a 2.2L engine and GFRP body panels. GM was keen to exploit the marketing potential from this project and show how efficient its next generation diesel engines were so, in 2002, it commissioned the Eco Speedster. Having minimal drag, low rolling resistant tyres and a 112bhp TURBO diesel it reached 160mph with 111mpg fuel consumption. It utilised an Out-Of-Autoclave carbon fibre pre-preg body made by Lotus on an Opel speedster chassis powered

by a 1.3L engine and weighing in at a mere 660Kg.

Early Mark I Elise brake disks were also made from Metal Matrix Composite (MMC), a composite of aluminium matrix and short random silicon carbide reinforcing fibres – the fibre content being 28%. This helped to reduce the unsprung mass of the car. The MMC disk weighed in at 2.65Kg compared to 6.0Kg for a traditional cast iron disk of the same size.

Lotus first used carbon fibre on one of its production cars for the 1999 Sport 350 Esprit. The rear wing, together with interior trim components, was made using autoclaved pre-preg carbon fibre. It was a 10 year wait before carbon fibre returned to the production line at Lotus. The 2009MY Exige Cup260 (and subsequently the 2010MY Exige Cup260) used

carbon fibre for both interior and exterior applications which, together with other weight saving features, helped to reduce the overall weight of the car by 38Kg compared to the previous year's car.

In 2009 Lotus Engineering delivered a Light Weight Design Exige Cup260 to Evonik in order for them to showcase their light weight advanced material technologies to other OEMs. The vehicle was a standard Exige Cup260 with additional Out of

Autoclave carbon fibre pre-preg panels including the front and rear clamshells and the doors. These panels saved a further 14Kg over their standard GFRP counterparts.

Carbon fibre was used on exterior panels of the Exige Cup 260 to primarily save weight, but supplementary to this we were able to integrate the exposed 2 by 2 twill weave pattern into a styling feature for the vehicle. The air duct, integrated into the roof and tailgate, formed a



## FEATURE

### A BRIEF HISTORY OF CARBON FIBRE COMPOSITES AT LOTUS

raised spine down the centre of the vehicle utilising this exposed carbon weave feature, which was also evident on the air ducts, access covers and front and rear spoilers.

Exposed carbon fibre was also heavily featured inside the cabin in the seat structure, centre console, dashboard, switch covers and sill kick plates.

The future Lotus products unveiled at the Paris Motor show last year will also feature carbon fibre applications. These will help to save weight and improve the performance and continue to provide the great driving experience for which Lotus cars are renowned. >

Paul Sills  
Lotus Engineering

#### What is a pre-preg?

A pre-preg is a mixture of reinforcement material, such as woven carbon fibre, with a partially cured resin matrix such as epoxy, combined at a precise fibre to resin ratio which ensures controlled laminate thickness results. Once the material has been "laid up" it requires pressure to consolidate the laminate and heat to cure the resin. Traditionally the pressure, and for that matter heat, has been applied by means of an Autoclave, but over the last 5 -10 years Out-Of-Autoclave pre-preg technology has advanced to the stage where class A automotive panels are achievable. Unlike traditional autoclave pre-preg, where all layers are identical in their construction, Out-Of-Autoclave pre-preg has two distinctly different layers.

The surface ply allows any entrapped air to find its way out of the system as it is partially impregnated with resin in order to produce very high quality surface finishes. The backing ply is syntactic (the matrix being bulked out by hollow microspheres) and has a greater resin content to supplement the system. In combination the surface and backing plies create a lightweight body panel system. With Out-Of-Autoclave systems, as the term suggests, there is no requirement for the pressure to be applied through an autoclave. The consolidation phase can be solely achieved via vacuum only, utilizing a vacuum bag process, and the heat element supplied via an oven. Tooling can be of composite construction, and single sided as used for the Exige Cup260 panels. The benefit over hand laminated wet lay up

techniques are the controlled resin content, "clean" process, repeatability, high quality and low void content.

Resin infusion is another Out-Of-Autoclave technology employed by Lotus in the manufacturing of the Exige Cup260 vehicle. Resin

infusion uses a vacuum to draw resin into a dry fibre pack, in this case epoxy and woven carbon fibre, using a one-sided mould tool. A plastic mesh is used to enhance resin flow within a vacuum bag system resulting in very high quality, void free, mouldings.



The Lotus Exige Cup260

## FEATURE

### THE LOTUS INTERVIEW: GENERAL MANAGER OF CHINA OPERATIONS HUI ZHANG

**Lotus Engineering is gearing up to take advantage of China's extraordinary expansion in car ownership. General Manager China Operations Hui Zhang talks to just-auto's Simon Warburton as the wholly-owned foreign enterprise looks to capitalise on the boom.**

**SW: How would you characterise the Chinese market at the moment and its importance to Lotus Engineering?**

**HZ:** China has been the largest automotive market since 2009 and automatically became one of the most important markets for Lotus Engineering – in 2009 total production volume was 13m vehicles, in 2010, 18m and this year we are expecting around 10%-15% growth.

Our main customers are Chinese OEMs and they experienced very

quick expansion. In terms of revenue and profitability everyone realises how important it is to improve engineering levels to satisfy local customers, hence gain more market share and meet international requirements for vehicle export. But there are still not enough experienced engineers with many years experience, so that is why I believe Lotus Engineering has a good chance.

**SW: What are Lotus Engineering's goals in China?**

**HZ:** We serve all the major Chinese OEMs and our current business model is our engineers from the UK are working on the project in China. According to the five-year strategy, Lotus Engineering wants to double global revenue to more than GBP100m to 2015 [and] 23% of that should come from Asia. So

we are trying to establish our own engineering capability in China.

The goal is to grow the Chinese organisation to become a full engineering delivery centre, eventually employing 200 staff. A new management team is in place and locally based engineers are being recruited – the majority should be Chinese engineers [although] we are trying to recruit ex-pats first. We want to target engineers with 5-10 years' experience.

All main Chinese OEMs already started huge recruitment years ago and SAIC (Shanghai Automotive Industry Corp) for example, has joint ventures with General Motors and Volkswagen respectively – there are some experienced engineers already. We want to improve the skills and capabilities of our local

engineering team so Lotus Engineering in China can become a Centre of Excellence. I am really confident because the market itself has changed a lot.

**SW: What are your areas of expertise in China?**

**HZ:** We provide services in core competencies: driving dynamics, electrical and electronic integration including Hybrid and Electric Vehicles, lightweight architecture and efficient performance. In China we serve all four competencies and our main focus in terms of the number of products now is driving dynamics from a few days' local tuning to complete chassis development.

**SW: How would you view hybrid and EV technology in China and what will drive its development?**



King Tower, Shanghai - Home of Lotus Engineering in China

## FEATURE

### THE LOTUS INTERVIEW: GENERAL MANAGER OF CHINA OPERATIONS HUI ZHANG

**HZ:** The current demand in China is not that big yet for new energy vehicles but I think the market will increase dramatically due to the following reasons:

**1. Government support.**

According to the draft energy saving and new energy vehicle development plan (2011-2020), the central government intends to provide GBP10bn capital supporting the development of new energy vehicles until 2020.

**2. China is rich in raw materials for producing lithium batteries.**

**3. China OEMs still have a cost advantage in vehicle production compared to western OEMs.**

**4. Potential huge market for purchasing vehicles.**

The country wants to establish production capacity of 500,000

new energy vehicles by 2012. I think China will become one of the world's leading countries in hybrid and EVs.

We can definitely be involved with EVs and hybrids – we have some good technology such as range extender engines for example. For Lotus Engineering, hybrid and EV [technology] is a key area where we are trying to establish ourselves.

**SW: How do you view the future for engineers in China and will there be more auto industry consolidation?**

**HZ:** All Chinese OEMs are recruiting new engineers, so in 10-15 years, China will have its own engineering capability.

I believe the Chinese auto industry is facing further consolidation. We still have



General Manager China Operations Hui Zhang

more than 100 OEMs in China, but in the rest of the world there are six large OEMs. In China there is a consolidation

phase and the Chinese central governments supports the market consolidation as well in order to have several large and

world-class [companies from China]. >

## FEATURE

### LOTUS AND THE EAST OF ENGLAND TO START WORK ON ONE OF THE UK'S MOST EXTENSIVE ELECTRIC VEHICLE RECHARGING NETWORKS

**Lotus Engineering has been at the forefront of development and production of hybrid and electric vehicles for many years and has recently been supporting the East of England 'Plugged in Places' bid. This bid was announced as successful, and EValu8 Transport Innovations Ltd is the company set up by the University of Hertfordshire to start delivering one of the most extensive electric vehicle recharging networks in the UK and across Europe.**

Currently, Lotus is conducting work on around 8 hybrid and electric projects, including a number of demonstrator vehicle programmes and being part of the EValu8 network will be incredibly useful, not only for being able to easily re-charge project vehicles but also to access the data that will become available. This data will provide a

constantly updated picture of real world vehicle usage and charging regimes and can be used to feedback into new project work.

'Plugged in Places' (PiPs) is a GBP30million UK government initiative to provide part funding for the installation of recharging points for electric vehicles to help stimulate the market uptake of a new generation of Low Carbon Vehicles including cars such as the Nissan LEAF, Peugeot iOn, Citroen C-Zero and the Mitsubishi i-MiEV. London, Milton Keynes and the North East were successful in Phase 1 of the initiative, with the East of England, the Midlands, Greater Manchester, Scotland and Northern Ireland announced as phase 2 recipients by the end of 2010.

The PiPs programme is being delivered by EValu8 and is happening concurrently with the

roll out of the UK government's Office of Low Emission Vehicles (OLEV) 'Plug-in Car' grant scheme. Both private consumers and businesses can now benefit from the 'Plug-In Car' grant when purchasing a qualifying ultra-low emission car and registering it in the UK. The UK government is adopting a 'technology neutral' approach to the problem of reducing emissions from transport meaning that cars with tailpipe emissions of 75g CO<sub>2</sub>/km or less, including electric, plug-in hybrid and hydrogen-fuelled cars are all potentially eligible for the subsidy.

The 'Plug-In Car' grant went live on the 1 January 2011, and purchasers of eligible cars are set to receive a contribution of 25% towards the cost of the vehicle, up to a maximum of GBP5,000 at point of sale. The first nine qualifying



vehicles for the scheme have been announced and include; Mitsubishi i-MiEV, Smart fortwo EV, Peugeot iOn, Nissan Leaf, Tata Vista, Citroen C-Zero, Vauxhall Ampera, the Toyota Plug-in Hybrid and the Chevrolet Volt.

#### **The EValu8 Project**

The EValu8 project has already begun to install an operationally effective electric vehicle (EV) charging network across the East of England, and a large number of Technology and Innovation

## FEATURE

### LOTUS AND THE EAST OF ENGLAND TO START WORK ON ONE OF THE UK'S MOST EXTENSIVE ELECTRIC VEHICLE RECHARGING NETWORKS

partners are lining up to use the network a test bed and innovation platform to build upon the region's significant innovation capabilities.

The EValu8 programme will be delivered over a 27-month period from January 2011, with part funding available to cover up to 50% of the eligible costs for the installation of 1,200 recharging points across the East of England (3 & 7kW). Assistance will be provided to new EV purchasers, with a 50% grant towards an approved home re-charge unit, provision of one off electrical EV-Ready installation grants for up to 500 Eco build domestic developments and the installation of eight CHAdeMO 50kW rapid charge stations. Green energy producer Ecotricity has also stepped forward to offer a renewable electricity sponsorship scheme for the

whole network for a period of two years.

Additionally, grants of up to 50% will be provided to employers for workplace recharging installation who encourage staff to drive EVs considered for grant funding. EValu8 members will be able to book ahead the network of publicly accessible recharging points to 'top up' their electric vehicles. Fully managed applications and welcome packs will be provided to network members and a monthly EV newsletter will keep members informed of extensions to the network as it evolves.

EValu8 will install an interoperable networked recharging infrastructure across the East of England and Group Lotus Plc has identified its requirements for installing charging points on site at Hethel



The Vauxhall Ampera is among the first hybrid vehicles to qualify for the 'Plug-In Car' grant

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# LOTUS AND THE EAST OF ENGLAND TO START WORK ON ONE OF THE UK'S MOST EXTENSIVE ELECTRIC VEHICLE RECHARGING NETWORKS

and these charging points will range from 3kW up to a fast charging facility of 50kW. The East of England charging network will also be linking in with adjacent recharging networks in London, Milton Keynes and the Midlands EV recharging networks.

With the total value of the project at around GBP7m announced in December, including a significant European Union contribution through the European Regional Development Fund, the significance of EValu8's potential has not been lost on the new UK coalition government who were particularly impressed in the way that the bid had secured significant automotive sector, as well as private and public sector backing. Indeed one major automotive stakeholder commented that "this is possibly the first time in

the East of England that all the major vehicle manufacturers, automotive consultancies, Tier 1 and 2 suppliers and energy

providers have united in one project." >

Phil Barker  
Lotus Engineering

### About the network

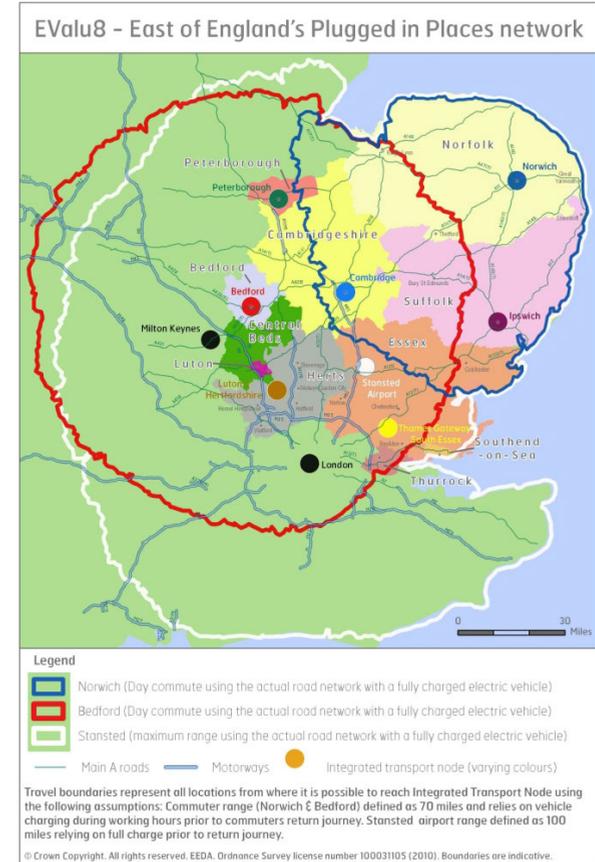
Within 2 years the EValu8 network will cover an area of 7,500 square miles. Initially posts will be focussed around Bedford, Cambridge, Ipswich, Norwich, Peterborough, Luton and Hertfordshire, Thames Gateway South Essex and London Stansted airport.

Eight EValu8 rapid rechargers will be strategically located on the East of England's main road network for drivers to 'top up' their EVs .

By the end of 2013, no resident or business in the East of England will be more than 25 miles from a recharging post.

EValu8 will offer an independent and integrated 'one stop shop' for potential EV buyers in the East of England, bringing together the UK recharging network, information on electric vehicles and other organisations associated with low-carbon transport including main-stream and niche vehicle manufacturers, electric vehicle dealerships and local transport authorities.

If you or your organisation are involved in low carbon transport and are interested in the EValu8 recharging network, the programme team can be contacted at [info@evalu8-ti.org.uk](mailto:info@evalu8-ti.org.uk) or visit <http://www.evalu8-ti.org>



## FEATURE

### Q&A WITH PROFESSOR BERNARD BÄKER

**Many of the most exciting innovations and developments taking place in the automotive industry embrace 'mechatronics' and the integration of mechanical and electronic engineering systems in areas like driver assistance. just-auto editor Dave Leggett interviewed Professor Bernard Bäker, an expert in the field who heads the Department of Vehicle Mechatronics, Institute of Automotive Technologies Dresden – IAD at the Technical University of Dresden, for proActive.**

**Dave Leggett: What's occupying your time at the moment?**

**Bernard Bäker:** My main research field is vehicle mechatronics and energy management which means to steer and control energy flows and streams. We work closely

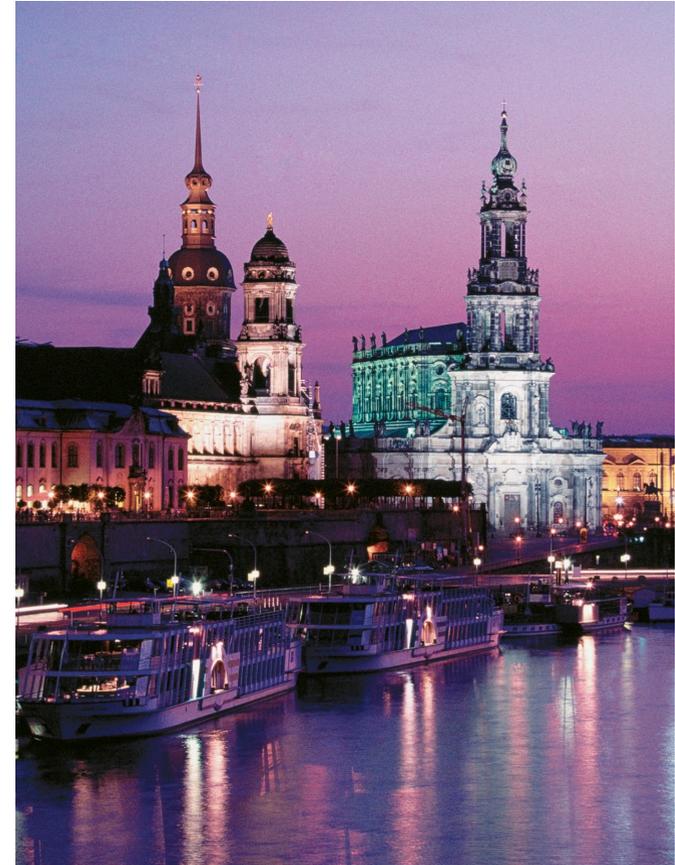
with vehicle makers and major suppliers. We are thinking about mobility and lifestyles and we are especially well known in the field of predictive control strategies which is about predicting the situation in the next 120 seconds, which is key. Your vehicle radar can be useful for the next two seconds, for security and safety aspects, but 120 seconds is very interesting for the energy aspect. For this prediction we use historical information. That's a very new topic. The historical information will be based on past journeys, for example, the journey made every day from your home to your office. We can use that historical information to predict a trajectory for energy aspects.

**DL: It's a busy research area?**

**BB:** Yes, there is a lot going on in this area and it is a centre

of research because of the challenges facing the automotive sector from an energy point of view. The situation is very interesting with a lot of different drive concepts upcoming. It is a great challenge for engineers and for researchers. In the automotive field, there is the whole question of battery and storage systems, control systems, human machine interfaces, mechanical systems and everything you need in the vehicle on the mechatronic side to make vehicles better and more efficient.

One very interesting aspect to the development of the car that we have identified is a kind of social community aspect to driving which is now becoming much more important – there is a parallel with social networking websites I think. These kinds of concepts are now growing



The Institute of Automotive Technologies is based in Dresden

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### Q&A WITH PROFESSOR BERNARD BÄKER

into vehicles – we are calling it social cars or social networked cars. BMW, for example, has developed what it calls ‘vision connected drive’ which means that while driving you receive information from IT networks around the road. While driving you receive a data fusion not only for safety and security but for energy efficiency as well, for forecasting, for predictions, for weather, for all the things you have on your iPhone. The approach is one of wanting to connect the vehicle to receive information from dynamic traffic lights, from traffic signs and so on.

Here in Dresden we started research into predictive control strategies five years ago. We have been looking at what kind of data we need in, in principle, in order to get energy efficiency benefits while a vehicle is in

use. The car companies that we partner with are working very closely with us to develop these new control strategies.

**DL: And this is something more than the traffic lights working to optimise traffic flows?**

**BB:** Oh yes, that was about optimising the traffic, but this is about optimising your energy drive through the traffic. The problem is that if you have an electrically driven car and you are waiting on the red light then you are losing distance and problems are compounded if your climate control is running and the energy comes from the drive battery – your available range is diminishing. The idea is that in 20-30 years’ time there will be no red traffic lights for electric cars because predictive algorithms override critical situations – traffic jams,

accidents, critical weather events – thus enabling the cars to travel freely.

**DL: Is the underlying challenge one of simplification in an increasingly complex world, from an engineering point of view?**

**BB:** Yes, I think that is a very big challenge facing the automotive industry. There are a lot of dependencies between things like IT systems of the vehicle and energy aspects; the challenges are in control aspects, vehicle design and there is a need to integrate all the systems and find the right path to navigate these complex topics.

**DL: Can you give an indication of how much energy saving potential there is from this work that you are doing?**

**BB:** The point is that the energy aspect to driving is very dependent on your driving cycle. And that’s also determined by which vehicle you are using and for what type of usage. A small truck that carries goods with a pattern of multiple delivery drops on short journeys has a very different driving cycle to a taxi or a car travelling a long distance. And there are big differences in the powertrain solutions that work best for these different situations.

We have identified in advance a situation catalogue that we can break into what we call sailing phases, when the car is braking. When braking on a highway at high speed, braking converts your velocity into heat in your braking system and that can be converted into electrical current. The question is: how many of these situations do you



Red traffic lights could be a thing of the past in 20-30 years

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### Q&A WITH PROFESSOR BERNARD BÄKER



Asia's rapidly growing urban areas and traffic could be helped by the research

have during the drive? Driving around a town centre there may be many braking phases but speed is less. We estimate that 4% of the driving cycle is in these sailing phases and the question becomes one of how much energy we can save in that 4%. The amount may not seem very high, but it adds up over time and becomes significant. It is even more important for pure electric vehicles.

We are not saving a huge amount of energy with highly efficient diesel engines, but it's more a question of how we fulfil our mobility demands in the context of megatrends such as urbanisation. There are also changes to the global economy which prompt us to ask what sort of vehicle concepts can we afford in the context of changing demand? In Asia, for example, car demand is mainly of the

downtown type, with a lot of congestion and so on.

**DL: So you see your research as being particularly relevant to the evolution of transport solutions in the rapidly growing urban conurbations of Asia?**

**BB:** Yes, but it is relevant everywhere. The question is, what are the enablers and keys in the development of future vehicles and their usage to cope with the challenges ahead? Traffic control and transport infrastructure, smart control systems are important aspects. We can call this 'infrastructure' but the big problem is who is going to pay for it? These countries may be developing and so do not want to pay for such things. And another question is, what should be built into the vehicle, for example, the ability to communicate with smart traffic

lights? Again, no one will pay for this as it is not needed at the moment.

We want to bring these fields together. For example, we have a huge research project with vehicle makers and specialist system suppliers to develop smart traffic lights in and around the city of Dresden that can communicate with cars. Should smart traffic lights communicate directly with the car, or should it go through a central point? There is a lot to consider.

**DL: So the alternative approaches to such communications are still being researched and studied?**

**BB:** Yes and there is also the broader question of what kind of mobility need we will have in the future? This will be influenced by things like energy costs, lifestyle,

the way communities want to live.

I believe that communities are changing rapidly. We can see that with the development of social networks, smart phones and all the applications that people want on them and so on.

New mobility and vehicle concepts have to address the challenges ahead and be part of changing technologies and ways of living.

The human machine interface is key in all of this. We do not want to overload the driver with too much information. There is a big debate about the best way to approach information and helping the driver get what they need to know and/or want to know.

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**DL: And there are some big political issues that have to be resolved with things like electric cars...**

**BB:** Right. The politicians may want to see many more electric cars on the roads, but there is an issue of how much they are going to cost to consumers as well as the whole question of infrastructure and energy management at a macro level. There are still a large number of uncertainties.

And look at today's energy situation. You drive with your car to the gasoline station and you are using that gasoline infrastructure because it is there. And with electric vehicles, you just plug them in. But there has to be a big discussion about where that electric current has come from, of course. It is a complex area, but I think in the

future there will be a new way of thinking about energy.

**DL: But that's perhaps a difficult thing, politically, if it means changing lifestyles and isn't the internal combustion engine set to remain dominant?**

**BB:** I often use the IT sector as a parallel. There have been very rapid changes that have changed our lives over the last twenty years and it has accelerated with the introduction of cell phones.

The world of mobility, by contrast, looks very conservative in comparison. But I think we are at the beginning of a period of great change for mobility.

**DL: And business models will change?**

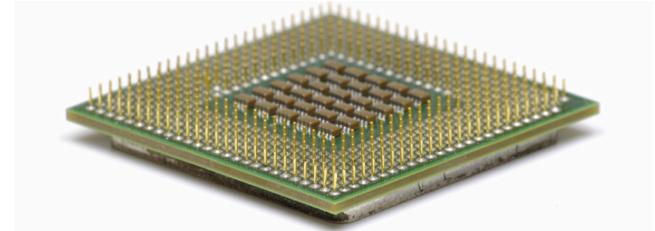
**BB:** Yes, I think they will as the social dimension becomes more important and we look to improve

energy efficiency and take into account all the energy that we are using in transportation.

Will we own cars the way we – mainly – do today? I think that is something that will change. It's a change of business models, of marketing concepts, of service concepts. You don't buy a cell phone, you rent a cell phone. Different behavioural models and strategies will come in with electric cars. It comes down to what we need, what we are prepared to pay for – what kind of mobility we can afford in the communities of the future.

**DL: Turning to automotive electronics in general, what do you see as the main developments currently?**

**BB:** I certainly feel that more computing power in the vehicle and what it enables is an important trend.



**Increased processing power brings both advantages and disadvantages**

Microprocessors with multi-cores brings advantages and disadvantages. From the point of view of calculations, it's an advantage. There is more data coming together and needing to be synchronised, to prepare the data for control strategies of the vehicle, for prediction for example.

Semi-conductors are being developed purely for automotive applications, which is a specialist area. There are innovations being developed by the car companies and major suppliers that are

becoming very important to the semi-conductor industry.

But increased electronics complexity can bring problems as well...

**DL: Like the kind of quality issues that affected Mercedes-Benz cars a few years ago?**

**BB:** Yes. Look at your laptop or PC. You are very tolerant when your operating system tells you there is a problem and it asks you to shut down and reboot. That's not how it can work with

## FEATURE

### Q&A WITH PROFESSOR BERNARD BÄKER

cars. The development work and process work is very tough to ensure that everything works and meets the required standards. It is essential if you want to be innovative. A number of Asian manufacturers have had a strategy to be followers rather than innovators. That is cheap, but the final product comes with less innovation. As they move to a strategy that comes with more innovation, then quality suffers because these companies are not so well versed on the development engineering side and the processes that comes with that. Daimler, for example, has learned a lot and has a large number of engineers dedicated to ensuring that the electronics is being developed in the right way.

Daimler and BMW have made a lot of progress in the last ten years in quality processes,

quality management and risk management in relation to proposed innovations and deciding whether or when to proceed with them. It takes a lot of money and a lot of time to get to the position that they are in.

**DL: And there are no short-cuts? This sort of knowledge can't be easily stolen or copied?**

**BB:** It is very easy to steal something, but can you use it? That is the more important question. And that comes down to the whole philosophy behind the engineering approach and your company's strategy, its investment in research and development over many years. And that's not something that can easily be replicated. There's an approach in Germany that is very thorough, very precise, everything very calculated. Data fits into an approach, long-term

company strategies and cultures and is not so easily transferable.

**DL: What's your feeling on wireless systems and likely future developments?**

**BB:** Today's wireless systems often run with tolerant zones. When you have bluetooth communications, for example, you want the voices systems in your vehicle to communicate with the dashboard – the distances involved are short, maybe up to 2 metres, sender to receiver. Things get more complicated with things like tyre pressure monitoring systems when you don't want to measure the tyre pressure of an adjacent car; now there are specific codes transmitted to prevent that.

But in my view, on-board wireless systems are quite restrictive and have limited

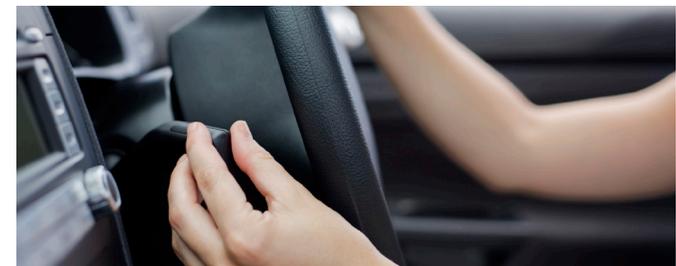
uses. Out of vehicle wireless communications – or 'off-board' – are more interesting and come with many smart communication possibilities, communications, safety, security, driver assistance.

For many on-board electronic applications, for basic drive functions, wireless is needlessly expensive and it is better to stick with cable.

**DL: Do you believe that the kind of research you are involved with – especially the mechatronics in areas like driver assistance - will help to**

**improve the driver experience? Some people believe that taking responsibility away from the driver through all the assistance becoming available is not such a good thing...**

**BB:** Compare your driving demand with a train. The question is where to draw the line between automatic drive and the reasons why that works and the person wanting control and wanting to drive themselves. And there is also the question of giving the driver the right assistance and information to enhance the whole experience.



Is taking driving responsibility away from the driver a good thing?

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### Q&A WITH PROFESSOR BERNARD BÄKER

With blind-spot detection, a text display to the driver doesn't work – an accident could occur while the display is telling you not to overtake. The manufacturers are working with colours and flashing lights but how many colours and flashing lights can the driver absorb as more driver assistance systems are added?

We are getting closer to full automatic drive, but that is extremely expensive and it perhaps makes sense to bear in mind that there are other modes of travel – trains and planes – that make more sense on long journeys. All of the different modes of travel need to be considered when looking at mobility and optimal solutions. There is a fundamental calculation that looks at how much energy is used to get how many people from A to B. And you have to decide also

how much it will cost to solve your mobility problem, from an individual point of view but also bearing in mind the mobility demands of the wider community and overall energy usage. But there is a balance to enhance mobility overall and, specifically, to make the driving experience better and fit within an overall strategy for transportation and energy.

**DL: There are some big questions still to be answered when looking at electro-mobility and how it will come about, how extensive it will be and so on. Some governments are making bold statements of intent, but how do you see it developing?**

**BB:** I think it will be a gradual process, with many innovations and small steps – evolution not revolution. The price of energy

could be an important factor in promoting new thinking. Cars will get smarter with control strategies and traffic strategies becoming more a part of the car or the car's usage – they will grow together, as we are seeing in other industries like IT.

We need more good engineers to meet future needs and we need to think more carefully about real mobility demand. I think that energy awareness will increase, too, with sustainable energy systems becoming very much more important.

But there is a long way to go with electro-mobility. It will be small steps. New advanced vehicle concepts for the future, including electric drive, combined with this focus on energy usage and utilising the connected car for more efficient traffic flows and vehicle drive are an important



**Professor Bernard Bäker**

Studied electrical engineering at the Technical University of Braunschweig with a doctorate on the topic "Energy and Information Management". Also conducted research at the University of Braunschweig in cooperation with Volkswagen AG. Worked for several years

with Daimler AG in Stuttgart developing novel diagnostic systems for motor vehicles.

Currently head of the Department of Vehicle Mechatronics at the Institute of Automotive Technologies Dresden – IAD at the Technical University of Dresden.

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### Q&A WITH PROFESSOR BERNARD BÄKER

part of the future mobility picture.

**DL: What do you like about your role? What drives and motivates you?**

**BB:** My main motivation is to help the young students here and help to make the world a little bit better. When you have been in the car industry for over twenty years, I think you know all of the problems and main challenges, but the fascinating thing is to look to the future and how quickly technologies are changing in areas like communications and connectivity.

Seeing the progress of the students, seeing them go on to good jobs, that is very pleasing and gives me a big sense of worthwhile achievement.

**DL: And you are optimistic about the future based on your contact with the next generations of engineers and scientists?**

**BB:** Yes and I think I have seen a shift in the last few years with the students becoming more technically minded, they are also very innovative and making use of greater social dimensions and possibilities that new technologies are making possible. They are good at combining the technical aspects with the social aspect and they look at the world in a particular way. Maybe they can produce new solutions for a better world in the future. Sometimes these innovations are only blocked by regulations and conventions, but I believe they can be solved by young minds with new ideas. We just need to give them the freedom to do it. >

#### **BMW's 'Vision ConnectedDrive'**

In the BMW Vision ConnectedDrive scenario, you are alone in the automobile. After you get in, your smartphone automatically connects to the vehicle, the vehicle-specific apps are activated and can be accessed from the main vehicle menu on the freely programmable instrument cluster. The vehicle then immediately synchronises with your calendar and learns that you have a lunch appointment with a colleague in town very shortly. It passes the address of the restaurant to the navigation system and searches for a suitable route in order to arrive at the appointment on time. Up-to-the-minute traffic information is a component of the route calculation, as well as preset preferences, which for instance might get you there particularly quickly or particularly efficiently.



In addition, parking options are considered as well as alternative methods of getting there by public transport.

When you arrive, the vehicle indicates the nearest free parking spot and directs you to it using augmented reality on the Head-Up Display. Before you leave the car and your smart

phone disconnects, the vehicle transmits a MicroMap to your mobile, detailing the last few metres through the building to the restaurant. Your mobile then takes over the guidance function. After you have got out of the car, the automobile drives itself automatically into the parking spot.



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