



proActive

ISSUE 45 - SUMMER 2012

EVORA 414E HYBRID

LOTUS FEATURED MARQUE AT GOODWOOD

NEW 2012 LOTUS EXIGE S

CORPORATE PROFILE OF TATA MOTORS

DAIMLER CEO DIETER ZETSCHKE INTERVIEWED





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Official fuel consumption in mpg (l/100km), Lotus Exige S: Urban 19.5 (14.5), Extra Urban 37.2 (7.6), Combined 28.0 (10.1). CO₂ emissions: 236 g/km. Lotus Elise S: Urban 27.3 (10.3), Extra Urban 47.6 (5.9), Combined 37.5 (7.5). CO₂ emissions: 175 g/km.



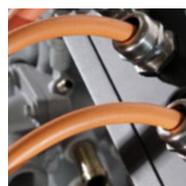
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FESTIVAL OF SPEED

Lotus featured marque at Goodwood 2012



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DR. DIETER ZETSCHÉ

just-auto editor Dave Leggett interviews CEO and Chairman of Daimler



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DAVID HEWITT

just-auto editor Dave Leggett interviews Group Lotus' Director of Operations

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Lotus News

Lotus Evora 414E Hybrid - it's now a runner

Brimming with innovation, technology, performance and power, the Lotus Evora 414E is a series hybrid technology demonstrator which shows some of the headline technologies that Lotus Engineering, one of the world's leading automotive engineering consultancies, has within its portfolio.

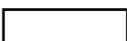
The Evora 414E is powered by two electric motor packs driving the rear wheels through its Xtrac transmission with a battery pack that can be charged by the Lotus range extender engine or directly from mains electricity.

The Lotus 3 cylinder range extender engine has been design protected to run on either gasoline or renewable bio alcohol fuels (methanol and ethanol). It drives an EVO electric generator which produces electrical energy to either charge the battery pack or power the EVO traction motors directly. In normal driving, the Evora 414E will run purely on electricity stored in the battery pack for up to 30 miles (48 km). With the Lotus range extender and the electric traction motors powering the vehicle through an Xtrac 1092 transmission, the Evora 414E is targeted to produce just 55 g of CO₂ / km emissions on the New European Driving Cycle (NEDC).

Should the driver require more performance, under hard acceleration, for example, the electricity will come from both the battery storage and the small range extender engine.

Evora 414E Hybrid

- 1,000 Nm (738 lbft) of Torque
- 414 PS (408 hp)
- 0-60 mph (97 km) in around 4 seconds
- Top speed 130 mph (209 km/h)
- Target emissions of just 55 g CO₂ / km (NEDC)





Hot off the back of unleashing its Evora GTC racer, Lotus Racing engineers have been honing the Evora to meet the requirements of North America's legendary sports car series, the GRAND-AM Rolex Sports Car Series

Lotus Evora GX fires up for Grand-AM road racing Rolex series debut

Later in the 2012 season the Evora will race under the Rolex Series' GT rules as GX rules begin in 2013. With the Evora GX, the driving experience is even more pure, and the beefy body kit is even more aggressive.

McMahon Raceworks with Condor Motorsport have placed an order for their Evora GX, and the team led by David McMahon with Armando Trentini as lead driver and consultant, will enter the GRAND-AM Rolex Sports Car Series.

Like the GTC, carbon-fibre doors, roof and engine cover have replaced the SMC and RTM composite panels of the previous evolution GT4 Enduro, and Plexiglass replaces the polycarbonate windows in order to trim yet more weight off what is already a very light car. At 1,150 kg, it tips the scales at just 10 kg over the weight of the

GTC model, despite being fitted with the much thicker US-spec roll cage

There are aerodynamic changes too, with a new front splitter and front bumper, and the standard Rolex Series rear wing which, along with the car's wide wheels and flared arches, give it very mean stance. To meet other series requirements, ABS and traction control have been removed, putting more emphasis on driver skill.

There's also a new fuel filler system, Continental tyres, and yellow headlamps in order to tick all the race series specific boxes. The 4-litre V6 continues to pump out 440 bhp and 440 Nm of torque, linked to an XTRAC six-speed sequential paddle-shift. The GX is priced at \$335,000.00 and will be built to order.





ICON Aircraft is collaborating closely with Lotus Engineering USA on key areas of the production design of the ICON A5 amphibious Light Sport Aircraft

ICON began working with Lotus Engineering in January to leverage their expertise in designing and mass-producing lightweight vehicle architectures. The work focuses on the A5's cockpit, where Lotus' experience in lightweight premium automotive-quality components is especially relevant.

"The collaboration with Lotus is perfect for ICON because it provides us with world-class expertise during this intense period of production development," said ICON VP of Design Klaus Tritschler. "Lotus has proven invaluable because of their experience designing and manufacturing high quality yet lightweight interiors in the same volumes at which we'll be producing the A5. Additionally, they provide key production knowledge and insights from the automotive industry, which we consider the benchmark in terms of quality and design."

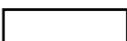
Lotus engineers are working alongside ICON's designers at ICON's facilities in California to supplement the ICON team.

A key objective of the collaboration is to minimise weight. This is being accomplished by engineering the

carbon fibre interior assemblies to act as both cosmetic and structural components so that no additional support structure is required. The cockpit also uses a high level of component integration to reduce weight. For example, structural air ducts bonded in side-panels that utilise the existing fuselage as structural element, contributes to reducing weight. Additionally the interior is being engineered to provide easy access to instruments and functional hardware using proven aerospace and automotive attachment systems.

"We're thrilled to be working with ICON on this project," said Lotus Engineering USA CEO Darren Somerset. "This collaboration capitalises on the extraordinary match between Lotus and ICON in terms of objectives, cultures, and philosophies. At our cores, we are both motivated by making products that bring excitement and passion to our users and fans, and we firmly believe in the power of combining world-class engineering and design to get there."

The joint team is finalising the design-for-manufacturing process and will soon receive the first rapid prototype parts.





Lotus Originals raises the style stakes in Monaco and London

Lotus Originals is the fashion arm of the legendary sports car and racing marque, and the collection is inspired by the British sense of style, heritage, innovation and rebellious spirit that goes into every on-road Lotus design. Lotus is hailed for its engineering and thirst for competition. It is also known for style. Heroes of reality and fiction, from Jim Clark to James Bond, have outgunned their rivals from behind the wheel of a Lotus, and they looked good doing it.

The boards that have recently been covering number 52 Regent Street in the heart of London's Piccadilly have been removed to unveil a new flagship store and Lotus takes pride of place to showcase its iconic brand in a new and accessible way. Lotus Originals arrives in the capital at a massively exciting time for the UK and everything British. As the nation is in full patriotic swing during the year of both the Olympics and the Queen's Diamond Jubilee, it is the perfect time for Lotus to demonstrate how its legendary British brand, one steeped in heritage and international reverence, deserves its place in the buzzing 2012 summer calendar.

Situated in London's Piccadilly, the Grade II listed 4,800 sq ft space, which was previously the 'Café Royal', will be host to a diverse collection of luxury apparel, luggage, gifts, toys, and limited edition collectables - this is a store for the fashion conscious and style orientated,

not purely a shrine for Lotus fans.

Partner Forza Rossa Holding, official Lotus cars dealer since 2011, joins the Lotus family with the opening of the Monte Carlo store.

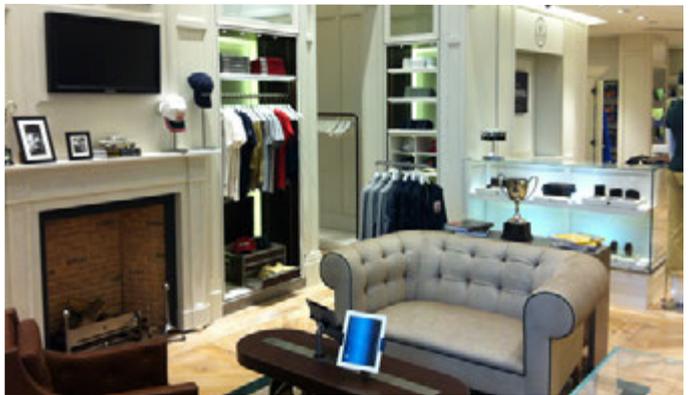
It's fitting that this first franchise store be in Monaco, the scene of the first grand prix victory for a Lotus, in 1960 at the hands of Stirling Moss. His Serene Highness Prince Albert II, Monaco's Mayor Georges Marsan and State Minister Michel Roger were joined by Lotus F1 Team's Gerard Lopez, Eric Boullier and Romain Grosjean, Lotus Sales and Marketing Director Maurizio Parlato and Forza Rossa Holding's President Ion Bazac at the opening of the store.

Speaking of which, we took the opportunity in Monaco to launch a special car designed for the next generation of Lotus drivers: a slightly smaller-than-usual Lotus Elan, one of Lotus' most-beloved classics which this year celebrates its 50th anniversary. What's more, the car is eligible for racing. The Little Big Le Mans, which forms part of the Le Mans Classic race weekend, is designed for lucky young drivers aged 6-14, and this Elan is eligible for this event.

Also, 20 years after we helped win gold in Barcelona in 1992 with the revolutionary Lotus Type 108 Superbike, we are showing for the first time, a stunning hand made carbon fibre black and gold bespoke bicycle from our new collaboration with Condor Cycles Ltd.

The development of the Lotus Originals retail concept has been rapid. Since its launch in September 2010 the offering has gone from online sales only via www.lotusoriginals.com to shops in London, Monaco, China and Norwich.







Technical specification: Type 1 LC Racing*

Frame: Condor Performance MMC carbon fibre with 3K weave, hand cut and wrap building process, internal cable routing, carbon fibre dropouts and forged aluminum replaceable rear derailleur hanger, 1112g

Fork: Condor 100% carbon fibre fork 1.125" to 1.5" steerer tube, integrated headset crown race, blades, and dropouts, 328g

Drivetrain: Campagnolo Centaur carbon shifters and derailleurs, Campagnolo Centaur 52/36T crankset, Campagnolo chain and 11-26T cassette.

Components: Campagnolo Centaur dual pivot brakes, Deda Zero 100 handlebar – shallow race drop, Deda Zero 100 aluminum 3D forged stem, Condor Supremacy UHC Performance carbon fibre seatpost, Fizik Arione with hollow Cr-Mo rails

Wheelset:

Mavic Cosmic Carbon SLR, 1,595g

Finish: Gloss carbon with gold and raw carbon

Sizes: 52cm, 55cm, 58cm, 61cm

Weight: 16.00lbs | 7.25kg

*based on 56cm frame size

Limited Edition Type 1 LC Racing Condor Lotus bicycle

Lotus and Condor were both born in 1948 Britain. Both brands are steeped in heritage and racing history, shaped by many championship titles and joined by the ethos to create lighter better products to enhance performance.

Condor's successes throughout the sixties helped many riders win international championship titles. Lotus is no stranger to cycling, flexing technological prowess when its engineers turned their attentions to redefining the bicycle and winning gold in 1992 at Barcelona.

Twenty years after gold medal success in Barcelona and on the eve of both companies 65th year, Lotus and Condor have partnered to celebrate their rich histories and work together to create speed through lightness and push the future of performance further. Two bicycles have been created in collaboration to mark the start of an on-going project that uses the knowledge of both companies in their fields to redefine what is known about speed on two wheels.

Condor selected one of its race proven carbon frames for the project, and fitted it with the lightest components in accordance with the Lotus ethos.

Design teams at Lotus and Condor developed the limited edition livery taking cues from Lotus F1 team and its return to the height of performance racing.

The Type 1 LC Racing combines comfort with function, blending sophisticated, high quality materials with precise attention to details and superb craftsmanship.

Price: RRP £5,150 including VAT. info@condorcycles.com, +44 (0)20 7269 6820 Limited edition of 64 bikes.



Lotus Elan celebrates 50th birthday!

The Elan was launched in October 1962 at the British Motorshow, just as the Sixties started swinging. Jaguar had launched the E-Type, AC had the Cobra and Ferrari the GTO. Big, expensive, powerful muscles cars. The Elan was very different, and typically Lotus - ultra modern, lightweight, rapid and huge fun. It summed up the Sixties: a playful topless two-seat ticket to freedom, it was technically innovative with the first backbone tube chassis of any road car; a fibreglass body, four-wheel independent suspension and weighing just 670 kg.

It came with luxuries that were a rarity at the time, like electric windows, carpets, a heater, and in vogue wooden fascia, but it was still light enough on the scales to outrun other automotive competition. The Elan Sprint, a more powerful 1973 alternative, could hit 60 mph in 6.6 seconds, which even now would be considered respectably fast, whilst its pop-up headlights could wink at admirers. The Elan found its way onto a magazine cover with Jimi Hendrix posing on the bonnet, and even inspired the lyrics to The Beatles' A Day In The Life. The Elan was Lotus' biggest commercial success to that point, reviving a company stretched thin by the more exotic, but in turn more costly to produce Elite.

Four different series were produced up until 1973, including a coupe version. Seventeen thousand original examples, including the Elan +2, were produced. The car was designed by Ron Hickman, who went on to make millions when he patented the Black & Decker WorkMate. He died last year, having earned an OBE for services to industrial innovation. The Elan was the design inspiration for the Mazda MX-5, which was one of the biggest selling sports cars of the 1990s, and the Elan is clearly the mother of the Lotus Elise, which has been a staple of the Lotus line-up since 1996 and is on its third evolution.

Fifty years on, the Elan has never gone out of style.





Lotus-Rebellion LMP1 team break Audi's domination at Le Mans 24 hours

Lotus-Rebellion finished fourth overall at Le Mans and were the only team to break Audi's domination. The #12 car was also the first placed petrol-engined machine. Both cars entered reached the finish line, and took first and third place in the LMP1 Privateer FIA WEC category. The team has extended its lead in the LMP1 Privateer championship.

The #12 Toyota-powered Lotus-Rebellion driven by Nick Heidfeld, Neel Jani and Nicolas Prost and #13 sister car driven by Andrea Belicchi, Harold Primat and Jeroen Bleekemolen were never out the top 8 (including the six Audi and Toyota factory cars) during the first four hours of the race. With mechanical and traffic issues for the factory cars, the two black and gold livered prototypes were strongly positioned in the top six from the sixth hour.

After the early retirement of both factory Toyota Hybrids, Lotus-Rebellion was the only team to break the Audi stranglehold with car #12 running fourth from the seventh hour. The night proved trouble-free, and #12 broke through the dawn still in fourth and resisting pressure from the #3 Audi R18 Ultra. The sister Rebellion was starting to have clutch issues and,

with just five hours to go, was pushed into the pits for 37 minutes while the crew took apart the rear of the car and gearbox to replace the clutch. The car emerged P11 overall. The final two hours were intense for the Swiss team. The #13 car pushed its way up to the Privateer Trophy podium. Meanwhile, Audi were hunting down a perfect top four lock-out at the front, and the Lotus-Rebellion was in the way. Neel Jani responded by setting lap times even quicker than qualifying, and then handed over to local favourite Nicolas Prost who took the chequered flag, maintaining the team's hard-fought fourth-place.

Bart Hayden, team manager: *"To secure fourth place overall at the Le Mans 24 Hours among Audi factory cars is just reward for the immense effort, contribution, dedication and determination of each and every member of our team. I am deeply proud of what we have achieved as a team. As announced before the season our aim was to repeat our 2011 result at Le Mans and win the FIA WEC Trophy for best Privateer. We are now in a good position to secure both of them after this Le Mans result."*

Industry News

UK: More boosted, downsized petrol engines coming

Engine downsizing, a major trend in European diesel engines over the past decade, will now occur with petrol engines which will increasingly become smaller and turbocharged, according to a new report.

"This trend will also have a positive impact on the demand for technologies supporting downsizing such as turbochargers and variable valvetrain," report author Frost & Sullivan said.

It found that suppliers with complete powertrain development and benchmarking capabilities would gain significance. *"Due to comparatively lower CO₂ emissions, diesel engines will not face a challenge in complying with CO₂ limits; hence, the limitations in downsizing diesel engines will not be an issue,"* said senior research analyst Bharath Kumar Srinivasan. *"Reducing the level of downsizing will also help control NOx emissions from these engines, which are being tightened for Euro 6 [emission laws to be enforced in 2014]."*

F&S reckons the number of cylinders in petrol engines is likely to decrease only for engines below 1.2 litres. About 35-38% of petrol engines are likely to be turbocharged by 2018. This high level of turbocharging by European automakers is likely to help in the market growth of boosting technologies.

Legal regulations and end-consumer environmental awareness will motivate the sales of vehicles with small engines. For example, the car scrappage schemes in 2009 reduced the average displacement of engines in western Europe. Such initiatives will help boost engine downsizing.

The addition of supporting technologies such as turbochargers and variable valvetrain technologies are expected to drive costs and this is likely to impact take-up rates in cost-sensitive segments.

Downsizing engines results in lower torque output from the engine and, hence, lower transient response. Variable geometry turbocharging (VGT) is a good solution for better torque output, however, introducing VGT at a low cost for petrol engines will be a challenge.

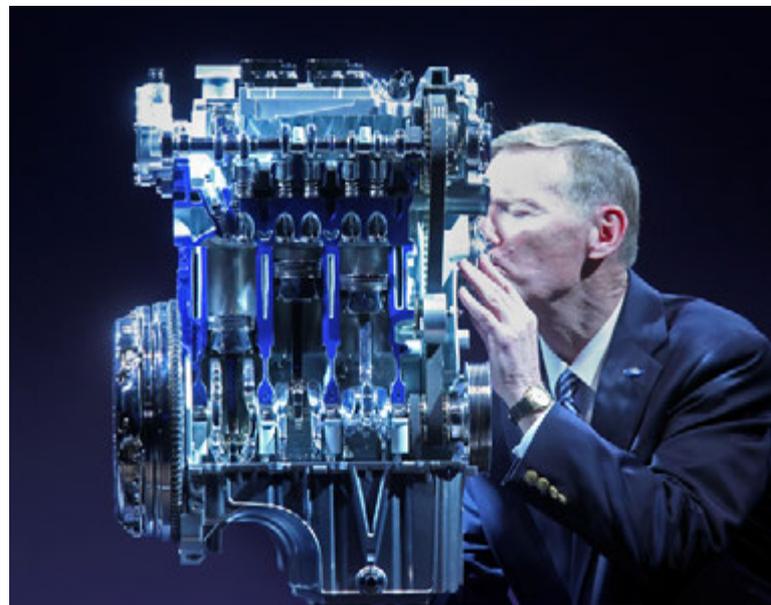
"In diesel engines, aggressive downsizing results in higher specific load and, therefore, increased NOx emissions," said

Srinivasan. *"This, in turn, will have an effect cost as NOx after-treatment technologies such as SCR are expensive."*

Automakers are likely to experience higher sales of low CO₂ emitting vehicles and thus pass on the tax benefits to the buyer. This offers excellent scope for selling low emission models such as Ford Focus, Volkswagen Polo, Volkswagen Golf and Opel/Vauxhall Corsa.

"With improved emissions and performance, without a drop in fuel economy, being the key drivers, engine downsizing is all set to have a major impact towards achieving CO₂ emissions of less than 120g/km in two-thirds of new car sales by 2016," Srinivasan said.

Author: Graeme Roberts



Ford CEO Alan Mulally shows his appreciation of Ford's 1 litre EcoBoost engine



UK: Ford to triple EcoBoost engines in Europe

Ford says it is planning to more than triple the production of its vehicles equipped with fuel-efficient EcoBoost petrol engines to approximately 480,000 a year by 2015, from 141,000 in 2011.

It says that more than 135,000 of those will be vehicles equipped with the 1.6-litre EcoBoost engine manufactured in Bridgend, Wales.

Ford says it will produce more than 1.3m low CO₂ EcoBoost engines to go into European vehicles over the period 2012-2015, more than 800,000 of which are expected to be the new 1.0-litre EcoBoost engine, produced at Ford's new plant in Craiova, Romania and in Cologne, Germany.

During this same period around 400,000 1.6-litre EcoBoost engines will be produced at Bridgend for European vehicles and production will total over 1 million engines for all export markets, including Europe.

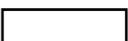
The production expansion coincides with an increase in the availability of EcoBoost engines across the model line-up in the European Ford range. The number of Ford models available with EcoBoost engines will double from five to ten by 2015 when EcoBoost engines will power more than half of all Ford of Europe petrol-engined cars.

"Our plans to expand EcoBoost availability are aggressive, but we believe as customers experience this engine family, they'll understand why," said Sherif Marakby, powertrain director, Ford of Europe. *"We're at the cutting edge of innovation and the 1.0-litre engine, for example, cannot be matched for its balance of efficiency, power and refinement."*

Ford's high-tech engine plant in Bridgend has

produced over 120,000 1.6-litre EcoBoost engines since 2010 and is set to produce over 230,000 in 2012, which is over 30% of the plant's annual total production forecast of 780,000. The export of this UK-built powertrain to the US and Mexico began this year. It powers Ford Focus, C-MAX and Grand C-MAX, Mondeo and S-MAX and Galaxy models sold in the UK and Europe.

Author: Dave Leggett





SARTRE road train debuts on public road in Spain.

SPAIN: SARTRE road train debuts on public road

Volvo has announced that a road train comprising a Volvo XC60, a Volvo V60 and a Volvo S60 plus one truck automatically driving in convoy behind a lead vehicle has operated on a public motorway among other road users – a first for the technology.

The historic test in Spain was highly successful, Volvo said.

Vehicle platoon tests in the SARTRE (Safe Road Trains for the Environment) project - a joint venture between Ricardo UK Ltd, Applus+ Idiada, Tecnalia Research & Innovation, Institut für Kraftfahrzeuge Aachen (IKA), SP Technical Research Institute, Volvo Technology and Volvo Car Corporation - are making progress.

One major step forward was taken last week on a motorway outside Barcelona - the first-ever test drive of a road train among other road users.

"We covered 200 kilometres in one day and the test turned out well. We're really delighted," says Linda Wahlström, project manager for the SARTRE project at Volvo Car Corporation.

A road train consists of a lead vehicle driven by a professional driver followed by a number of vehicles. The vehicles monitor the lead vehicle and also other vehicles in their immediate vicinity. By adding in wireless communication, the vehicles in the platoon "mimic" the lead vehicle using Ricardo autonomous control - accelerating, braking and turning in exactly the same way as the leader.

The project aims to deliver improved comfort for drivers, who can now spend their time doing other things while driving, Volvo maintains. They can work on

their laptops, read a book or sit back and enjoy a relaxed lunch.

Naturally the project also aims to improve traffic safety, reduce environmental impact and - thanks to smooth speed control - cut the risk of traffic tailbacks.

"Driving among other road-users is a great milestone in our project. It was truly thrilling," says Linda Wahlström. The vehicles drove at 85 kilometres an hour. The gap between each vehicle was just six metres.

"During our trials on the test circuit we tried out gaps from five to fifteen metres," Wahlström added.

The three-year SARTRE project has been under way since 2009. All told, the vehicles in the project have covered about 10,000 kilometres. After the test on the public roads in Spain, the project is now entering a new phase with the focus on analysis of fuel consumption.

"We've learnt a whole lot during this period. People think that autonomous driving is science fiction, but the fact is that the technology is already here. From the purely conceptual viewpoint, it works fine and road train will be around in one form or another in the future," Wahlström says.

"We've focused really hard on changing as little as possible in existing systems. Everything should function without any infrastructure changes to the roads or expensive additional components in the cars. Apart from the software developed as part of the project, it is really only the wireless network installed between the cars that set them apart from other cars available in showrooms today."

Author: Dave Leggett

BELGIUM: Euro-NCAP to drive adoption of autonomous emergency braking

From 2014, it will be 'practically impossible' for new vehicles to receive a five star EuroNCAP rating if they are not fitted with an Autonomous Emergency Braking (AEB) system. The independent consumer organisation says that universal fitment could reduce the number of road accidents in Europe by 27%, saving around 8,000 lives a year and reducing the number of people seriously injured by around 4,000.

At a recent event in Brussels, EuroNCAP secretary general Michiel van Ratingen revealed that his organisation's research has shown that 79% of European passenger cars are not currently available with any type of AEB. "We are beginning a journey that we hope will lead to 100% fitment," he told just-*auto*. "We are giving vehicle manufacturers two to three years to put the technology on their cars if they want to continue winning five star ratings."

Autonomous Emergency Braking Systems help to avoid crashes or reduce their severity by warning the driver of an impending impact and supporting his braking response. The technology generally uses radar for long-range sensing and either vision sensors or lasers for short range sensing. Several vehicle manufacturers now have (or will shortly have) systems on the market but they don't all work across the full speed range. Lower-cost vehicles typically avoid the expensive radar systems by offering only operation at city speeds, which represent a high proportion of relevant impacts.

EuroNCAP's campaign will help consumers understand the differences between systems and recognise their benefits. "We would like all new cars to have systems that operate across the full speed range, but recognise that this will only be achieved when fitment rates are high to bring costs down," commented Ratingen. "Today, we are delighted that that we are starting to see systems that are priced appropriately for their target markets with city systems available even on a few entry-level vehicles."

Speaking at the event, the European Commission's Head

of Unit, Automotive Industry, Philippe Jean, said that autonomous braking systems have been identified as the single tool with the greatest potential to reduce injuries and deaths. "The predicted reduction in death and injuries compares favourably with electronic stability control, which prevents a similar number of serious injuries each year but prevents around 2,000 deaths, compared with 4,000 for AEB," said Jean.

Jean also presented figures for the economic benefits of AEB. "It is not possible to produce a precise figure for the cost of all Europe's road accidents, but we estimate that the cost of avoidable accidents that AEB will address is between EUR5bn and EUR8bn a year. The impact assessment studies we have carried out indicate that the resulting reduction in congestion due to accidents would represent an economic value of around EUR100m in Germany alone."

From November 2013, the European Type Approval of new commercial vehicles will require AEB to be fitted. From November 2015, every new commercial vehicle sold must have the technology fitted. "We are considering extending these regulations to passenger cars," Jean concluded.

The Brussels event last month was timed to celebrate EuroNCAP's 15th year. The organisation's evaluation programme and the information available to consumers on its website are widely credited with considerably accelerating the development of safer cars.

Author: Dave Leggett





GERMANY: BMW and Toyota formally deepen common goals with MoU inking

BMW and Toyota have formally inked a memorandum of understanding aimed at collaborating on a wide range of shared fields, including fuel cell development.

Signing the deal in BMW's home city of Munich, Toyota president Akio Toyoda and BMW chairman, Norbert Reithofer, outlined four areas of common goals namely: joint development of a fuel cell system; joint development of architecture and components for a future sports vehicle; collaboration on powertrain electrification and joint research and development on lightweight technologies.

"We aim to further strengthen our competitive position in sustainable future technologies," said Reithofer. "We signed an MoU to this effect today. Toyota and the BMW Group share the same strategic vision of sustainable individual

future mobility. Together we have a great opportunity to continue leading our industry through this transformation."

For his part, Toyoda added: "BMW and Toyota both want to make ever-better cars. We respect each other - that is why we already can take the next step together. Toyota is strong in environment-friendly hybrids and fuel cells ... I believe BMW's strength is developing sports cars. I get so excited thinking about the cars that will result from this relationship."

In March 2012, the BMW Group and TMC signed a binding agreement on collaborative research in the field of next-generation lithium-ion battery cells.

In addition, BMW and Toyota entered into a contract in December last year, under which the BMW Group will supply 1.6 litre and 2.0 litre diesel engines to Toyota starting in 2014.

The MoU formalises the companies' agreement in December last year to identify and discuss other possible collaborative projects.

Author: Simon Warburton





DAIMLER

Konzernzentrale

Dr. Dieter Zetsche

Dave Leggett hears from Daimler's CEO and Chairman

Mercedes-Benz is on a roll this year and on track for record car sales. From January to June, a total of 652,924 Mercedes cars were sold, almost 7% up on last year. Chairman and CEO Dieter Zetsche is highly satisfied with the performance given the travails of the global economy and Europe's particular problems.

He highlights the importance of emerging markets for a premium car brand like Mercedes, but without losing sight of traditional markets and strengths.

"We look for maintaining and increasing our strength in developed markets, but at the same time we want to add strong leverage of the growth potential in emerging markets such as China" he says.

The first half sales totals illustrate the importance these days, in particular, of the Asia-Pacific region. It accounted for 166,740 units, 8.6% ahead of a year earlier. There's a bounce-back in Japan this year, but China is now by far the biggest market in Asia for Mercedes-Benz:

first half sales were 99,391 units, 7.8% up on last year. But the traditional developed markets still make up the bulk of sales: Western Europe and NAFTA sales accounted for two-thirds of Mercedes' first half car sales. The biggest national markets for Mercedes are the US and Germany (US H1 sales up almost 16% to 128,595 units; Germany up 4.5% to 128,529).

And Zetsche sticks to that combination of 'traditional' and 'non-traditional' theme when viewing the product evolution.

"We want to make our internal combustion engines more efficient, but at the same time adding alternative drivelines, which we are showing for example with the all-electric smart which is launching this year.

And with the product portfolio, we want to stay on top with large cars. The CLS shooting brake is a good example of our strength and depth in this area. But we also want to add more strength in compact car segments."

If Mercedes is going to hit its long-term targets for volume growth, China is going to play a vital part. Is he worried about the risks - economic or political - associated with China? He draws on the past to play them down.

"China has been, for that last fifteen years, the least volatile market of any in the world. It came through the Asian [economic] crisis, the financial crisis, with very solid growth continuing. It doesn't mean that it will continue that way, but among all the question marks for the future development of the world, I would say that the Chinese one is a smaller one."

Zetsche mentions the need for economic management in China to provide sufficient employment, but not to overshoot. He sees continued economic growth and growth of car sales through this decade in China as the most likely scenario.

In the short-term, Europe is a much more pressing concern. Zetsche highlights the mixed picture across the continent but sees some underlying robustness for the premium segment.

"We had hoped for better market conditions in Europe, but within those conditions, we are doing relatively well and our sales are up this year. We are also more competitive and that is being helped by a stronger competitive position in compact cars, which are especially important in Europe."

'Compact premium' a strategic focus

The B-Class has been a strong seller this year and Mercedes will get a boost from the new A-Class over the next few months. Compact models are going to be a strategic focus for the brand in the medium- and long-term.

"The range of Mercedes products in the premium compact segment will increase from the previous two to five models. These five newcomers will be a major driving force in our Mercedes-Benz 2020 growth strategy."

"The new generation will make a major contribution to our objective of making Mercedes-Benz the number one in the worldwide premium segment by the end of the decade at the latest. This attack is being launched at the right time because there is increasing demand in the premium compact segment. Over the next 10 years, the market for these will increase from the current 6.57m to around 10.6m units globally."

The focus on compact cars also helps with lowering average CO₂ for the brand

and Zetsche sees an industry convergence around broadly similar efforts to lower CO₂ and improve fleet efficiency. It's about lowering air drag coefficients, downsizing engines with turbochargers and light weighting wherever possible.

"Nobody has an exclusive technology which others can't use" he says. "It is ultimately leading to similar results but with a lot of cost involved."

Zetsche is confident that his company has a strong R&D capability able to meet the challenges ahead.

"As a group we are somewhere between EUR100bn and EUR110bn revenues and we are running R&D budgets at 5+%, so that's EUR5bn-EUR6bn a year. It doesn't matter if you sell three times as many small cars, it matters what kind of revenues you are generating. We are second to none as far as our technological resources and capabilities are concerned."

There's a potential difficulty though. If there's a cost squeeze going on, won't the change to model-mix to include more small (and lower margin) cars adversely impact future profit?

"We have to make sure that these smaller cars are more profitable than they used to be. Our new compact car family will have significantly higher volumes, with a lower labour cost average. We believe we will be very competitive, which allows us some price premium. We think we will have top profitability in that segment."

It seems likely that Mercedes will be looking to add around 100,000 units of annual production capacity for the new small cars and to shift the geographic production balance so that more of these future small cars are made in low-cost parts of the world.

"We are investigating production in China and looking at ways to expand capacity in Russia and we are very optimistic about the volume prospects and opportunities for us ahead in compact cars."

Partnership with Nissan

Another route to reducing cost is to collaborate with others. Nissan is a partner. Daimler and the Renault-Nissan Alliance announced a 'strategic collaboration' in April 2010 and are extending their reach into the US as part of both companies' growth strategy. They are working on vehicle platform sharing between Infiniti and Mercedes and developing 'zero-emission' [electric] vehicles. Jointly producing

engines in the US is the largest joint venture outside Europe.

In May Nissan's US unit broke ground for an engine plant that will produce I4 petrol engines for Infiniti and Mercedes-Benz C-class cars assembled at Daimler's plant at Tuscaloosa, Alabama.

"Through the strategic extension of our cooperation with Renault-Nissan we can realise near-market engine production in the NAFTA region on attractive economic terms and make optimum use of synergies arising from the cooperation. This helps us to reduce our foreign exchange exposure and with logistics also in terms of supplying our assembly plant at Tuscaloosa. It's a huge investment for an engine plant and you need certain volumes to make it feasible. By joining forces with Nissan we can add volume for the engine plant and keep the cost down."

Zetsche speaks very positively about the developing relationship with Nissan and how such opportunities have become clearer since they agreed their strategic partnership. He sees it as the reverse of the DaimlerChrysler experience.

"The cooperation we have with Renault-Nissan is a very rational one. With DaimlerChrysler we joined forces and then looked at where we could cooperate. This time, we looked at our two companies and strategic areas where we could leverage a partnership to meet future targets. One, for example, was our next generation smart cars; one was small four-cylinder engines; a third was small vans. We could do these things on our own but it is better to leverage the incremental volume that comes with working with a partner. And the 3% cross-shareholdings were a symbol of the partnership."

Zetsche describes a disciplined management approach to the cooperation between the two companies.

"There are monthly management meetings between the three brands; Carlos and I see the papers and results and participate in the meetings every third time – which is four times a year."

The meetings discuss potential new projects, but focus is highlighted. *"The first priority is to do what we are already doing right"* Zetsche emphasises.

He's also pretty relaxed about supplying engines to power Nissan's Infiniti brand, not seeing it as a major head-to-head competitor

in the premium brands area. The small number of Nissan customers considering a Japanese or a German premium brand are mainly considering Infiniti or BMW, Zetsche maintains. And the Mercedes brand comes more into the Japanese/German premium cross-consideration competitive mix with Lexus.

Besides the direct cooperation on engines and platforms, there are also insights to be gained from working with a partner with a different culture and approach.

"They [Infiniti] have been able to get results with relatively low investment," Zetsche acknowledges. Speccing cars is one area where Infiniti's approach has been very different to Mercedes. *"We are potentially speccing some things that are not adding value. These are very interesting learning experiences we are having."*

Technologies for the future

What does Zetsche see as the key technological direction for Mercedes for the future?

"We are following the vision of emission free driving on the one hand, and accident free driving on the other."

Zetsche qualifies that by outlining three main strategic thrusts for the Daimler Group:

- Emerging markets
- Being 'green'
- Being 'digitalised'

Being 'digitalised', Zetsche explains, has many aspects and levels. *"It is about the workplace, about the customer relationship, mobility concepts [connectivity, car and customer]."*

To pick up on mobility, does he see the autonomous car around the corner?

"Technologically, it is not a big deal. There are, however, two major constraints. One is legal and the question of liability [with accidents that may occur when the driver is not in control]. And secondly, we want to keep the driver in control. We want to build a safety net around the driver."

Zetsche describes the possibility of hackers causing problems for autonomous systems as well as zealous government regulators proactively controlling things like vehicle speeds remotely.

"We don't like these scenarios and we are not striving for the autonomous car. We think we are

Mercedes developed the Mercedes-Benz B-Class F-CELL and put it on a round-the-world drive test for usability and durability

After more than 30,000 kilometres, three Mercedes-Benz B-Class F-CELL vehicles with zero local emissions drivelines crossed the finish line and returned home to Stuttgart. The hydrogen-powered B-Classes and their support vehicles set off from Stuttgart at the end of January 2011 and crossed 14 countries on four continents.

The exclusive partner for hydrogen supply on the F-CELL World Drive was the Linde Group. It was able to guarantee fuel supply throughout the entire world trip. A jointly developed mobile refueling unit based on a Mercedes-Benz Sprinter accompanied the tour – the only way to ensure fuel supply even on the most remote stretches.

The technology for the B-Class F-CELL drive system is some 40

percent smaller than the system in the A-Class F-CELL from 2004, but develops 30 percent more power while consuming 30 percent less fuel. The main drive system components include a compact fuel cell stack, a powerful lithium-ion battery and a compact, lightweight drive motor at the front axle.

The hydrogen used to run the fuel cell is stored in three tanks at a pressure of 700 bar. Each tank holds just under 4 kilogrammes of the gaseous fuel. The tanks are hermetically sealed from the outside world, preventing the loss of hydrogen into the atmosphere even if the vehicle is left to stand for long periods.

Mercedes says that the B-Class F-CELL can cover long ranges of up to 400 kilometres with the tanks

full, over twice as far as the A-Class F-CELL. If the tanks are empty, they can be filled simply and quickly in less than three minutes, thanks to a standardised refuelling system.

The electric motor – a permanently excited synchronous motor – develops a peak output of 100 kW (136 hp) and a maximum torque of 290 Nm, which is available from the instant the engine starts to turn. Daimler claims that the the local zero-emission electric drive with fuel cells consumes the equivalent of just 3.3 litres of diesel per 100 kilometres (NEDC).

A powerful high-voltage lithium-ion battery is used to store the power. It boasts an energy capacity of 1.4 kWh and is cooled via the air-conditioning system circuit.



Mercedes has high hopes for 'compact premium' models in the future. Last month, it commenced production of the new Mercedes-Benz A-Class at Rastatt



Dr. Dieter Zetsche

Dr. Dieter Zetsche has been a member of the Board of Management of Daimler AG since December 16, 1998, and Chairman of the Board of Management of Daimler AG since January 1, 2006. He is also Head of Mercedes-Benz Cars Division which includes passenger cars of the brands Mercedes-Benz, Maybach and smart as well as Mercedes-Benz AMG and Mercedes-Benz McLaren.

Dr. Zetsche was born in Istanbul, Turkey, on May 5, 1953. After attending school in Frankfurt and obtaining the Abitur (university entrance examination), he studied electrical engineering from 1971 to 1976 at the University of Karlsruhe and graduated as an engineer. He joined the research department of the then Daimler-Benz AG in 1976 and became assistant to the Development Manager in the Commercial Vehicles business unit in 1981.

Dr. Zetsche completed a doctorate in engineering in 1982 at the University of Paderborn. From 1984, as part of the Daimler-Benz Commercial Vehicles Management Development Team, he was responsible for the coordination of international development activities.

at the leading edge as far as the technologies are concerned, but we want to use it for accident free driving and not for autonomous driving.”

How far away are fuel cells?

“Technically, I think we are there. We can offer a car to a customer that is reliable, which has similar driving characteristics to a combustion engine driven car and the customer can enjoy it. What’s missing now is the benefit of high volume industrial processes for cost efficiency. And you also need infrastructure, for the battery-electric car and the fuel cell car. The difference is that you can make the first steps for the battery-electric car from your garage, but you can’t with a fuel cell car. The cost to allow the fleet to grow is rather higher for battery-electric than for fuel cell because of the charge times being higher requiring more charge points.

We’re working with other OEMs, governments, utilities and making some progress. It’s about lobbying and creating momentum.”

It does seem to be taking time though, in the classic chicken and egg manner. Zetsche sounds an optimistic and confident note.

“I have no doubt about the product and the technology. We are more optimistic about the possibility to get to cost levels where you start to become competitive.”

What would that cost level be?

“It would be in the range of a diesel hybrid and we are not quite there yet, but we see that as a realistic objective.” And how far away is that? “We’re talking about five years.”

Mercedes has developed a fuel cell for the B-class. Zetsche sees that fuel cell applications as having a role distinct from battery electric cars and therefore featuring in bigger vehicles.

“Battery electric is basically for urban use and small cars. Fuel cells [with longer range] have possibilities outside the city and for larger cars. We have an execution that can go in the engine compartment of a conventional sedan.”

But how far away are they, really?

“I believe that in 3-5 years you will be able to go to a showroom and buy a fuel cell vehicle. By the end of the decade you will see them in some numbers on the streets.”

As far as combustion engines go, Zetsche sees diesel engines declining in small cars as more efficient gasoline engines gain ground. On the other hand, there are efficiency refinements

coming on diesel engines to improve efficiency and Zetsche sees diesel as retaining their central importance for Mercedes cars in the future.

“Diesel has a major impact on our overall average CO₂ fleet average. Now we have diesel hybrids also. The emission targets are expensive to meet and we have established diesel technologies.”

In the field of electric vehicles, Daimler is cooperating with Renault-Nissan and with Tesla. Is there a potential conflict? Zetsche highlights the need to have broad contacts and influences in this area of emerging technologies. “We think it is smart to understand what is going on in more than your own field. We were the first to cooperate with Tesla and we have a preferential partnership with them. They learn from us, we learn from them. We are happy with our partnership with Nissan and with Renault and when it comes to specific technologies – such as fuel cell – we see two partners who can join forces to become more efficient. It’s a balance.”

So would that be small EVs for partnership with Renault-Nissan and larger vehicles with Tesla?

“We do not have a general strategy in this regard...with the last generation [electric] smart we worked with Tesla and for the new one we will have our own battery which will be used in a Renault vehicle as well.”

While working with partners is an important part of the Daimler strategy, Zetsche underlines the importance of developing products that can adequately differentiate the brand.

“We are in a transformation in our industry right now. When we look at alternative drivelines, there is plenty of room to differentiate yourself from others and the same things apply to areas like digitalise and safety. I find it amazing how big the differences can be in some of these fields.”

Zetsche acknowledges industry convergence in areas of basic vehicle quality and capabilities, but sees a continuing place for premium brands.

“I am not afraid that there will not be enough room for premium manufacturers altogether or for Mercedes-Benz in particular, to set itself apart from the rest.”

Author: Dave Leggett.



Festival of Speed

Lotus Cars was the featured marque at Goodwood 2012

Every year a different car company sponsors a centrepiece sculpture for the Goodwood Festival of Speed, this year the sponsor was Lotus Cars





There was no doubting Lotus was the star of the show at Britain's biggest car culture celebration, the Goodwood Festival of Speed

On the Thursday night the great and the good of two and four wheels descended on Lord March's estate for a traditional ball, only to be awestruck by the enormous sculpture on the stately lawn with six very significant Lotus racing cars bolted high up, colour floodlit, and shadowing the famous hillclimb that runs past Goodwood House.

It was the ultimate sculpture to Lotus' past and present. The current black and gold Lotus F1 car was flanked by Jim Clark's 1965 Type 32B, Graham Hill's Type 49, Emerson Fittipaldi's Type 72, Mario Andretti's Type 79 and Ayrton Senna's Type 99T. Not models you understand, actual history-making gems.

Fittipaldi was just one of the Lotus legends who turned out to support Lotus and reacquaint himself with the car that made him famous – the JPS-liveried Type 72. Jackie Oliver was out in the Gold Leaf-coloured Type 49 which earned him a podium in Mexico '68, and Sir Stirling Moss, the first man to win a grand prix in a Lotus, was also there, defying his 82 years by pushing his Rob Walker blue Lotus 18 – the model that blitzed Monaco in 1960 – to the cheers of the crowds huddled behind hay-bales.

This being England, the weather changed minute to minute but by the end of Sunday the sun was out on what was the biggest Festival of Speed yet.

The Lotus stand was a big draw, showcasing the

current model range as well as cars from the past like the dinky and loveable Lotus Elan which blows the candles out on its 50th birthday this year.

Lotus used the opportunity to get miles under the belt of its new rally car, the Exige R-GT, at the hands of Portuguese Bernardo Sousa, while the road-going models also drew many admiring glances in the supercar paddock, the Evora GTE and Exige S outperforming and stealing attention from their more costly neighbours both at standstill and on the course.

Forty Lotus cars paraded around the Goodwood grounds, with just about every model represented. Classic Team Lotus' customers were high up the leader board at the end of proceedings when the hillclimb times were read out. Chris Locke and his Type 77 were 11th having set a 54.39, while Andrew Beaumont won the Lotus bragging rights in his Type 76 with a 49.74 second run, which put him seventh overall.

There was also the opportunity to own a piece of Lotus history yourself. Olav Glasius' collection went under Bonham's hammer to gross £977,000, the top sale being the 1962 Lotus-Buick V8 Type 19 'Monte Carlo' at £158,300, closely followed by the historically significant ex Le Mans 24 Hours Team Lotus Lotus Eleven, which was raced by Cliff Allison and Keith Hall in 1956. It sold for £152,700.



Towering Symbolism

Lotus Cars commissioned the Festival of Speed sculpture



A racing car is designed with singularity of purpose: to complete a set number of laps and within a set of technical rules in the fastest time possible. But, emotionally, it is so much more. Its focused design carries the hopes and fantasies of more than just the driver sat in its snug, spartan cockpit. Racing cars are inspiring, and the Goodwood Festival of Speed exists to celebrate that fact and place thoroughbred racers and sleek sports cars on a pedestal of almost religious worship.

And, just as a cathedral has a tower so as to be seen from a distance, Goodwood had an automotive sculpture to draw

followers in, and act as its festival centrepiece.

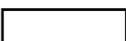
Each year, Goodwood has a featured marque; a car maker which inspires disciples, maybe because of its style, or success on the track, often both. In 2012, the featured marque is Lotus. It is fitting that this most British of automotive icons is toasted at this most British of garden parties, six decades in and with its foot on the gas.

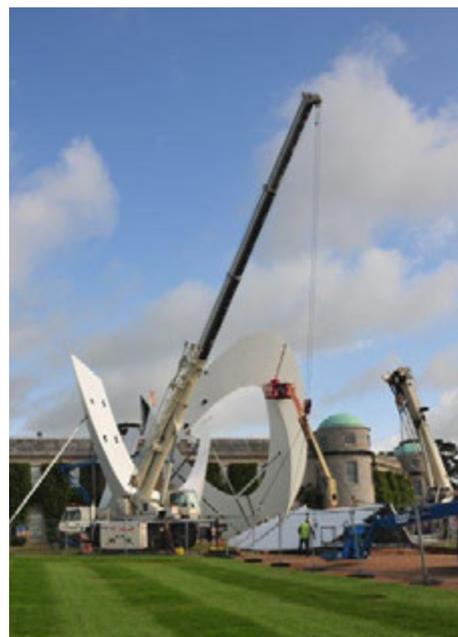
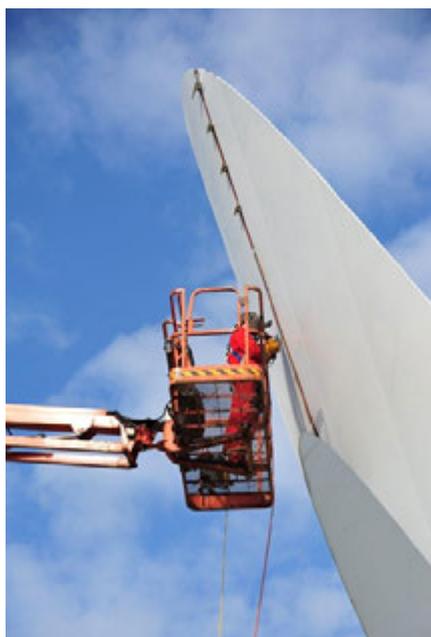
Artist and designer, Gerry Judah was commissioned by Group Lotus to create a bold centrepiece that captures the essence of Lotus from its beginnings to the present.



Artist and designer Gerry Judah was commissioned by Lotus to create the sculpture

RIGHT: Sculpture being assembled at Goodwood





A 3-D infinity loop, 28 metres high, it resembles the grandest, most ambitious slot racing track ever imagined. The winding curves represent Lotus' natural environment; cars that are built for cornering. It's a monocoque structure, an engineering approach pioneered in FI by Lotus.

"The monocoque structure, which is made of steel plates and joined together to create the loop, is meant to highlight the engineering DNA of Lotus" confirms Gerry. *"It's a lightweight engineering construction. I think its form shows the Lotus psychology and culture."*

The sculpture is a race track, and sat on its tarmac are six very significant Lotus cars. Not scale models: full-size, genuine, actually-been-raced examples from Lotus' longstanding motorsport campaign. There's a green and yellow Type 32B, the car in which Jim Clark won the 1965 Tasman Series in Australia and New Zealand. Then there's the red and white Type 49, in which Graham Hill raced to the FI crown in 1968. Next is the JPS liveried Type 72, in which Emerson Fittipaldi became Formula One's

youngest champion in 1972. Then the black and gold Type 79, the ultimate ground-effect car now high in the air, and responsible for Mario Andretti's world title in 1978. A bolt of yellow in the shape of the Lotus 99T next, the last Lotus driven by Ayrton Senna. And, finally, we have the current Lotus grand prix car as driven by Kimi Räikkönen and Romain Grosjean.

Judah has now built 15 statues for Goodwood, so he knows what he's doing. *"Many years ago Charles March [the owner of Goodwood House and the organiser of the Festival of Speed] was a commercial photographer, and back in the 1980s I used to build sets for him. Having not seen him for about 15 years or so, he called me up in 1997 and asked me to build something for him: a triumphal arch with a Ferrari hanging underneath. Despite terrible rain and winds to endure when we put it up, it was great fun and a few months later he asked if I wanted to do another."*

Judah worked closely with Lord March and Lotus to determine the design. *"I came up with a couple of concepts and then we had a dialogue. A great piece of art doesn't just*

come from the artist, it comes from the client too and Lotus' Head of Marketing, Tommaso Volpe, really had that vision."

Cars have always been a passion of Judah's.

"I've always admired Lotus since I was a boy. They're such British cars, with that ideology of clever, forward thinking science and engineering. That was something I knew I needed to embrace. It's almost unconscious how I approach sculpture. I don't do brands. None of the sculptures I've done for Goodwood have spoken about the brand, you can get an advertising agency to do that. I do something more intuitive. It is, dare I say it, a spiritual journey in design." Speaking of spiritual journeys, he says inspiration for his work can be traced to India, where he was born. His mother was from Calcutta, his father from Rangoon, and Gerry was raised in West Bengal till the age of ten when the family emigrated to London. *"The landscape, the awesomeness of the huge temples and mosques, the rituals, the architecture... everything had a sense of grandeur. Not necessarily scale, but grandeur of spirit."*

Before turning his attention to public sculpture, painting and fine art, Gerry had made a name for himself in theatrical, movie and television set design, establishing a studio on Shaftesbury Avenue after graduating Goldsmiths College and Slade art school. The dramatic elements to his work are clear, and this has been embraced not just by marques such as Porsche, Audi and Jaguar but by Michael Jackson, Paul McCartney, The Who and Led Zeppelin to create the most impressive rock shows. And there has been darker subject matter, none more serious and introspective than a large model depicting Auschwitz at the Holocaust Exhibition for the Imperial War Museum.

Working with the Lotus models up on the huge 3-D loop, and with Clive Chapman – the owner of the five classic F1 models - has been

important in order to convey Lotus' integrity.

"Everything up there is original,"

says Gerry, "because that's the whole idea of Goodwood. These are the original racers and they project that spirit of not just the Festival of Speed but of the history of motorsport, to which Lotus has been such a significant contributor. We could have stuck the cars up on podiums as you might in a museum, but that wouldn't give the cars the salute they deserve. You need some element of danger and panache, as exhibited when they're racing on the track."



Raw Performance

New Lotus Exige S with 345 bhp supercharged V6



The Exige represents the very essence of Lotus – raw performance, agility, unparalleled ride and handling and mind blowing driving experience...





First round of the first season of the Autobytel Lotus Championship featuring the Lotus Sport Elise was held at Brands Hatch

Born on the track in 1999

The new Exige S is the latest in a line of high performance, track-focused racing cars from Lotus. Encapsulating the ethos of Colin Chapman (lightweight, agile, power to weight, ride and handling), the Exige has a strong and loyal following among racing aficionados, and can often be seen at open track days giving more powerful and more expensive sports cars a run for their money.

In 1999 Lotus created a track only Lotus Sport Elise used in a one make series racing, this led to a road car version, named the Exige from the French word 'exiger' meaning 'to be demanding'. The first road based

Exige was essentially a raw race car for the road, with a highly tuned 1.8 litre VHPD normally aspirated engine producing up to 190 bhp. The bodywork was borrowed directly from the Sport Elise and generated 80 kg of downforce at 100 mph from the massive front air dam and rear wing, and a roof-mounted air intake forced cooling air to the engine bay. Weighing just 780 kg the Exige had a top speed of 136 mph and 0-60 mph acceleration in under 5 seconds. Lotus had introduced a new genre of car, a useable track car that could also be used on the road, with 583 SI Exiges built from 2000-2001.



The first Exige was launched in 2000 with a 1.8 litre K-series engine generating up to 190 BHP



Second generation launched in 2004

The series 2 Elise was launched in 2002 with a new chassis approved for the Federal market powered by a 1.8 litre VVTl-i engine, followed by a new Series 2 Exige in 2004 with more aggressive track-focused styling, a large rear wing and roof mounted air scoop. Fitted with a 189 bhp 1.8 litre VVTl-i engine that was capable of pushing the 875 kg Exige to 147 mph and from 0-60 mph in just 4.9 seconds. In 2006 an even more powerful variant (the Exige S) was launched in which the engine was supercharged to provide 218 bhp and 215 Nm of torque,

providing 0-60 mph acceleration of just 4.3 seconds.

With performance from the 1.8 litre supercharged engine pushed to 260 bhp in the cup 260 version in 2010, engineers started to look for a new powertrain for future models, fortunately work had started on the Evora S, supercharging the 3.5 litre V6 in the standard Evora from 276 bhp to 345 bhp, an ideal choice for the next Exige.

The S2 Exige S was launched in 2004 with a supercharged 1.8 litre VVTl-i engine generating 190 bhp, followed by the Exige S in 2006 which had a supercharged engine generating 218 bhp





Development programme

A programme was launched to package the V6 into the Elise platform. An Exige mule car with the engine and gearbox of the Evora was created to test the concept and identify areas that would require re-engineering. Due to the width of the rear Evora module (which includes rear subframe, powertrain and suspension track), it was not possible to style or match the wide rear of the vehicle to the narrower mid-section and front. So a new rear subframe was engineered to fit the V6 engine, keeping the wheel track width to a minimum, to be in keeping with the Elise chassis. Along with the rear sub frame, wider track and larger tyres at the front to deal with the extra power

and torque of the engine had to be identified and developed.

The supercharged V6 engine delivers 345 bhp and 400 Nm of torque, so the engineers identified larger and wider tyres to accommodate the huge power and torque to the rear wheels, with tyre size and width increased at the front to 205/45 R17, and the rears to 265/35 R18.

With engine, packaging, tyre choice and styling decisions made, work started on selecting the make and compound of tyres and determining the required steering ratio. Due to the longer wheelbase the steering speed was felt to be too slow, so this was increased to improve agility and alertness. For the tyres Pirelli was chosen as the

supplier selecting the Pirelli P-Zero Corsa and Trofeo tyres as the best application for the new Exige, but as there were no Corsa tyres in the size Lotus required, Pirelli started development on bespoke Corsa tyres for the Exige. Tyre selection and setup is important to any car, and a key goal of the Exige programme was to ensure the driver had maximum confidence in the car's capabilities, feeling the limits of grip.

Whilst Pirelli worked on the new tyres, Lotus began winter testing in Sweden, working with Bosch to calibrate the vehicle's ESP systems (forming Lotus DPM). An additional car was built so that ride and handling work could be started. Developing the car at Idiada in



LEFT: Lotus DPM has four modes (Touring, Sport, Race and Off)

LEFT PAGE: Exhaust system has an extra valve which protects the engine and provides a sportier exhaust note

Spain, Lotus Ride and Handling teams started work on the springs, damper rates and anti-roll bar tuning. New lower friction gear cables and reduced flywheel mass to reduce inertia were developed to provide an improved gearchange. This transformed the performance with the improvements also incorporated into the MY11 Evora upgrades and the Evora S.

As development progressed, Pirelli issued three submissions (each submission incorporating up to eight different specifications of compound and construction) of development Corsa tyres for testing which progressed at the well known

testing circuits of Idiada and MIRA. Testing incorporated calibrating and developing software updates to the ESP system from Bosch, as well as different suspension set-ups and brake testing, with additional brake fade characteristic testing carried out at the Stelvio Pass in Italy.

On Pirelli Trofeo tyres, the vehicle really came to life on the track, the tyres providing increased response, higher grip and improved body control, the trade-off being higher wear rate and firmer ride, whilst the Corsa tyres proved to be exceptionally good, offering very capable all-round use, with improved wet weather grip

over the out going Exige due to the aggressive front tyre treads dispersing surface water therefore enhancing the grip of the wider rear tyres.

The Exige S is available with two suspension setups, standard and an optional 'race pack' setup, both developed at various locations including the Nürburgring, in Germany, where the team had the opportunity to fine tune the Sport suspension settings and further develop the new race mode DPM setting, optimised for use with the Trofeo and Corsa tyres.

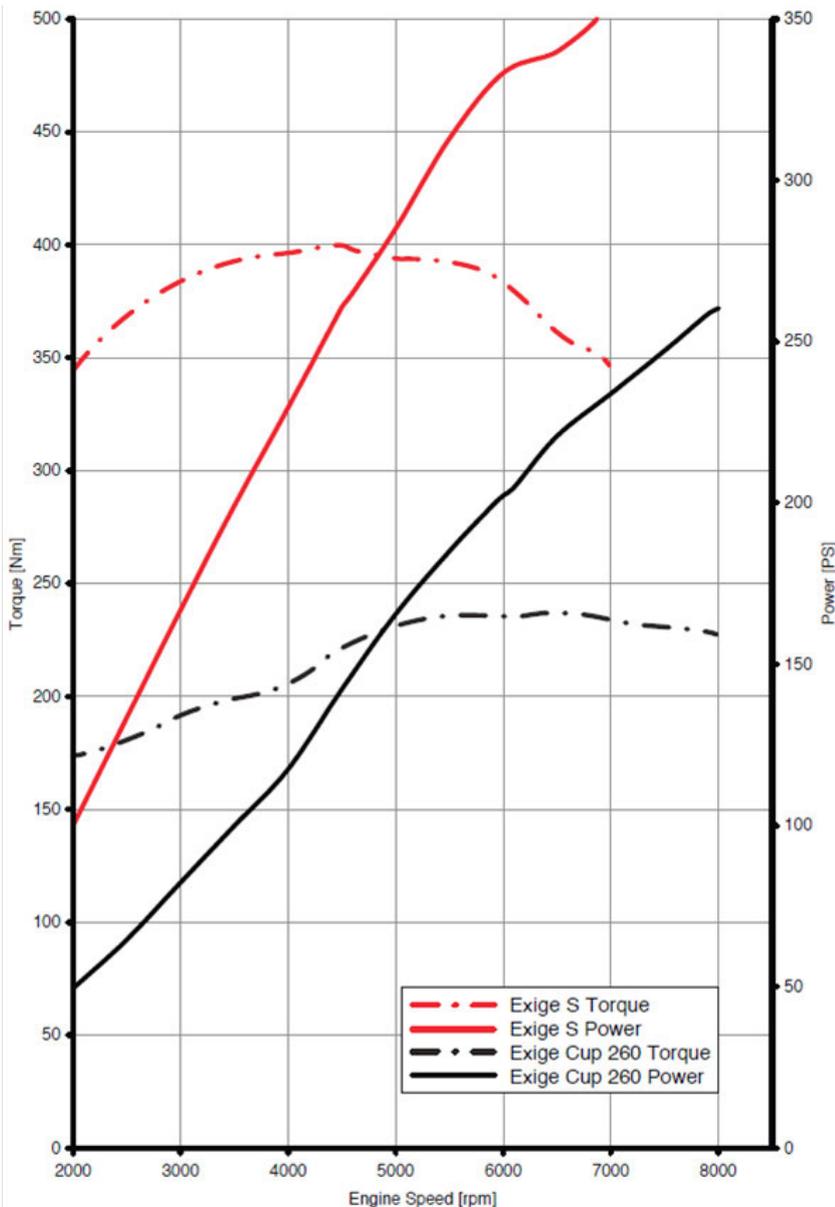
Pirelli P Zero Corsa tyre



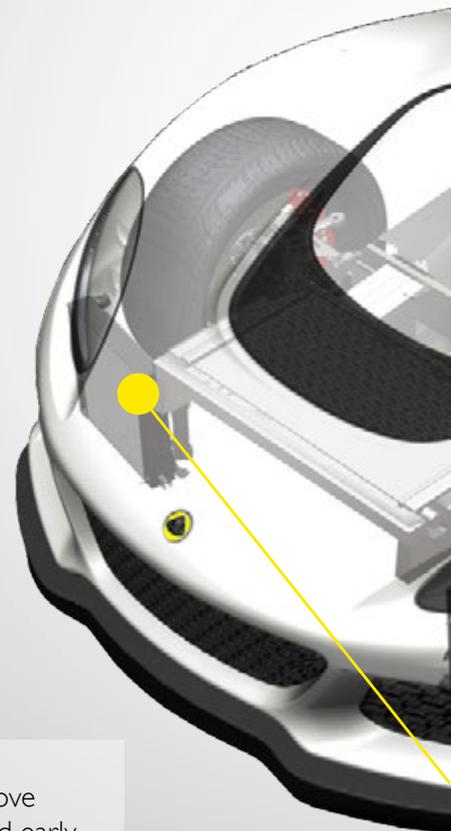
Pirelli P Zero Trofeo tyre



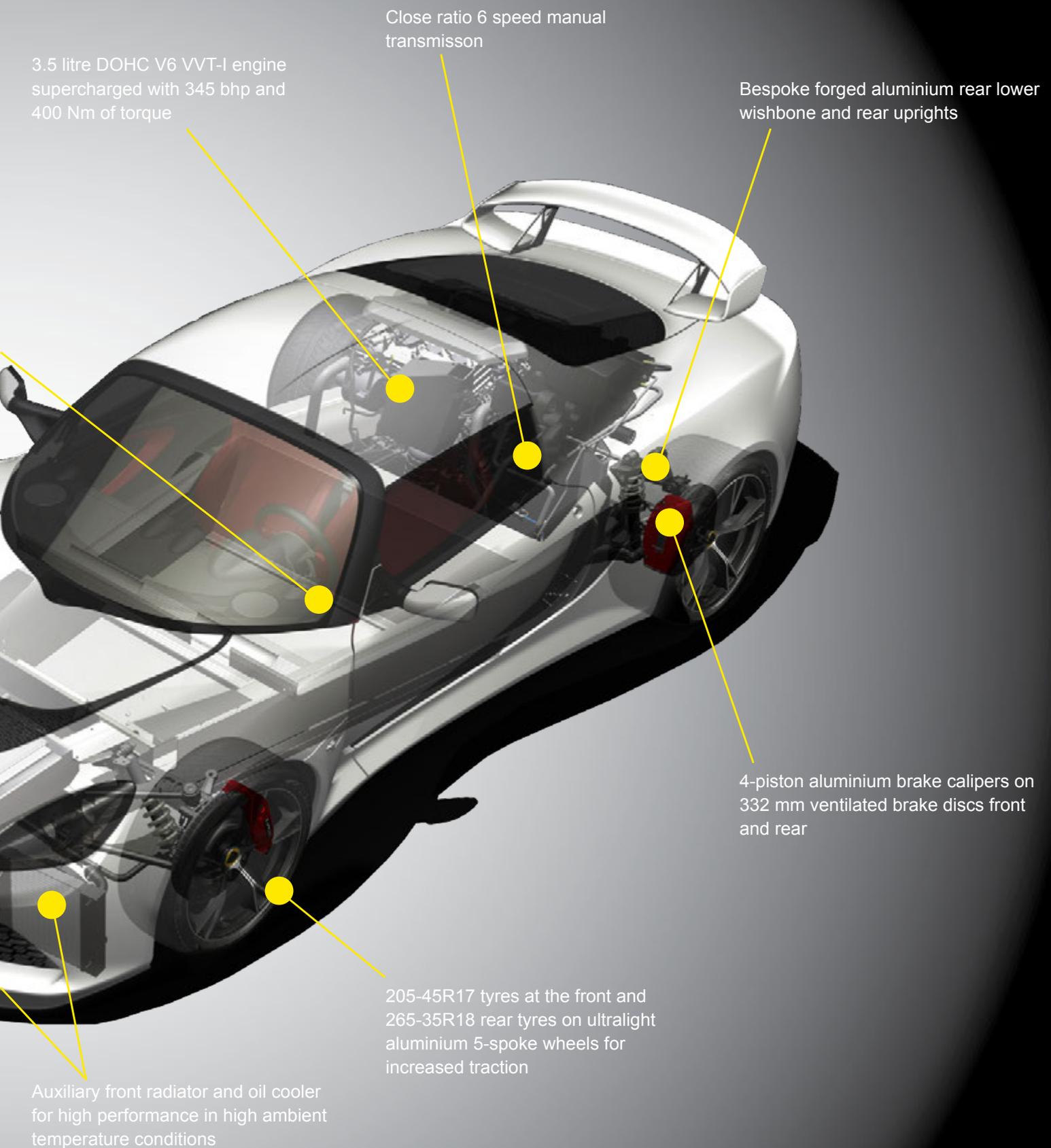
2012 EXIGE S COMPARED TO EXIGE CUP 260



Driver adjustable multi-mode Lotus DPM system (Dynamic Performance Management)



From the start of the programme the ride and handling team were keen to improve the outgoing Exige's award winning driving feel and handling as much as possible, and early comments on the new Exige setup were that it was not as focused as its predecessor, due to characteristics of the improved rear suspension design. However, further development work on the ride and handling ensured that the new Exige is true to its track-born roots and whilst not as extreme as the outgoing Exige Cup 260, the new Exige S is a competent road car and like all Lotus Exiges an unrivalled car for the track.



3.5 litre DOHC V6 VVT-I engine supercharged with 345 bhp and 400 Nm of torque

Close ratio 6 speed manual transmission

Bespoke forged aluminium rear lower wishbone and rear uprights

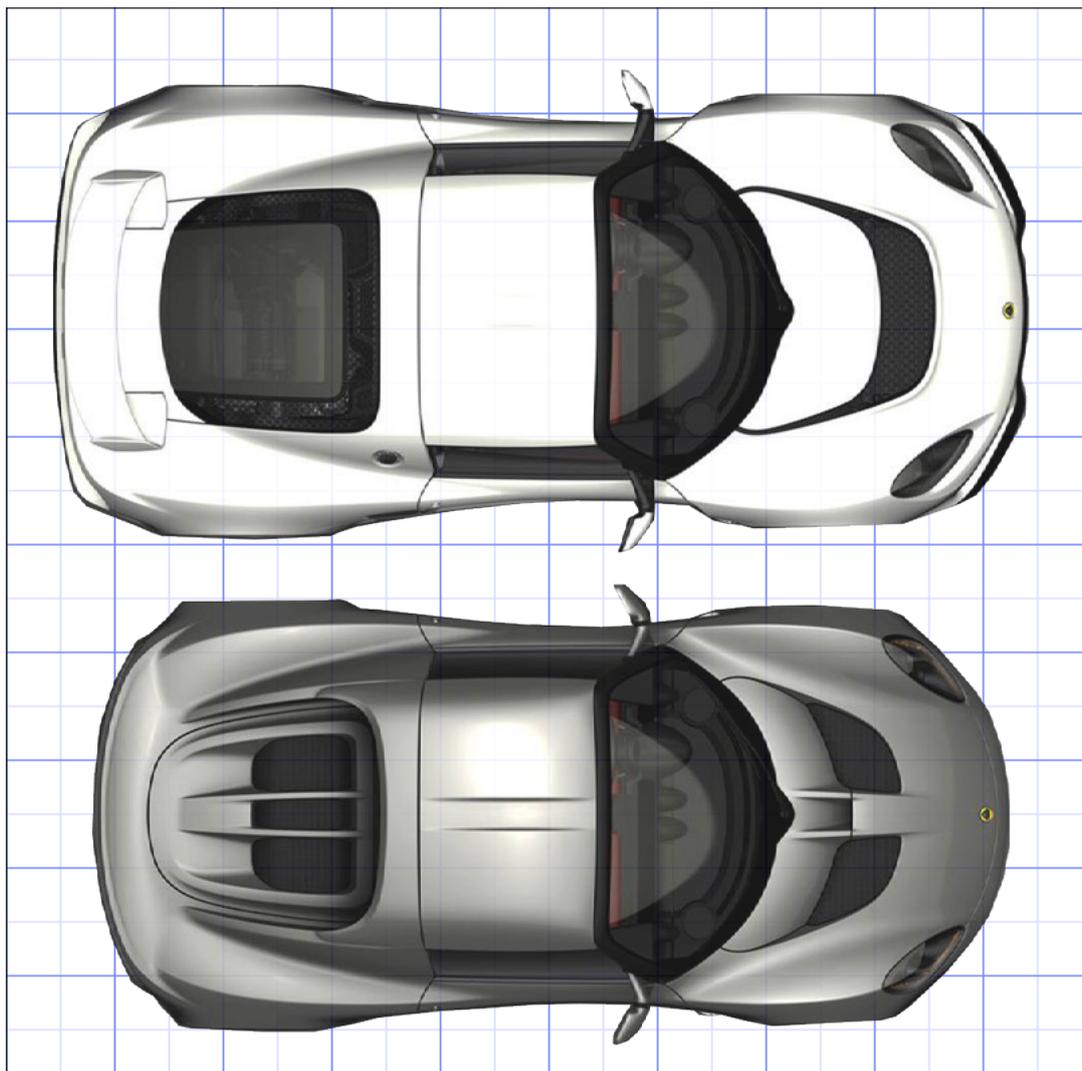
4-piston aluminium brake calipers on 332 mm ventilated brake discs front and rear

205-45R17 tyres at the front and 265-35R18 rear tyres on ultralight aluminium 5-spoke wheels for increased traction

Auxiliary front radiator and oil cooler for high performance in high ambient temperature conditions

The 2012 Exige S wheelbase is increased by 70 mm to accommodate the V6 engine. The front track width has been increased by 25 mm and the rear by 38 mm for enhanced stability

(Elise shown for comparison)



The 2012 Exige S

The new Exige S was unveiled at the Frankfurt Motorshow 2011 and Lotus has already taken a large number of orders. The powerful engine, combined with the aggressive track-orientated design (with styling cues providing a route from the old cars to the future cars shown in Paris), the vehicle is true to its racing series roots, whilst the powerful engine and advanced DPM will enable more drivers to use the vehicle to its capabilities with greater stability and safety both on track and on

the road. With 345 bhp and a low vehicle weight of 1,176 kg, the Exige has a top speed of 170 mph, and can accelerate to 60 mph from standing in just 3.8 seconds. An Exige S Roadster concept was shown at the Geneva motorshow in March and the Exige R-GT starts its rally season in 2012 continuing the racing legacy of both Lotus and the Exige, a car born on the track yet at home on the road.

Author: Paul Culley



2012 Lotus Exige S

345 bhp

400 Nm torque

3.5 litre supercharged V6

0-60 mph in 3.8 seconds

0-100 mph in 8.5 seconds

Top speed of 170 mph

Weight 1,176 kg

236 g/km CO₂



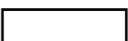
Tata is India's sixth-biggest company, and one of few emerging-market automakers to have established a truly global presence, achieved through the \$2.3bn acquisition of Jaguar Land Rover in 2008

While the acquisition of Jaguar Land Rover (JLR) has turned out to be a major success for Tata Motors, the company finds itself at a crossroads. At the end of the year, Ratan Tata, the 75 year old grandson of the company's founder, steps down as chairman of both Tata Motors and Tata Group. He has no children, so his successor, Cyrus Mistry, comes from outside the family.

Mistry is spending this year working alongside Ratan Tata, learning his way around a business in which his family owns an 18% shareholding.

When he takes command, he will take on the outgoing chairman's stated goal of building group revenues to a staggering US\$500bn by 2022.

Automotive activities are the single biggest division of Tata's empire – bigger even than its substantial Tata Steel business – Tata Motors will have to deliver some substantial growth. And not just JLR. The Tata brand is going to have to provide some of the global growth too. But business has been far from smooth for Tata's own car company.





Tata Motors

Mark Bursa takes a closer look at prospects for Tata Motors

Tata Nanos being built at Tata Motor's plant at Sanand, Gujarat, inaugurated on June 2, 2010

Nano gamble falls short

The big gamble on the Nano microcar has fallen well short of targets, and has been fraught with problems, including a damaging dispute over the original site of the new plant to build the car, which had to be abandoned. A plan to enter the European market with electric cars also seems to have been scrapped, setting back plans to expand the Tata brand beyond India and neighbouring Asian markets. And a joint venture with Fiat seems to be unravelling as Fiat looks elsewhere for partners.

On top of that, Tata's core Indian market products, including the latest versions of the Indica, India's first completely self-developed car, have not been selling well in the fast-growing domestic market. Tata is number three automaker in the Indian market, a long way behind market-leader Maruti and second-placed Hyundai Motor India, which exports vast numbers of small cars worldwide from its base in Chennai.

Indeed, Tata's own-brand car company only

contributes around 10% of Tata Motors' profits, the bulk comes from JLR. Effectively, JLR's more profitable luxury car and sports utility vehicle (SUV) sales are propping up Tata Motors.

Just look at the numbers. Total Tata Motors global sales in the 2011-12 Indian Fiscal year (to March 31, 2012) were 1,252,173 units, up 16% on the same 2010-11 period. Within this total, JLR sales almost matched Tata-brand passenger car sales. Full-year sales of Jaguar Land Rover cars for the year reached 314,433, up by 29% on the previous year. But Tata-brand cumulative car sales for the fiscal were 337,813, up just 3% over 2010-11, a figure that includes some Fiat cars that are distributed by Tata.

Tata had had more success with commercial vehicle (CV) sales – sold under Tata, Tata Daewoo, Tata Hispano Carrocera brands – they reached 599,927, up 17%. The CV range includes everything from small microvans to heavy trucks and buses, and for the moment, it is CV sales that give Tata Motors its global scale.



JLR a growth engine

JLR remains the principal engine for growth. Tata is showing big ambitions for the two brands, pouring in investment both in the UK and elsewhere. Of the two brands, Land Rover (and Range Rover) contributes by far the biggest volume. In Fiscal 2011-12, cumulative sales of 4x4 vehicles rose 37% to 260,394, while Jaguar sales remained relatively static at 54,039, higher by just 2%.

Tata has combined much of the back-office functions of JLR, effectively running them as one business unit. This allows JLR to set a bolder ambition than either brand could manage on its own – that of becoming a genuine competitor to BMW and Audi, offering a large range of vehicles including saloons, sports cars and SUVs.

This will require a substantial investment in new models and investment in production facilities in other markets, especially emerging markets, as JLR would effectively need to be around three times its current size to be truly competitive against its German rivals.

Nevertheless, Tata does appear to be splashing the cash. A GBP5bn investment plan was announced by JLR at the Geneva motor show in March 2012, which would see the launch of 40 “significant new products” over

the next five years.

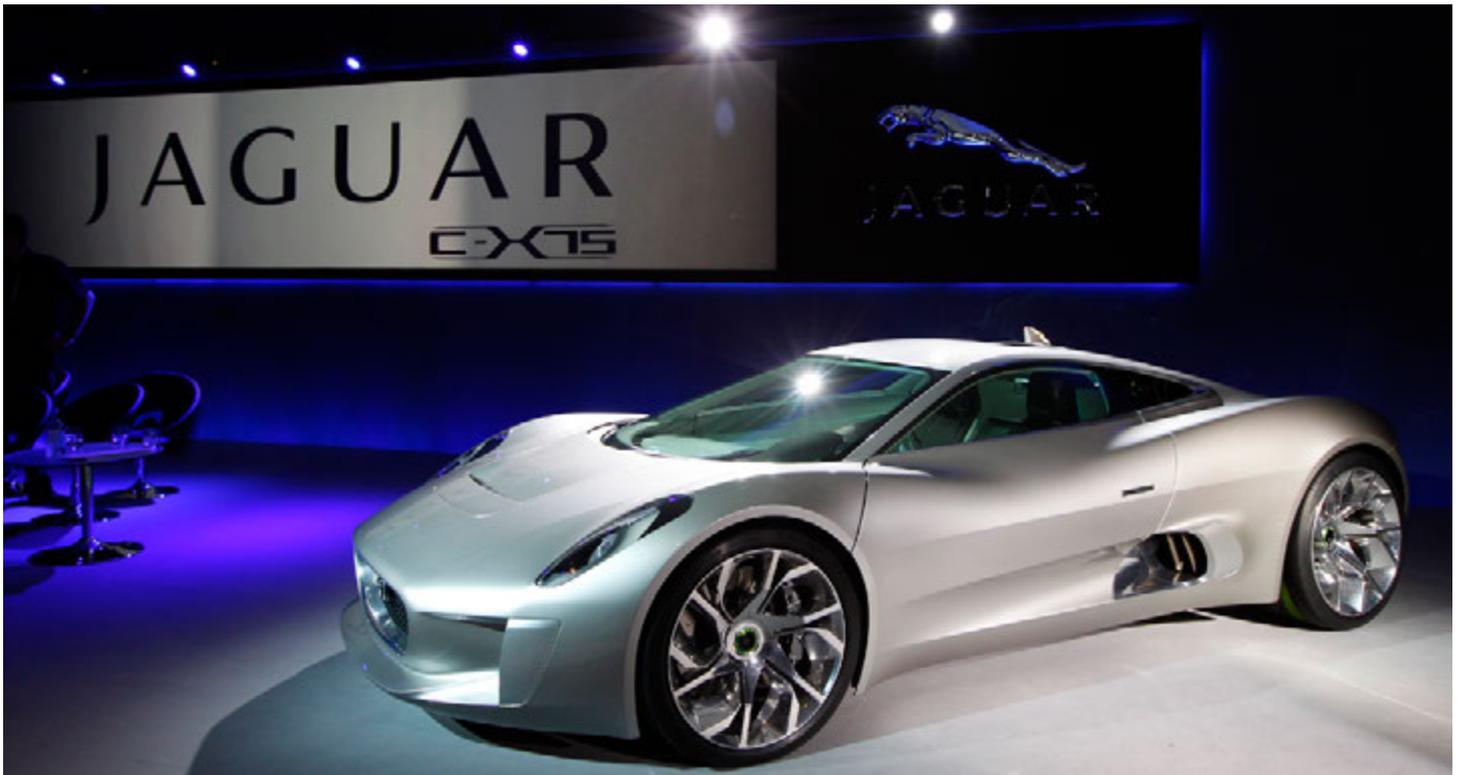
JLR recently broke ground on a new GBP355m engine plant in Wolverhampton, central England, and has begun recruiting workers - 1,000 workers for its plant in Halewood, near Liverpool, and 1,000 at its Solihull plant near Birmingham, both of which build Land Rover models.

Halewood has benefitted from the success of the Range Rover Evoque compact SUV, a competitor for the BMW X1 and Audi Q3. Halewood is now running 24 hours a day to cope with demand for Evoque – it has taken more than 60,000 orders for the small SUV since it was launched in 2011. A convertible version was shown at the 2102 Geneva Show in March and this looks likely to become a production model.

Further growth is coming from India, where Tata has started CKD assembly of the Land Rover Freelander SUV at one of its plants in Pune. And Tata is considering also building the next generation Land Rover Defender in India, either in Pune or at its major new plant in Sanand, from 2015. Engines for Indian-built Land Rovers could also be built in India, which would help boost local content levels.

Indian volumes would be between 30,000

JLR's Halewood plant is running 24 hours a day to meet demand for the new Range Rover Evoque



Jaguar C-X75 hybrid supercar given green light for limited-number production

and 40,000 units a year, with the majority – between 60% and 80% - being exported to overseas markets, including Europe. It's possible that the next Defender could be built only in India, freeing up more capacity in the UK for increased Range Rover production.

This plan would boost Land Rover production to more than 300,000. But Jaguar offers greater room for expansion. In 2011 around 54,000 Jaguars were built, with all three models – XF, XJ and XK, built at Castle Bromwich in Birmingham. To expand sales, Jaguar needs a broader range – especially in the vital European D segment, where BMW's 3-Series and Audi's A4 are major players.

Of course, Jaguar has been here before. Under Ford, it tried unsuccessfully to crack this sector with the X-Type, based on the Ford Mondeo platform but equipped with permanent four wheel drive. The car flopped and the Halewood plant, which had been configured to build it, was swiftly reconfigured as a Land Rover plant.

But everything now points to Jaguar having a second go at a smaller car, this time building a range of cars including sedan, hatchback and crossover, allowing it to compete with the likes

of Audi's A3 and A4 as well as the new Q3. Jaguar also needs smaller and more fuel efficient models in its range to help it meet more stringent US CAFE fuel economy rules due in 2016.

This all points to a 2015 production start for the new small Jag, likely to be called XD.

JLR would probably use the Evoque's LR-MS platform as the basis for XD, though it might be difficult to squeeze it into Halewood given strong demand for the Evoque. Production in India is a possibility, as JLR has stated it would like to start Indian assembly within five years, but initial volumes are likely to come from a UK plant.

Due this year is an estate version of the XF, while a smaller sports car, codenamed XE and designed as a spiritual successor to the legendary E-Type of the 1960s, is in the pipeline. The C-X75 hybrid supercar will also be built, giving a top of the range "halo car". The C-X75 combines supercar performance with 99 g/km CO₂ emissions. It will be built on a carbonfibre chassis in collaboration with the Williams Formula 1 team, and just 250 will be made, each priced at around US\$1m.

Jaguar's Chinese expansion

As well as range expansion, Jaguar's geographical spread needs to be widened too. This is likely to be boosted by a new Chinese factory to be built in partnership with Chery Automobile. This is still awaiting regulatory approval from the Chinese government. The company is also exploring South America for a production base, though a plan to build a plant in Brazil appears to have been cancelled.

JLR already has a good base in China, where it sold 42,000 vehicles in 2011 (compared to fewer than 2,000 in India). JLR's China sales rose 60% against 2010 and equate to 17% of the group's global sales, up from just 1% in 2005. Indeed, China is the JLR's third-largest market, after the UK and US.

Luxury car sales in China are booming, and Mercedes, Audi and BMW are all present with local production bases. Volvo, another key rival, is now owned by the Chinese Geely Corporation – Chery's arch rival in the small car sector.

To compete in China, Jaguar will have to develop long-wheelbase versions of its XF and probably of the future D-segment car, as these vehicles are vital to compete in the Chinese market. Audi A4, BMW 3-series and even the VW Passat come as LWB models specifically for China.

The Chery JV will build both Jaguar and Land Rover vehicles, and the choice of Chery is an interesting one, as the company has very little experience of working with overseas partners. A deal to produce cars with Fiat fell through, while talks with Chrysler foundered when Chrysler hit financial trouble in 2008.



Tata brand faces challenges

While JLR seems set fair for growth, Tata brand has problems. The Nano, conceived by Ratan Tata as an affordable vehicle for Indian families – essentially a trade-up from a moped – has had a fraught start.

Initially, Tata wanted to build the Nano at a new plant at Singur in West Bengal state – but this plan was met with violent protests over the seizure of farm land. The farmers demanded more money – but Tata refused to cave in, and in October 2008 the company took the extraordinary step of abandoning the 95%-complete Singur plant and announced that the project would be relocated to a new site at Sanand in Gujarat state.

In order to get the Nano to market, Tata had to manufacture the car at its existing plants at Pantnagar and Pune. As a result, the project has fallen behind schedule, and has not hit the sort of volumes that Tata had expected.

Tata needs to sell 15,000-20,000 Nanos a month to make the project successful – Sanand's capacity is 240,000 Nanos a year. Tata had hoped for sales of up to 500,000 of the US\$2,500 cars a year, but it has not come close to this level. The monthly unit peak was 10,012 in April 2011, but sales have fallen since then. In May 2012, sales of the Nano were 8,507 units, up by 31% on the 6,515 units sold in May 2011, but still way off target.

As well as production delays, there have been quality issues, including a number of Nanos catching fire in 2010, which further damaged the brand. The bigger problem seems to be the perception of Nano as a "poor man's car", and Tata is expected to "reboot" the Nano in the next year or so, adding more upmarket and sporty models, as well as electric versions and even a version that runs on compressed air, using a system developed by MDI of Luxembourg. Prototypes are currently being tested.

Whether Nano will recoup its costs is another matter. The plant relocation added vastly to the project's costs, and export sales to Western markets were delayed pending the construction of the Sanand plant, and a restyled Nano Euro version shown in 2009 at the Geneva Show has not reached production. Ratan Tata is on record as saying that Asia and

LEFT: Jaguar XJ Ultimate Edition was unveiled in Beijing



Ratan Tata with the Nano at the vehicle's launch

Africa will be the main focus for Tata brand in the next few years.

A European relaunch of the Tata brand had been built around a battery-electric version of the Indica Vista, though this project, developed by Tata's UK technology centre, has been cancelled. This has made any European relaunch look doubtful – the standard Indica Vista is sold in some markets, such as Spain, via independent importers, and Tata sells small UK-assembled electric vans in the UK, but the current state of the European economy is probably not ideal for the launch of an Indian budget brand. Export sales actually declined 24% in May 2012 to 4,219 vehicles from 5,534 vehicles in May 2011.

The problem is compounded by stagnant domestic sales in an increasingly competitive domestic market. Nano is the only model that is actually increasing sales year on year. Indica range sales fell 1% to 5,467 (against 5,497), while the Indigo four-door sedan fell 20% to 3,397 (4,268). Sales of Tata's Sumo, Safari, Aria and Venture SUVs were flat at 3,132 units in this month.

And in a further blow for Tata's Indian dealers, Fiat and Tata Motors are ending a distribution agreement under which Tata dealers have sold Fiat vehicles. Fiat is taking control of its

distribution, though a joint venture Fiat and Tata car plant at Ranjangaon near Pune will continue.

Tata's commercial vehicle operations remain strong. A new plant at Dharwad to make the Tata ACE Zip pick-up and the Tata Magic IRIS small minivan is now up and running. These low cost, utilitarian vehicles, launched in 2011, have been strong sellers in India, offering a better alternative to three-wheeler trucks and tuk-tuks.

It's possible that light commercial vehicles (LCVs) might offer a better start point for Tata as an exporter rather than cars, though margins are notoriously slim on such vehicles. And whatever niches exist for, say, cheap pick-ups or microvans in Western Europe are likely to be filled by Chinese automakers such as Great Wall or Dongfeng, both of which already sell such vehicles in the UK.

The focus is likely to remain on JLR, where a solid strategy seems to be in place and is clearly starting to deliver results – though a lot more investment is going to be needed if JLR is to become a "British BMW". But the Tata brand runs the risk of becoming an also-ran, even in India, unless an equally strong strategy can be devised. Over to you, Mr Mistry.

Author: Mark Bursa

Torque Control

Functional safety management of torque vectoring on the 414E



Virtual tests to support functional safety of a torque vectored electric vehicle

The powerful (1,000 Nm) torque vectoring driveline of the Lotus 414E has the potential to improve the vehicle's dynamic response and stability but also creates some potential hazards, for example, a fault in the system which generates incorrect torque on one or both rear wheels could disturb the vehicle's intended path.

This is one of many potential hazards identified by Lotus as part of the integration and development of the 414E functional safety control strategies.

What is functional safety?

Safe operation of the vehicle requires the hardware and system to be operating correctly in response to its inputs, including the safe response to hazards caused by the environment, driver, hardware or control system.

A safety function needs to be put in place (within the control systems) to address and mitigate each identified potential hazard. Functional safety is achieved when every identified safety hazard has a function in place and meets the level of performance required of it.

Lotus uses virtual and hardware in the loop (HiL) testing to identify, simulate and prove out the functional safety control systems, in advance and support of physical testing.

What is virtual testing?

Traditionally each engineering function group develops its own hardware and systems, and tests them in isolation. Integration and commissioning starts when the individual systems are connected in an engineering prototype car and only then can the vehicle development process start refining the performance and safety functions. This process is long and costly as some issues found during development may require new hardware to be built and then integrated into the engineering prototypes.

With a virtual testing process each function group contribute computer data models (as they are developed) of their components (e.g.

Simulink, C, Dymola or Simpack). These models are combined within a virtual workshop into virtual vehicles. This data modelling stage helps resolve cross functional issues much earlier, and as individual components are tested, refined and proven the virtual prototype vehicle can be continuously tested with the new components.

This process is known as model in the loop (MiL) testing and can be conducted entirely on a computer.

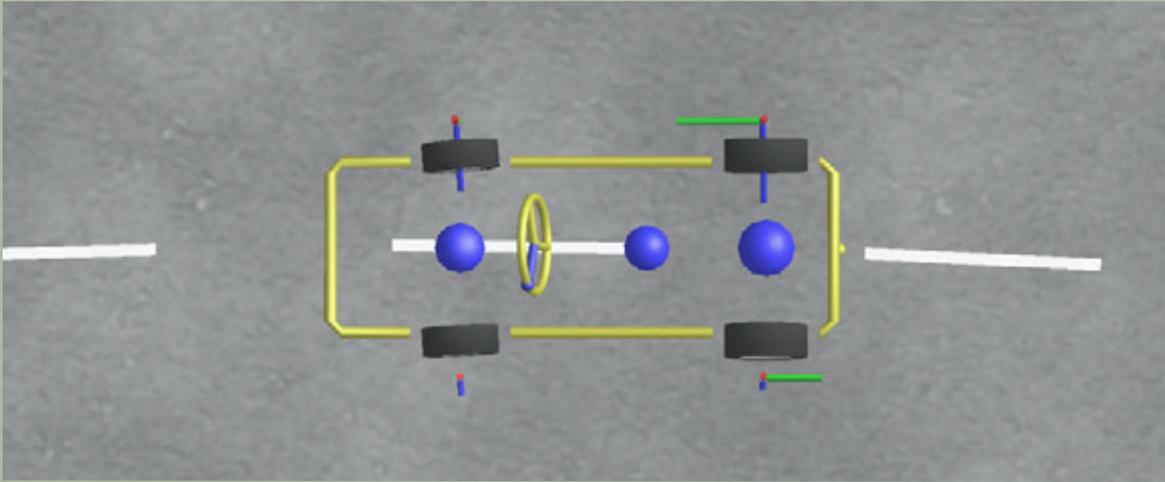
These virtual vehicles can then be simulated on virtual roads and circuits by both virtual and real drivers, bringing the test track to the desk of every engineer. This enables the vehicle control system development to progress before building the first prototype vehicle.

This parallel process not only shortens the development time and results in a more robust solution, it can identify design changes early enough to be incorporated in the final release.

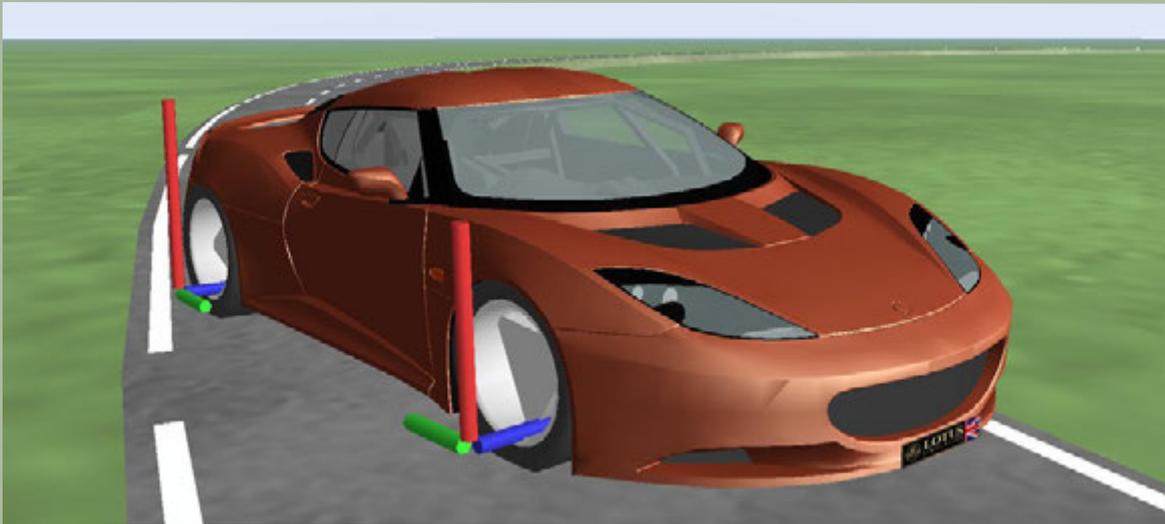
Any industry standard test like lane change, real driving route or bespoke manoeuvre can be simulated and any particular hazard can be programmed to occur during these tests to see how the system reacts. Even extreme tests, not feasible or safe for the real vehicle can be carried out in the virtual environment, and thousands of tests, varying vehicle or test parameters, can be carried out in hours and repeatedly re-run as required.

The raw data models have to be compiled (effectively compressed) for use in the production ECUs (electronic control units). Electrical interfaces can then link the physical ECUs to the virtual vehicle model and in this way the real hardware can be used as part of the virtual vehicle simulation as if it was being driven in a real vehicle.

This is known as hardware in the loop (HiL) and is another important part of the Lotus virtual testing toolbox.



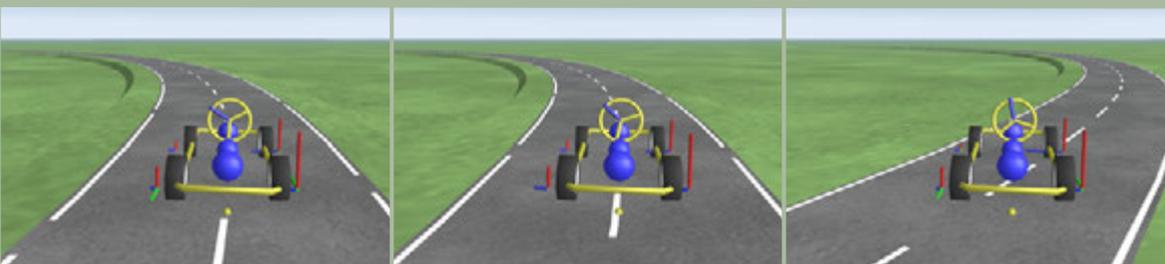
Forces are shown by the coloured bars, displaying direction and magnitude. In this case a simulated fault creates undemanded drive torque to one wheel and retarding torque to the other



Example of oversteer in virtual testing (due to excessive yaw)



Vehicle fails test by leaving the road due to understeer



Images shows vehicle with no fault (left), with undemanded torque to one wheel but with Lotus safety system in place (middle), and same fault but with the safety system switched off (right)

Virtual testing on the 414E

The software toolbox we use is based on the IPG CarMaker software system which provides a flexible platform for building the vehicle with roads, manoeuvres, a driver model and automated test manager.

In addition to the data models supplied with the software, any additional models can be added (e.g. a vehicle dynamic control system) or can be substituted by another model (e.g. a bespoke powertrain model).

This is complemented by the HiL system in which the 414E controllers “in the Loop” operate exactly as they would do in the real car, thus testing both the code and communications between controllers.

To support early development of algorithms, both on the bench and later in the first prototypes, Lotus uses a very powerful ‘rapid prototyping’ system allowing the control algorithms still in their raw data model form to control the vehicle. This speeds up both development of the algorithm and early prototype development as modifications can be incorporated “on the fly” by the test engineers.

Functional Safety of the 414E

Each rear wheel of the 414E is separately driven by powerful axial flux electric motors. This gives the opportunity for controlled torque vectoring to enhance the vehicle’s agility and stability, but presents some potential hazards and control challenges for the four Lotus ECUs. Lotus identified potential hazards and driving situations, with associated ASIL (automotive safety integrity level) functional safety ratings for the 414E vehicle applicable to its restricted use on the test track by skilled drivers.

Pass/fail criteria similar to those used in developing ESC (electronic stability control) were agreed, principally being a large change in yaw rate which the driver would find difficult to control and hazards where the driver would not be able keep the vehicle in lane.

Methods to identify when faults occur, and strategies to mitigate their effects on the vehicle, were developed and programmed.

Virtual test routines to establish effectiveness of mitigation were run to simulate these hazards and evaluate the effectiveness of these strategies.

There are numerous variables that need

to be tested, these included Lotus mitigation switched on or off, ESP on or off, different speeds and road friction levels, straight line, curves of different radii and open and closed loop virtual drivers.

The open loop driver gives no or minimal steering correction whereas the closed loop driver simulates a typical skilled driver attempting to maintain control. Depending on the system speed of response, the driver can sometimes make the situation worse.

For the 414E, virtual testing involved 61 automated scenarios resulting in a total of over 2,700 test runs. The fidelity, plausibility and calibration of each of the data models is correlated as far as possible, using real world testing on the Lotus track and in Lotus test laboratories. Test manoeuvres and pass criteria were automated allowing rapid and repeatable testing. Log files recorded key data from each test. The Status of the test (passed, failed or aborted) is automatically reported in a “traffic light” system.

To further improve interpretation of the tests the logged data was used to populate a matrix which quickly showed not only if there was a the failure to meet the criteria, but which criteria failed and its severity.

As development progresses

Lotus virtual testing can help integrate systems, develop the potential effectiveness of mitigation strategies and help pre-empt cross system conflicts ahead of prototype running for safer and quicker vehicle development.

The 414E program is now carrying out dynamic and durability testing with a prototype vehicle, incorporating the functional safety control strategies developed using virtual and HiL testing.

Virtual testing helped to define the testing schedule for the real vehicle and virtual testing continues to run in parallel with the 414E development, as the data models are refined with feedback from the real-world data to help improve its not only the functional safety but also performance and economy.

Authors: Richard Hurdwell and James Waters

Powering Ahead

Adaptive energy management on the Evora 414E Hybrid

An important factor in hybrid vehicle ownership is the running cost, Lotus Engineering has been working on a cost-based adaptive energy-management control strategy for the 414E



Introduction

The series-hybrid powertrain architecture on the Evora 414E Hybrid allows some interesting optimisation work to be performed, giving the vehicle an ability to minimise its own fuel consumption in response to electrical vehicle power demands.

To manage energy

flow between the battery, range-extender and vehicle loads, an adaptive energy management technique has been developed where the arbitration of power flow is derived by evaluating an instantaneous “fuel equivalent cost” of the range-extender and battery.

The energy manager calculates the average vehicle power demand

over a series of trailing time windows and evaluates instantaneous cost functions before determining the feed forward range extender operating point.

The aim of the energy management system (EMS) is to determine and apply the best ratio of engine-to-battery power, in order to minimise fuel consumption. The EMS must consider a

number of different engine powers in order to form a comparison and decide on the optimal powertrain state. Options of engine power are formalised as average vehicle power demands, calculated across trailing time windows of 1-20 seconds, as well as the instantaneous power demand.

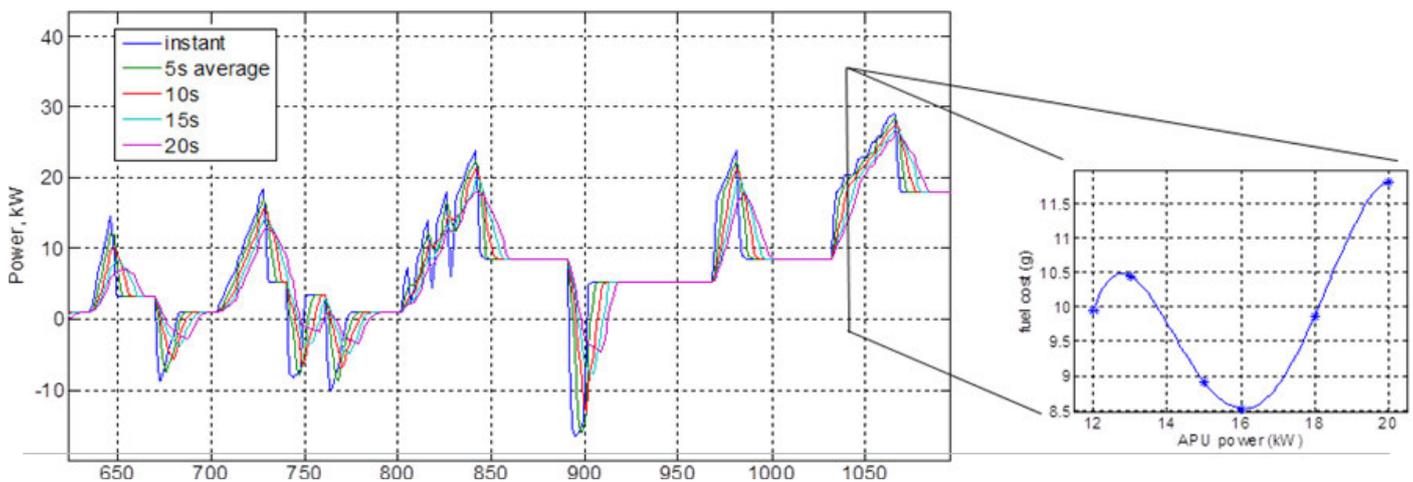


Figure 1. Trailing Window Average Power Demands

Vehicle power demand is measured directly from the DC bus that delivers energy to every part of the vehicle system. Measuring total power demand this way ensures that the EMS not only optimises road loads, but additionally the auxiliary loads demanded by the

complete vehicle system.

Figure 1 shows trailing-average power demands with time over a section of the NEDC drivecycle. At each time step, the EMS takes a vertical slice through the trailing-average ribbons and evaluates the cost of running the engine

at the power level stored in each average buffer. If the average power stored in the buffer is not equal to the instantaneous vehicle demand, a voltage difference in the circuit will cause the battery to passively absorb or dissipate energy, so the DC bus

always delivers the exact power that the vehicle requires.

The combination of engine and battery power corresponding to minimal fuel consumption is then applied in a feed-forward control approach.

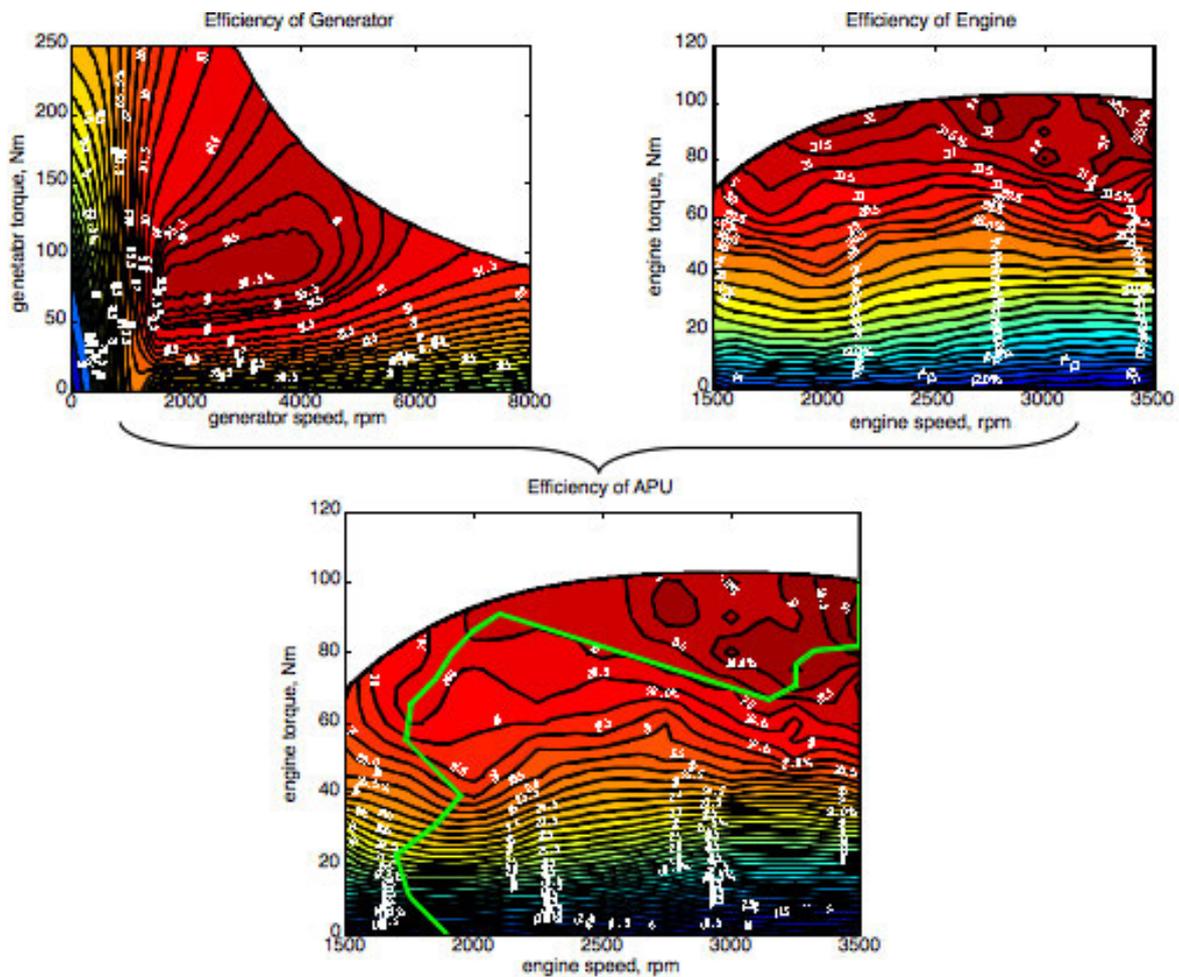


Figure 2. Optimal APU Operating Locus (Best Fuel for Power)

Engine Cost

Because the range-extender engine is not mechanically coupled to the driven wheels in the series-hybrid architecture, its speed & torque does not have to be correlated with the speed & torque

required by the driven wheels.

Instead, we can operate the range-extender over the speed-torque locus that results in minimum fuel-burn per unit of energy. This is found by combining the efficiency maps of the

engine and generator, and tracing power contours until a maximum efficiency point is found for that specific power output.

The fuel-equivalent cost of the auxiliary power unit (APU) power is calculated from the efficiency map in

Figure 2 and the calorific value of the fuel. A transient correction factor is included to account for extra fuel consumption during transient power demands.

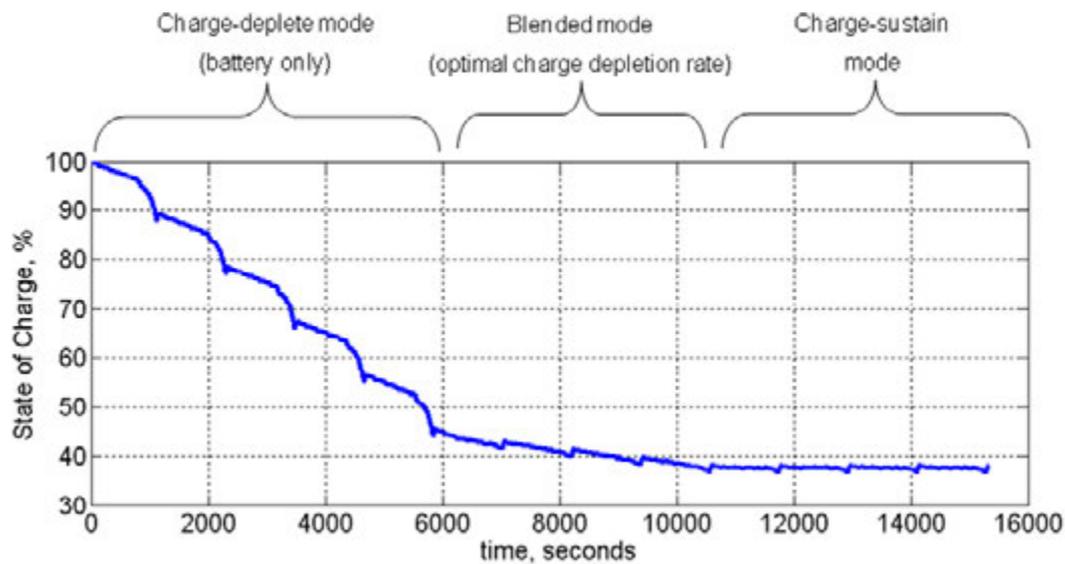


Figure 3. SoC Trajectory Over Repeated NEDC Cycles

Battery Cost

The cost of applying battery power is evaluated in terms of fuel used to charge the battery, as well as efficiency losses from the battery internal resistance (ohmic resistance).

At an instance when the battery may be charged completely or partially from the excess range-extender power, the portion of fuel being used to charge the battery is amplified by the efficiency loss while the battery is charging, and again by a predicted loss for when that energy is drawn out of the battery later on.

Ohmic-resistance losses are proportional to the rate of power draw from the battery. Because we don't know the rate at which the battery will be depleted in the future, we project an average battery power draw, accumulated from the beginning of every trip.

As we reset the average

battery draw value at the beginning of every trip, the system reliably optimises over varying driver behaviour - if you're driving particularly aggressively one day, the system responds to power demand over a short time horizon and is not tuned with a single set of fixed parameters that capture the "average" driver behaviour. This gives a more adaptive, locally-relevant optimisation than conventional approaches. The fact the overwhelming majority of trips are initiated when state of charge (SoC) is high enough to facilitate electric-only operation also means that the driver behaviour is usually captured adequately by the system before the APU is engaged. This negates a lengthy "learning" period initiating when the range-extender turns on for the first time in a trip.

In the instance of a battery discharge event,

the amount of fuel used to charge the battery up to this point is known, so the round-trip efficiency of energy from fuel used in the battery cycle is based on a total knowledge, and prediction of future parameters are not required as in the battery-charging case.

Battery discharge is scaled by a term, δ , which is the fraction of all energy stored in the battery at any time that has been provided by the range-extender engine, i.e. from the combustion of fuel.

If the battery contained only energy that has been provided by grid-electricity during a plug-in charge, δ would equal zero.

Throughout a long drive, the engine will top-up the battery and δ will increase. As this happens, the perceived fuel-equivalent cost of discharging the battery will also increase. As a result, the rate of battery

discharge that the energy management system deems to be optimal will decrease, and the battery will eventually reach a stable state-of-charge, where the perceived cost of charging is roughly equivalent to the cost of discharging.

Many other systems scale the battery cost based on how far the current battery state-of-charge is from a predetermined target, where battery cost is perceived as a negative quantity when SoC is above this target. We choose to use the fuel-portion δ instead, as it consistently provides a cost which is relevant to the variable we are aiming to minimise, i.e. fuel consumption.

We aim for a target SoC to be maintained in charge-sustaining operation, although the system will allow the battery to deplete further if the global cost function shows it is optimal to do so. The

battery is also allowed to discharge in accordance with the instantaneous kinetic energy of the vehicle, because we know that when the vehicle decelerates, generally a consistent amount of energy will be recuperated (regenerative or regen

braking). We observe a fluctuation of about 2-3% in battery state of charge over a single charge sustaining cycle.

Physical hard-limits are enforced in the controller too and these are based on empirical data from either the cell manufacturer

or independent test houses. Each cell has to be operated within certain parameters, for example Voltage. If the voltage of a cell is allowed to drop too far, an irreversible chemical reaction takes place, and it may not be possible to charge the cell

ever again. Depending on how the battery pack is designed and constructed, this renders the pack at the very least ineffective and possibly unusable without cell replacement.

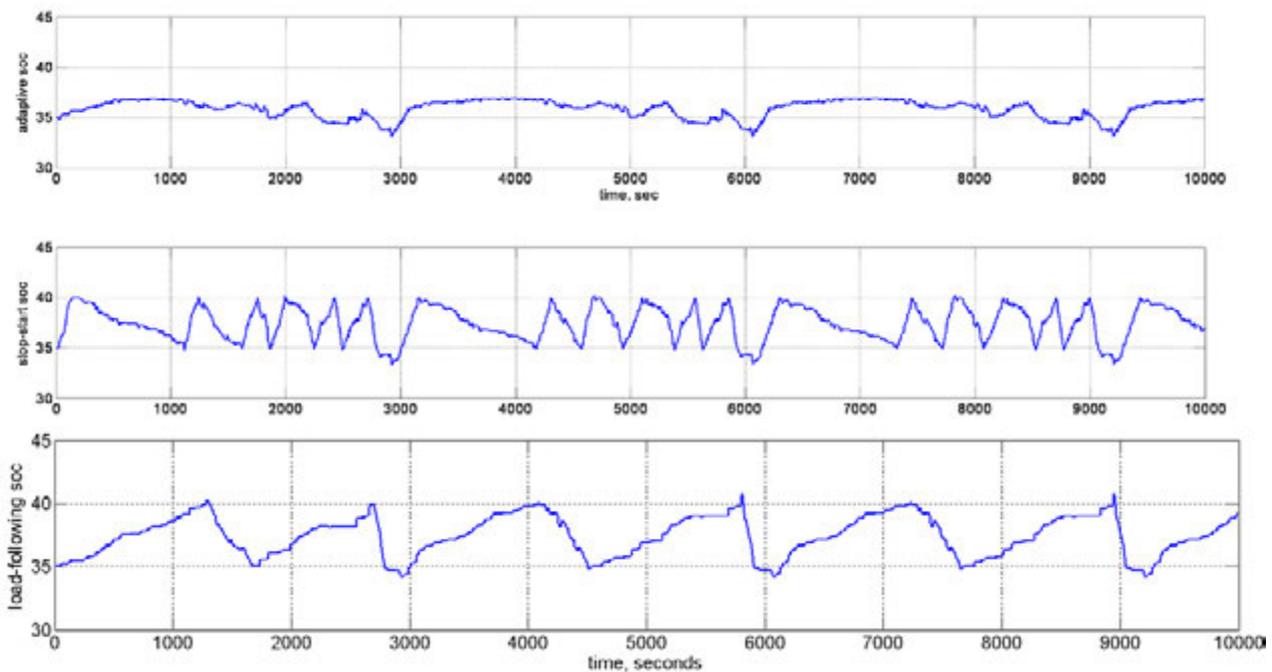


Figure 4. SoC Trajectory for Three Charge-sustaining Strategies

Comparison with other systems

To highlight the benefits of the new adaptive energy management system, we can compare performance to that provided by a simple stop-start strategy and a load-following strategy.

In the stop-start strategy, the APU runs at a fixed point - its peak efficiency load-point (which usually does not correspond with peak battery charge

efficiency), charging the battery until an upper threshold SoC is reached. Once the battery is sufficiently charged, the APU powers off and the vehicle runs on the battery alone until a lower threshold SoC is achieved, and the process repeats.

This results in the battery SoC following an aggressive, fast acting saw tooth shaped cycle with time.

The load following strategy runs the APU at

a power level equal to the instantaneous powertrain demand. The battery charges up gradually as regenerative braking energy is accumulated until an upper threshold SoC is reached, at which point the APU powers off and the battery is used down to a lower threshold. The cycle repeats less frequently than with the stop-start strategy, but the large swings in battery state of charge are still prominent in the graph,

see Figure 4.

The SoC trace produced by the Lotus adaptive EMS has a more gentle flowing nature and shows smaller swings in SoC with time. The EMS carved out its own SoC trajectory based on the most efficient action of the options posed to it, and it is a coincidence that this SoC profile causes less degradation to the battery. This is not to be overlooked as one of the largest perceived

issues to the consumer is battery lifetime. Battery degradation operates on a similar principle to mechanical fatigue, where a small number of low-magnitude cycles cause

less damage than large number of high-magnitude swings. The degradation manifests itself as a reduction in capacity and the automotive industry has defined a battery as being

not fit for purpose when the capacity has degraded to 80% of its value when new. At this point, the battery is still useable and there will become a time when there is an industry

of 'second use' batteries, where they are removed from vehicles and used, for example as stationary energy storage.

NEDC	Weighted CO ₂ (g/km)	Adaptive advantage
Adaptive EMS	38.5	
Load Following	51.1	24.66%
Stop-start	38.4	-0.26%

ARTEMIS	Weighted CO ₂ (g/km)	Adaptive advantage
Adaptive EMS	52.9	
Load Following	57.6	8.16%
Stop-start	54.6	3.11%

Table I. Weighted CO₂ Emissions for Different Strategies

Performance of the adaptive energy management system, in terms of fuel consumption and linearly-related CO₂ emissions are impressive when compared to performance of the stop-start and load-following methods.

The adaptive system used 0.26% more fuel than the stop-start system on a simulated NEDC drivecycle as shown in Table I. On inspection of Figure 5, we can see that CO₂ accumulates rapidly with a stop-start strategy during battery-charging, and then descends during the battery-discharge. As a consequence, it is possible for total CO₂ to be low at the end of a trip with a stop-start

controller, although there is an element of luck involved - the stop-start parameters are non-adaptive and hence the end state is not controllable. It is, infact, more likely that a trip utilising the stop-start controller will end with a very high CO₂ output and a battery having more energy stored in it than it had at the beginning of the trip. The adaptive method, however, provides consistently optimal fuel consumption and emissions.

When weighted with statistical distributions of trip distances, the probability of the adaptive system burning less fuel than the stop-start system is greater than 98%. This is because the adaptive system is favourable over

shorter trip durations and short trips are far more frequent than very long trips.

Authors: Adam Chapman and Phil Barker

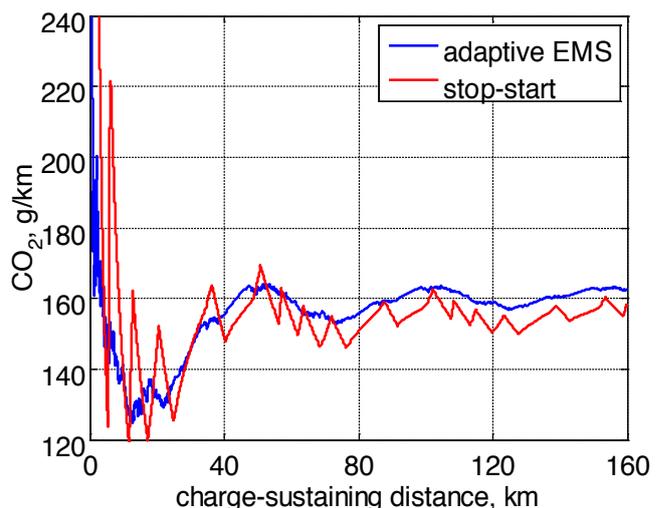


Figure 5. Comparison of Stop-start and Adaptive CO₂ Emissions



David Hewitt

Dave Leggett interviews Lotus' Operations Director

David Hewitt is tasked with directing the manufacturing operations of Lotus, ensuring that Lotus Cars is able to build cars for its customers around the world

DL: What's on your mind and occupying your time right now?

DH: Two things stand out. Firstly, there's the whole question of our production activity – it's a constant. We're very much in full swing at the moment in terms of building cars. It's about costs, quality, time...making sure we have got the right product coming out of the door; making sure we're delivering the right levels of quality and continuing to try and improve that, making sure we are doing it on time... and just generally making sure that the machine keeps pumping out the cars that it needs to. It is never straightforward, never easy. Huge amounts of time can be spent sorting

out relatively minor issues but issues that are important to getting cars out the door. It's a major challenge.

A second challenge for me is that we are in the final stages of finishing our preparation to launch Exige S into production. So we're making sure everything is in place to ensure the smooth introduction of that product without causing pain to any of our other existing product lines. That's keeping a lot of people's attentions focused right now and there's a lot of excitement around the site connected with that.

DL: Just on the day-to-day of keeping the production lines running, are there recurring types of issue for you to deal with?

DH: For the current models – Evora and Elise – production issues are pretty much 'wrinkled out', but there's always room for improvement in terms of trimming time or finessing the quality. Generally speaking though, in terms of putting those cars down the line and assembling them, we're pretty much there in terms of knowing what to do and how to maximise the resource we have available. Examples of unexpected problems would include things like a critical plant failure. We had one recently that took us down for a couple of hours and it was all hands to the pump to get that rectified.

Supplier issues? Generally speaking our suppliers are pretty good but there's always going to be that supplier who puts the wrong part in the box or goes back to a previous level of part rather than the current one, or has an unforeseen problem themselves. Those kinds of things can come along and trip you up and however good your systems and processes are, some will slip through and that's when action needs to be taken.

DL: How many vehicles does Lotus produce annually and what's the model-mix?

DH: This year we're looking at producing just over 2,000 vehicles. In terms of the split by model, currently we're 50% 'large car' – by large we mean Evora - and 50% 'small car', which is split evenly between Elise and Exige.

DL: And how many people are employed actually making Lotus cars?

DH: It's around 300 what I call 'direct overhead' and wrapped around that are the supply chain and logistics functions which we couldn't build the car without, but they are not classified under the direct overhead.

DL: And how do you calibrate skill levels to your manufacturing needs?

DH: The vast majority of that 300 are skilled assembly workers who have been with the company for a significant number of years. Many are highly skilled, very loyal, have worked in a number of different areas – they have amassed invaluable experience. The manual element

for us is quite high and there is very little automation and we have moved to single line, so the skills and flexibility for the operators are very important. Each operator can be working on six different product lines at any one time, so a high level of training is provided by us and they have to have a high level of skill and capability.

Within the manufacturing function we also have manufacturing and production engineers who are specialists in looking at things like process and manufacturability issues.

DL: Do you have any difficulties in the area of recruitment? Are there certain types of engineers, for example, that are difficult to find?

DH: The simple answer is yes, for certain disciplines. Take the example of a welder. We need welders for our fabrication operations and this isn't an area that has a massive population of welders and we're competing with the offshore energy industry which is close by and wants welders for offshore rigs.

So yes, there are some shortages. If we're looking for people with the right willingness and enthusiasm, then getting general operatives that we can train up isn't normally an issue. If we're looking for people that have a specific skill – for example, trimming or painting – then that can be difficult.

The good thing for us at Lotus is that once we have got people, they tend to stay with us for a long time.

DL: I'm interested in how manufacturing works in a low-volume automotive context. Can you describe the basics of the Lotus Cars manufacturing set-up?

DH: The obvious thing is that it is manually intense with very little automation. In terms of the direct car build, the process starts with the assembly of the engine into the front and rear modules which are built at Lotus Lightweight Structures at Worcester. The car starts life being pushed around on a trolley and ends its manufacturing life by being taken off the trolley and pushed around on its own wheels.

The car develops and matures as it comes through the system based on individuals in locations working on a vehicle and the vehicle being hand-pushed from station to station. It almost replicates an automated production line



David Hewitt and COO Aslam Farikullah with the first production Exige S chassis loaded on to the assembly line

but with the automated activities taken away and the track that pulls the line along also removed. It's a kind of hybrid way of operating. It's not what I call 'cottage industry' where you have a car in a location built up from a bag of nuts. We have a production flow, but it's a flow driven by people and the steps within that flow are all operated by people.

Added to that we have a paint shop on site, a trim shop on site – so we create a lot of our own trim here.

DL: And it's a process that has been refined over time to be as efficient as possible given the volumes you are building and the level of craftsmanship that comes with the high manual element?

DH: Absolutely. And given that's how we operate and given that a car will be at a station for between 30 minutes and 50 minutes, we're expecting individuals to be able to work for up to 50 minutes on anything from an Elise to an Exige, to an Evora, automatic and manual examples thereof. We clearly need to have very highly skilled individuals.

DL: How do shifts work?

DH: We operate one shift throughout the plant. We do have the option of twilight shifts in some bottleneck areas but that is very much on a needs basis.

DL: Where are the main components for the cars coming from?

DH: Near and far. Engines, for example, are coming from Toyota (Elise engines from Deeside, UK; Evora engines from Japan).

Body panels are composite and they are currently coming from France and the UK. We have two or three main suppliers.

There are also significant German suppliers and we have a number of suppliers in the local area (small parts and fixtures and fittings typically come from the Norwich area).

Aluminium extrusions come from Lotus Lightweight Structures – part of the family – based in Worcester.

It's a real global gathering, but a lot does come from the immediate area.

DL: Do you hold significant stocks of parts? How lean is your manufacturing?

DH: We try, where we can and where it makes sense, to emulate just-in-time models. No matter how big or small you are, holding stock costs money. We try to minimise our stock and bring it in just-in-time and we have daily 'milk runs' across the UK and Europe to bring parts to the line immediately. It's a challenge – there can be freak weather, ferry delays and so on. That's a constant challenge.

Clearly, when we are talking about engines coming across from Japan, that creates a slightly different challenge and on things like that we can bring in more stock, whereas a local supplier who is machining parts for us might be on a scale of hours rather than days.

The business model we try to operate is bring the parts in as close to production time as possible.

DL: Are you seeing your costs hit by external factors outside of your control such as exchange rates and rising prices of some raw materials?

DH: These things can vary on a daily/weekly/monthly basis. Do I get a sense of whether we are net-up or net-down? Probably net-up and I would say I have got a very good purchasing team who seem to be able to continually perform magic and keep our costs at a relatively stable base. They seem to be able to manage it fairly effectively.

DL: How much manufacturing does Lotus do for third parties these days?

DH: We manufacture for a number of OEMs through Lotus Lightweight Structures (LLS) and we also manufacture through our ASO (aftersales organisation) for a number of parties who we have previously built cars for (examples include the GM Speedster, Tesla Roadster, and the old Aston Martin Vanquish). There's a requirement to meet their aftersales organisations with products for those vehicles. LLS is slightly different in that it specialises in extruded aluminium, bonded aluminium and they have a number of OEMs for who they supply parts directly.

DL: I understand you've been quite involved with the 'Make it in Great Britain' campaign. What's that all about and what's the extent of your involvement?

It has been something that has gathered pace through the course of this year. I was very pleased to be nominated as an 'industry champion' back in February. The UK government is very much wanting to highlight the manufacturing capability of the UK, especially with this year with the Jubilee and the London Olympics, so the spotlight is very much on UK plc.

It's an opportunity to shout about UK manufacturing and Lotus is an example of something that we should be shouting about. We are a UK manufacturer, we support a fairly substantial UK supply base and we deliver products of which Britain should be very proud.

What does it entail for me? There was a kick-off event in London in February and then there has been a lot of regional and trade interest, interviews for trade magazines and the local press here in Norfolk. We've also gone down the route of using this as a springboard for promoting manufacturing in local schools and colleges. The University Technical College (UTC) in Norwich, for example, is an institution that we work very closely with. They've just been awarded Technical College status [these are very much linked to industry] and we were very much involved in that and used the Make it in Great Britain campaign to support and champion their activities.

DL: Is there much benefit for Lotus in this?

DH: Oh yes, massive. Going back to the recruitment issue, we want to be able to cherry pick what comes out of the other end of the UTC. And we run our own vocational courses here which can link into local colleges. This can help us grow and nurture the right kind of talent that we will need in the future at Lotus – engineers, designers, manufacturers and managers.

The first
Exige S comes off
the production line



DL: What inspires you, gives you a kick?

DH: For as long as I remember I have been passionate about cars. What gets me out of bed in the morning? First and foremost, I get to work with exciting sports cars. We could be manufacturing tins of beans or washing lines, but we get to manufacture on a daily basis, nice shiny, expensive sports cars. I find that incredibly stimulating, interesting and exciting.

The fact that I also get to do that working alongside people who are incredibly passionate,

motivated and enthusiastic makes life even better.

One thing I say to people is that I can be having the most miserable of days and then I take a walk into the plant, and ten minutes watching the production line flow and cars coming off at the other end is enough to turn a dire day into a happy day, every time.



David Hewitt

Having trained as an engineer, David started life working for a British engineering firm in Cheshire prior to joining the automotive industry.

Career highlights include senior management positions and continuous improvement (in Six Sigma/Lean Manufacturing) leadership at Volvo Cars, Vodafone and Lotus Cars Ltd.

David is representing the Government's 'Make it in Great Britain' initiative as an Industry Champion. He has a passion for supporting British manufacturing.

UK: JLR INCREASES SPEND WITH LOCAL SUPPLIERS

Jaguar Land Rover, the UK luxury car unit of Tata Motors, is to spend an additional GBP1bn (US\$1.6bn) with UK suppliers over the next four years as demand for the Range Rover Evoque continues to grow around the world.

JLR has already increased the value of UK supply contracts by GBP1bn, in addition to the GBP2bn (US\$3.2bn) supply contracts it awarded to over 40 suppliers here in March 2011. These suppliers provide components, facilities and services for Evoque production at the former Ford and Jaguar plant at Halewood, near Liverpool.

JLR also confirmed that a new logistics facility in Ellesmere Port, Cheshire [also home to Vauxhall's Astra plant], will open this summer to support the sales success of both the Evoque and Land Rover Freelander 2.

US: 3M EYES GROWTH IN ADHESIVES FOR BIW BONDING

Adhesives specialists at 3M believe there is a growing market for the use of adhesives for bonding in automotive body structures, citing several advantages over conventional spot-welding. As well as weight reduction and improvements to stiffness, 3M says that growing process robustness can simplify manufacturing especially as more assembly is conducted off-line and before paint.

Abs Master, a business development manager with 3M's Automotive Adhesives business, told just-auto that adhesives are becoming increasingly important as vehicle manufacturers explore lighter materials.

"Many lighter weight materials require specialist adhesives to bond them together," said Master. *"The latest generation is perfectly suited to Body-in-White bonding requirements. And interest from the auto industry is growing around the world as vehicle manufacturers come under increasing pressures to reduce fuel*

consumption and lower CO₂ emissions."

The clever innovation that can reduce vehicle weight is the ability to join thinner gauge – and lighter – materials with adhesives than is possible with spot-welding and maintain body stiffness. 3M is focussing its R&D on techniques that allow this to be accomplished alongside improvements in process efficiency and robustness.

CHINA: BYD 6B DEBUTS WITH IN-DASH SPEAKING ROBOT

BYD has launched the 6B, the replacement for the F3. The Civic-sized sedan features several innovations, one of which is a speaking robot that rises out of the dashboard.

The new car was seen earlier this year at the Beijing motor show, badged as the F3 Plus concept. This pre-production model looked all but identical to the new 6B.

BYD is launching a telematics software package with the 6B. The car's so-called 'i-system' can reportedly be used in conjunction with a smartphone to locate the car, as well as lock or unlock it. The company notes that the driver can also 'use the embedded terminal equipment to download or upgrade applications and music in the BYD application store'. Further, a small robot, which sits atop the dashboard, will reportedly read out news headlines or other relevant, requested information.

US: AI23 SYSTEMS CLAIMS LI-ION TECHNOLOGY LEAP

AI23 Systems, recently troubled by a recall of Fisker Karma battery packs, is claiming a breakthrough development enabling lithium ion batteries to operate at extreme temperatures without a cooling system.

The technology is called Nanophosphate EXT and was designed 'to significantly reduce or eliminate the need for heating or cooling systems'.

"We believe Nanophosphate EXT is a game-changing breakthrough that overcomes one of the key limitations of lead acid, standard lithium ion and other advanced batteries. By delivering high power, energy and cycle life capabilities over a wider temperature range, we believe [it] can reduce or even eliminate the need for costly thermal management systems which we expect will dramatically enhance the business case for deploying [our] lithium ion battery solutions for a significant number of applications," said AI23's CEO David Vieau.

He added the supplier would offer the technology to existing customers and look for new applications *"that previously were not possible to cost-effectively serve with lithium ion batteries"*.

US: SAIC UNVEILS NEW NORTH AMERICAN OPERATIONS CENTRE

Shanghai Automotive Industries Corporation USA (SAIC USA) has unveiled its new North American Operations Centre in Birmingham. The new centre is an SAIC hub for purchasing, international logistics and design engineering.

The company said that it marked 'an important step in creating a stronger connection between the US and Chinese automotive industries'.

With the increasing importance of cooperation between the major global automotive markets, this move by SAIC to strengthen its US presence is significant, SAIC said in a statement.

SAIC said that the 'the totally refurbished' 30,000 square foot three story SAIC USA Building in the Detroit suburb of Birmingham, MI will eventually house nearly 100 people and will focus on three main areas of SAIC USA's automotive business: purchasing; logistics and technology; and engineering (design, engineering and quality control for development and production of vehicle parts and components).



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Official fuel consumption in mpg (l/100km), Lotus Exige S: Urban 19.5 (14.5), Extra Urban 37.2 (7.6), Combined 28.0 (10.1). CO₂ emissions: 236 g/km. Lotus Elise S: Urban 27.3 (10.3), Extra Urban 47.6 (5.9), Combined 37.5 (7.5). CO₂ emissions: 175 g/km.