proActive

ISSUE 46 - AUTUMN 2012

GETTING CONNECTED

Between the personal and automotive world

WINTER TYRES

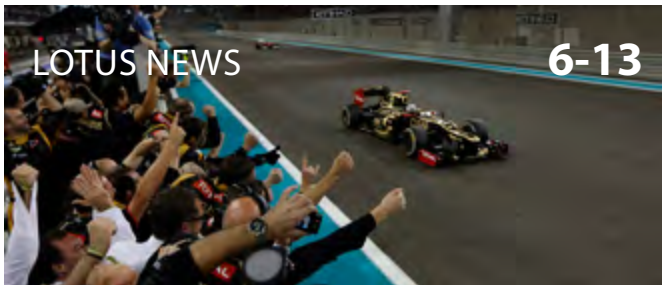
Benefits and compromises

SERIES HYBRIDS

The case for range extended electric vehicles

LOTUSCARS.COM

CO_2 emissions: 175 g/km.



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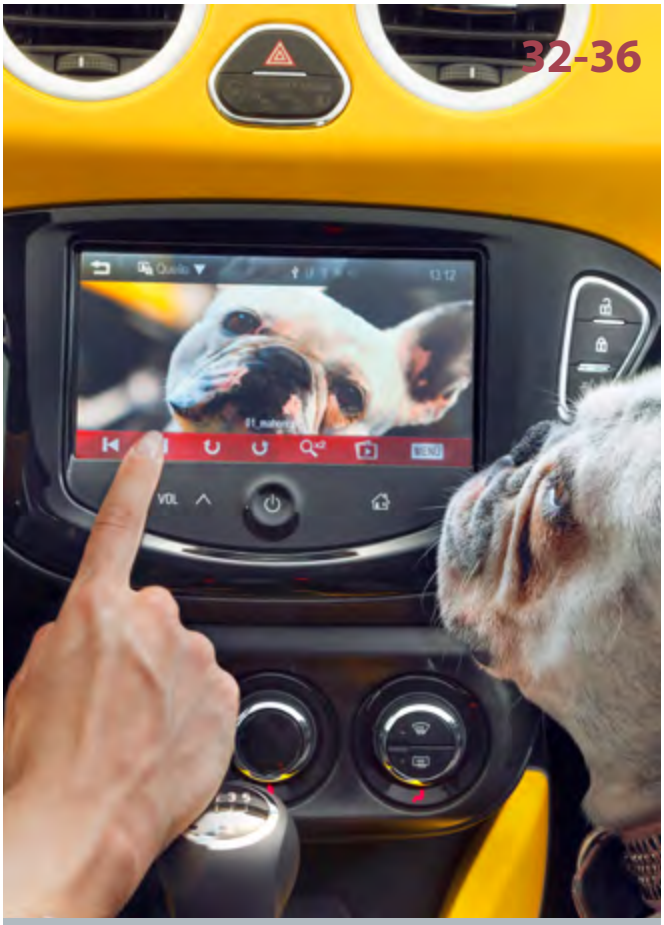

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Lotus News

"Leave me alone! I know what I'm doing!"

Kimi Räikkönen

Lotus F1 Team win Abu Dhabi Grand Prix

Kimi Räikkönen has taken his 19th Grand Prix victory, the 48th win for an Enstone team and the 80th win for the Lotus brand. It is the first Grand Prix win for then Lotus F1 Team and the first for a Lotus F1 car since 1987 when Ayrton Senna won the Detroit Grand Prix driving the Lotus 99T. Kimi made an excellent start to take second place at the start from fourth on the grid, then capitalised when Lewis Hamilton's McLaren retired.

Kimi maintains third position in the Drivers' Championship on 198 points; 47 shy of Fernando Alonso and an increased 31 ahead of Mark Webber. The team remains fourth in the Constructors' Championship on 288 points; a reduced 30 behind McLaren and an increased 152 in front of Mercedes.

Kimi Räikkönen: "*I'm very happy for the team, and for myself also. You never know what's going to happen during the race; the safety cars made it quite tricky, but I've had similar races many, many times this year. Today we had a clear circuit to be able to use our speed. Perhaps we were not the fastest at the end, but we were quick enough and consistent enough to win so it's great for the team. We've had some difficult races in the second half of the season so it's fantastic to come back with a win.*"

Eric Boullier, Team Principal "*I have one word first of all: Great. Then there are many words such as 'relief' and 'deserved'. It's obviously a very well deserved result for the team. I'm pleased for Kimi and he did a very good job. We've been pushing very hard all season and we've nearly had it before. There's a little frustration not to have had a win sooner, and we have been waiting for it, but it's a fantastic feeling to finally take that victory and a superb reward for the team. It's great for Formula 1, it's great for Kimi and it's great for our team.*"


PIRELLI
UBS
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LOTUS

Lotus Exige S voted joint winner of evo's Car of the Year award 2012

It is with great pride that Lotus announces its success in securing the top honour from evo magazine's gruelling 'Car of the Year' test, marking the huge achievement of the entire Lotus workforce to bring to life the hotly anticipated Exige S.

Since the Evora (previous evo COTY winner itself) was launched in 2009 the question resonated, *"when are you going to put that 3.5 litre V6 in an Exige?"* the appetite for power on a lightweight platform was huge and this is pure Lotus territory. So, with the S2 Exige reaching the end of its lifecycle and the demand for its successor high, the challenge was set, a task force was assembled and work started to create the most exhilarating road car in Lotus history – and that is some benchmark to set ourselves!

Exotic designs were drawn, clever architecture and engineering strategies were forged and dynamic mule cars soon started testing. It wasn't long before the covers came off the prototype at the Frankfurt motorshow in 2011 and the Exige S graced the world with its presence. The new Lotus was heralded as a thing of beauty and since that day the phones at Lotus have not stopped ringing with eager prospects and journalists desperate for a drive!

Now, with an army of valued customers in tow and extensive road tests under its belt, the supercharged 3.5 V6 Exige S realises its destiny! Weighing in at 1,176 kg, capable of reaching 62 mph from standing in 4 seconds and with a power to weight ratio of 293 bhp/ton, brimming with 400 Nm (295 lb/ft) of torque the Exige S really is something special! Scrutinised by Evo's panel of experts and pitted against the best offerings to the sportscar market this year, the Exige S ties with the Pagani Huayra for first place in the toughest test in the industry.

Battling against nine opposing candidates to make the top six selection in a high octane shoot-out on road and track, and then taking on the giants in the final round on some of Scotland's finest driving roads, this couldn't be a more exciting win for the *"gorgeous Exige S"*.

Richard Meaden,
motoring guru
and evo

contributing editor remarked on the Exige S *"I adore its looks, its presence. It's like a little shrunk-down, condensed, distilled supercar. And I love the fact that when you're on the road and going for it, it just takes off."*

The evo team clearly felt the spirit of the Exige S, and in turn waxed lyrical about its attributes. Lotus is incredibly proud of the Exige S, and even though the calibre of this year's competition was immense, it could not top the Exige S.

The Alpina B3 GT3, Toyota GT86, Mercedes C63 AMG Black and Morgan 3 Wheeler were also entered, but were eliminated in the first round.

For the GBP 52,900 Exige S to tie with the GBP 820,000 Pagani is a massive accolade and illustrates just what amazing value for fun the Lotus powerhouse delivers.

So, the Exige S really is as good as it looks!

"I adore its looks, its presence. It's like a little shrunk-down, condensed, distilled supercar. And I love the fact that when you're on the road and going for it, it just takes off."

Richard Meadon - contributing editor, evo magazine

British team in a British Car win British championship

A championship victory for Evora GTC and the Bullrun team. Having already secured the Class Honours at Brands Hatch back in August 2012 all efforts over the past few weeks have been focussed on ensuring that they brought home the overall title as well.

Despite an unscheduled stop to rectify a small electrical issue, the 4 hour night race ended with Richard Adams bringing the car across the line to record an overall Championship victory by 3 points.

This latest triumph makes Bullrun the most successful team in Britcar history, adding the 2012 GT Championship to the Production Championship they won in 2010.

David Green said *"This time last year, we had only just begun exploratory talks with Lotus about the possibility of developing the GTC Evora with them – now the car is finished and the Championship is ours!" Back at the Autosport Show in January 2012, Rupert Manwaring (Head of Commercial Motorsport at Lotus) said that "it would be something very special if a British Team, in a British Car could win a British Championship" – well that's exactly what we have done – and we couldn't be more delighted! It's been a remarkable year! We would also like to thank our title sponsors of Bullrun, Giant Film & TV and Luxor, without whose continued support our success this season would not have been possible".*

Commenting on the partnership between Lotus and Bullrun, Richard Adams explained that *"It was a big step into the unknown for both of our teams – we hadn't previously worked together and so as in any new venture, pooling our respective skills, experience and resources to make one effective and enthusiastic group of people was going to be essential. If we are honest, I think we were all genuinely surprised how quickly the teams came together and everyone found their role – we had to focus not only on the development of the car itself – but also mounting a credible challenge for the Britcar title.*

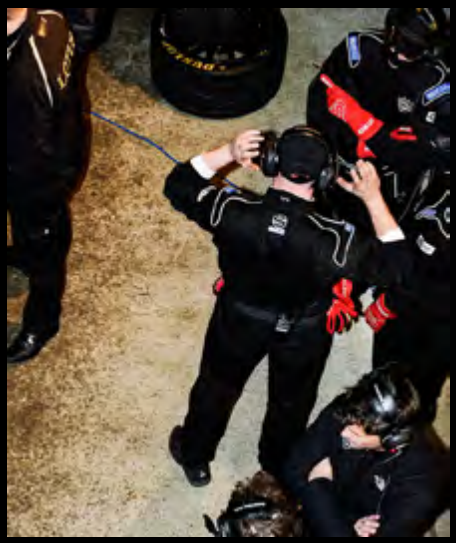
It is a testament to the professionalism of Gavan Kershaw (who led the Lotus Engineering team), Mickey Galter (who led the race set-up for each round for Bullrun) and Elliot Martin (from Cosworth) that we got so much

pace out of the car so quickly – and continued to make handling and performance improvements all year. On a personal note, being able to bring such a diverse set of personalities and individuals together into such an effective force was one of the most rewarding parts of this journey for me."

Martin Byford added *"I believe we have raised the bar this year in terms of the standards of preparation, focus, discipline and teamwork that are now required to win Britcar – helping to stack every small advantage we could in our favour. We had our fair share of luck – but we firmly believe that you make your own luck – and we have worked incredibly hard for ours! The car has been an absolute delight to drive and help develop – in addition to the Championship win, the fact that we managed an overall race win at Oulton Park earlier this season (beating both Class 1 and Class 2 competition) shows just what the car is capable of!"*

Bullrun are already exploring options for next season with Richard Adams confirming that *"we are in early negotiations with a number of parties to help us identify where our next challenge might be – all we can say at this stage is that we would very much like to continue our successful partnership with Rupert, Gavan and the team at Lotus Racing and would like to think we will be driving a Lotus again in 2013 – exactly where that will be is too early to say. But for now, for the next few days at least, we are all going to enjoy our win!"*

Images © garryfuller.com



Lotus Engineering adds lightness to a Crossover Utility Vehicle

California Air Resources Board (CARB) publishes results of Lotus Engineering's vehicle mass reduction study on a crossover utility vehicle (CUV)

- Results show a total vehicle mass reduction of 31% (528.3 kg or 1,162 lbs.) and a USD 239 saving in overall vehicle cost
- Body structure utilises advanced materials including high-strength steels, aluminium, magnesium and composites along with high tech joining and bonding techniques.

Following on from Lotus' successful "Phase One" study, published in 2010, which looked at the empirical and theoretical weight saving for a standard CUV, Lotus Engineering conducted further research to confirm if a lightweight and commercially feasible body structure, has the potential to meet or exceed the requirements for size, luggage volume, comfort, crashworthiness and structural integrity.

Lotus Engineering's Phase Two body structure design was based on the dimensions of a 2009 Toyota Venza CUV and utilised advanced materials such as high-strength steels, aluminium, magnesium and composites along with advanced joining and bonding techniques to achieve a substantial body and overall vehicle mass reduction without degrading size, practicality or performance. The body mass was reduced by 37% (311 lbs), which contributed to a total vehicle mass reduction of 31% (1,162 lbs) including the mass savings of other vehicle systems (interior, suspension, chassis, closures, etc.) That had previously been identified in Phase One.

The detailed computer aided engineering (CAE) analysis undertaken indicated that a 31% mass-reduced vehicle with a 37% lighter body-in-white (BIW) structure has the potential to meet U.S. Federal impact requirements. This includes side impact and door beam intrusion, seatbelt loading, child seat tether loadings, front and rear chassis frame load buckling stability, full frontal crash stiffness and body compatibility and frame performance under low-speed bumper impact loads as defined by the Insurance Institute for Highway Safety (IIHS). The result is a BIW design with a 20% increase in torsional stiffness over the class leading CUV.

Although the significant mass savings in the BIW design results in an increased BIW cost of USD 723, the overall vehicle cost is reduced through savings identified across the whole vehicle and when manufacturing and assembly costs are included in the analysis. A significant reduction in the parts count from 269 to 169, achieved by an increased level of component integration, also helped offset the increased BIW piece cost.

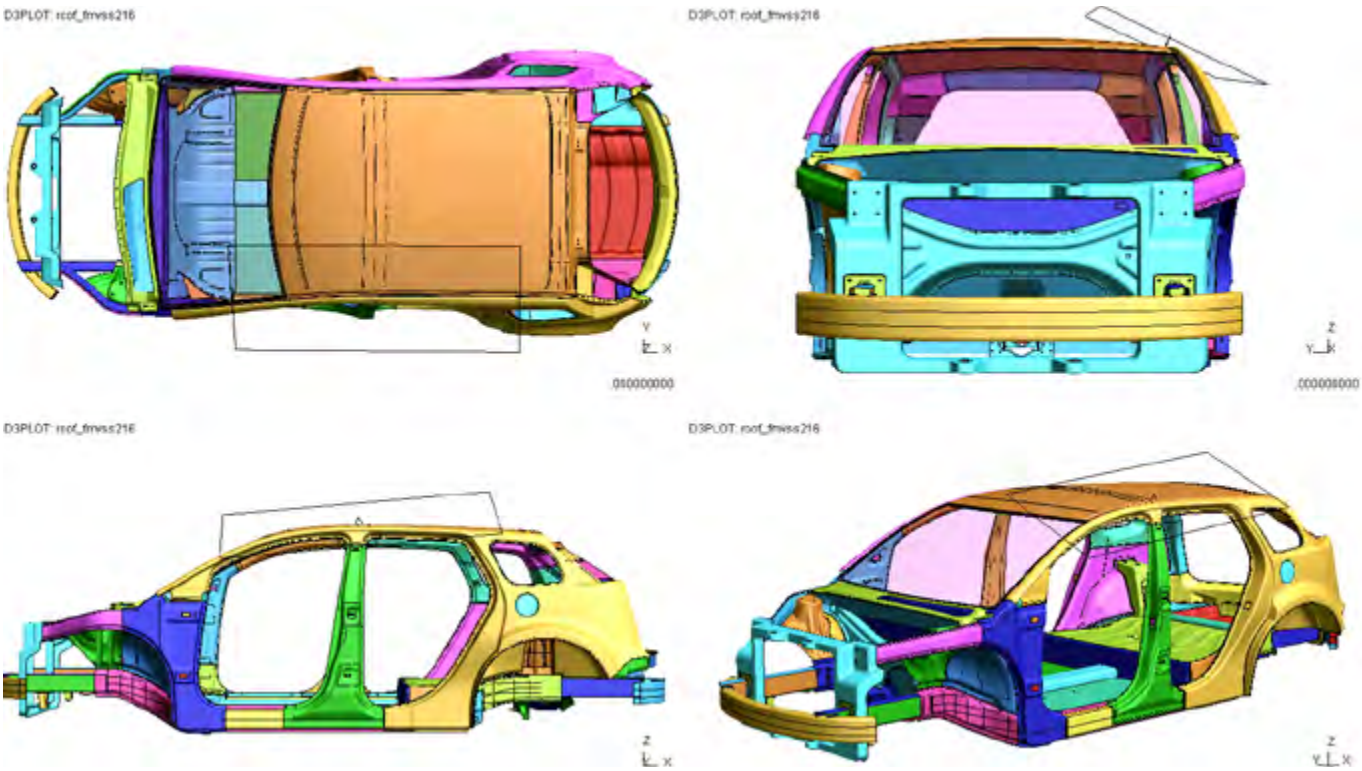
The background to the study

In April 2010, Lotus Engineering concluded the first phase of a study which substantiated that a reduction in vehicle mass could be achieved for medium production volume vehicles (approximately 50,000 units per year) with a 23% reduction in fuel consumption. In September 2010 the CARB commissioned Lotus Engineering to initiate Phase Two of the study and take a deeper look into the future of lighter, more efficient vehicles manufactured using lighter yet stronger materials.

Lotus has always been about Lightweight

When Lotus founder Colin Chapman coined the phrase 'performance through light weight' he was referring to much more than mere accelerative performance. In the broader sense he meant that a lighter vehicle does everything better, including being more fuel efficient. Over the past 60-plus years, Lotus road and racing vehicles have consistently benefited

Vehicle mass reduction study by Lotus Engineering results in a body mass reduction of 37 percent (311 lbs) and a total vehicle mass reduction of 31 percent (1,162 lbs).



from this core philosophy and Lotus has developed a strong reputation as a leader in lightweight vehicle technologies.

After decades of most manufacturers building increasingly heavy, feature-laden cars, now the very aggressive corporate average fuel economy (CAFE) standards are increasing from a target of 35.5 mpg in 2016 to 54.5 in 2025 which has all manufacturers reevaluating the virtues of mass reduction and prioritising the materials, technologies and production methods that will enable lighter, stronger and more efficient vehicles. This project used emerging technologies, advanced materials, state-of-the-art manufacturing and bonding techniques and innovative design to develop a low-mass vehicle that has the potential to meet or exceed modern vehicle demands of functionality, safety and structural integrity. Both Phase One and Two studies combined indicate that it is technically feasible to develop a 30 percent lighter crossover utility vehicle without compromising size, utility or performance and still meet regulatory and consumer safety requirements as well as production cost targets.

Industry News

UK: Exige based 'Nemesis' breaks UK EV landspeed record

The 'Nemesis' has broken the UK electric car land-speed record – reaching 151 mph. The existing record of 137 mph was set by Don Wales, grandson of legendary speed-merchant Sir Malcolm Campbell.

The Nemesis is the result of nearly two years' hard work by an 'A-team' of ex-motorsport engineers, with the brief from Ecotricity founder and MD Dale Vince to *"blow the socks off Jeremy Clarkson and smash the stereotype of electric cars".*

The result is awesome: faster than a V12 Ferrari, with 0-100 mph in 8.5 seconds and a top speed of 170 mph. All powered entirely from the wind. Or to be more precise by green electricity produced by Ecotricity's windmills and delivered by the grid..

Mr Vince said: "*This is brilliant. We built the Nemesis to smash the stereotype of electric cars as something Noddy would drive – slow, boring, not cool – and I think we've done exactly that today.*"

"*Hopefully this will further stimulate debate about the future of transport in Britain and how we'll be getting around when the world runs out of oil.*"

"*What we've been able to demonstrate is that wind-powered cars are not just feasible, but can be a load of fun.*"

Powered entirely by 100% green electricity made by Ecotricity's network of 53 windmills around the UK, the Nemesis was designed and built in less than two years by an 'A-team' of leading British motorsport engineers in Norfolk.

Unlike a combustion engine, electric cars have 100% torque from a standing start and in initial speed tests last year the road-legal Nemesis did 0-100 mph in 8.5 seconds. The Nemesis completed two runs along Elvington Airfield over a one mile distance, with Nick Ponting breaking the record on the first set of consecutive runs with an average speed of 148 mph.

Ponting further extended the record later in the day, to 151 mph.

Key stats: Battery 36 kWh, two 125 kW motors (330 bhp), maximum torque 600 Nm, 0-100 mph in 8.5 seconds, weight 1,166 kg.

UK: Jaguar wants F-Type to 'do an Evoque'

The new F-TYPE needs to do for Jaguar what the Range Rover Evoque has done for Land Rover, says the head of sales and marketing for the Tata Motors luxury car unit's two brands, Phil Popham.

"*It won't be the same in terms of volumes, which will be quite small, but it will have a halo effect on the rest of the range. Ninety per cent of sales will be conquest business,*" said Popham. "*It brings us back into the full-size sports car market, which we once dominated, with a more-than-credible car which is not only beautiful but packed with technology.*

"*It is the developing face of Jaguar and signals a big investment in new products and infrastructure for the company.*

"*We will be putting a huge PR operation behind it,*" he added. "*In developing markets people are only just beginning to understand what Jaguar is, while in established markets it will put us back on to consideration lists.*"

The car will go on sale next year with a choice of three supercharged engines - two three-litre V6s and a five-litre V8 - with prices starting at GBP 58,500. Half of all sales will be accounted for in just three markets - America, the UK and Germany.

Jaguar will use a lot of social media in its communications and will emphasise the bloodline that the F-TYPE draws upon by parking it alongside the C-, D- and E-types which preceded it at selected events.

"*We will certainly leverage our heritage where it is appropriate, but we won't let ourselves get shackled by it,*" said Popham. "*We want people to understand that this is a leading-edge car.*"

UK: Ford claims 'undercover agents' helped develop B-Max

Ford said it used 'undercover agents' to develop its new compact MPV, the B-Max.

Stationed around shopping centres and schools, they secretly watched owners strapping in children and loading up the things they had bought. They then fed the information they had gathered to a UK-based innovation team tasked with making the B-Max the most practical small car on the market.

The solution the team came up with was a car with no central pillars between the front and rear doors, making it much easier for people to get in and out. The central pillars are integrated into the hinged front doors and sliding rear doors so that when they are closed they form a solid, safe structure.

Ford said the B-Max is more rigid than the Fiesta on which it is based, and is confident of a maximum five-star Euro-NCAP safety rating when the car is tested in November.

The B-Max replaces the European Fusion [a higher-riding, hatchback version of the previous generation Fiesta, not the North American sedan] in Ford's line-up but is not a direct substitute, said the company's UK managing director, Mark Ovenden.

"*The B-Max is an excellent example of how we can react to the changing needs of customers. It's a more emotionally engaging car than the Fusion. I will admit that the Fusion could have been better in terms of style but it had a 1% market share, and most of our competitors would die for volumes like that. And it was phenomenally successful in Russia.*"

"*The wow factor with the B-Max is the door system. But it is also stylish, economical, luxurious and technologically advanced. People are making lifestyle choices to trade down to smaller cars and the B-Max is at the premium end of the small car sector.*"

It is available with six engines, including 100 PS and 120 PS versions of the three-cylinder 1.0 litre turbocharged Ecoboost petrol unit which is already mopping up 30% of Focus sales just a few months after launch, and a new 1.5-litre turbodiesel. Equipped with the auto-start-stop as standard, the 120 PS 1.3 variant achieves class-leading CO_2 emissions of 114 g/km and fuel consumption of 57.7 mpg – 15% lower than the closest petrol competitor. Other petrol engine options include the 90 PS 1.4 litre Duratec, and the 105 PS 1.6 litre Duratec engine paired with the PowerShift six-speed dual clutch automatic transmission.

The two Duratorq TDCi diesel engines are the 95 PS 1.6-litre engine (104 g/km and 70.6 mpg) and the 75 PS 1.5-litre diesel, closely derived from the 1.6-litre engine with CO_2 emissions of 109 g/km and fuel consumption of 68.9 mpg. The B-Max is the first mainstream European Ford to offer Sync, the company's voice-activated connectivity system which automatically summons help from the emergency services after an accident or breakdown. It also offers an automatic emergency braking system to prevent low-speed nose-to-tail collisions in traffic. It goes on sale in October. In the UK, there is an entry-level Studio model at GBP 12.995, while the mid-range Zetec versions which are expected to account for six out of 10 sales start at GBP 15,600.

PARIS SHOW: New Range Rover loses 400 kg

The fourth generation Range Rover was seen for the first time at the Paris motor show in September. Land Rover said the new model will be over 400 kg lighter thanks to its aluminium platform.

The new vehicle, developed under the L405 codename, is claimed to be the world's first SUV with an all-aluminium unibody structure. In US market spec, the weight saving of the 5.0-litre V8 model is said to be 700 lbs, while Land Rover quotes a figure of 420 kg (926 lbs) for variants sold in some other regions. The outgoing model has a steel body and an architecture which was derived from that of the E53 BMW X5.

As with the current Range Rover (L322), pneumatic suspension is to be standard for all model grades but this is a new system which takes into account most of the 40% weight loss. The ride is said to be as good as that of the acclaimed third generation model but steering feel and cornering abilities are claimed to be have been greatly improved.

Land Rover has also paid attention to NVH, specifying acoustically laminated glass for the windscreen and side windows. The emphasis on improved passenger comfort also sees rear legroom extended by 'over 4.7 inches'. Buyers can also order the vehicle with two rear seats instead of the standard bench.

The split tailgate that has always defined the Range Rover now features electric opening and closing for both upper and lower sections.

The engine line-up consists of V6 and V8 diesels as well as normally aspirated and supercharged versions of the existing 5.0-litre petrol V8. Land Rover is yet to reveal the new model's full specifications. The division says it will do so "*in September 2012, ahead of the Paris motor show*". An on-sale date of December is quoted for North American markets and January for the UK and other parts of Europe.

The new Range Rover should get off to a strong sales start thanks to the current model having built up a large owner base in the almost ten years it has been in production. It also hits the market ahead of the replacements for the BMW X5, Audi Q7 and Cadillac Escalade, each of which is due to be launched in 2013, as is a mid-life facelift for the Porsche Cayenne. The Lexus LX 570 is not due to be renewed until 2014, while it is not yet clear if the Lincoln Navigator and Navigator L will be replaced in 2013 due to low sales of the current models.

US: Large connected-car field trial underway

A year-long crash-avoidance pilot project involving nearly 3,000 'connected' vehicles has been launched in Ann Arbor, Michigan.

The test, involving cars, trucks and buses equipped with wi-fi technology that allows the vehicles to 'talk' to each other ('V2V'), is the largest of its kind, according to the US Department of Transportation.

The USD 25m project, which is being coordinated by the University of Michigan Transportation Research Institute, was launched by transportation secretary Ray LaHood who said: *"This cutting-edge technology offers real promise for improving both the safety and efficiency of our roads."*

The test cars, trucks and buses are equipped with vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication devices that gather data about how traffic is flowing and warns of potential hazards and help to reduce crashes.

According to DOT's National Highway Traffic Safety Administration (NHTSA), V2V safety technology could help drivers avoid or reduce the severity of four out of five unimpaired vehicle crashes.

Hazards that the technology can highlight include an impending collision at a blind intersection, a vehicle changing lanes in another vehicle's blind spot, or a rear collision with a vehicle stopped ahead.

"*Vehicle-to-vehicle communication has the potential to be the ultimate game-changer in roadway safety – but we need to understand how to apply the technology in an effective way in the real world,*" said NHTSA administrator David Strickland. "*NHTSA will use the valuable data from the 'model deployment' as it decides if and when these connected vehicle safety technologies should be incorporated into the fleet.*"

More than 70 miles of roads in and around Ann Arbor have been fitted with transmitters and receivers to help relay the messages.

Vehicle makers taking part are Daimler, Ford, GM, Honda, Hyundai, Nissan, Toyota and Volkswagen.

UK: BYD electric minicabs for hire in London from 2013

Chinese electric car maker BYD - in which legendary US investor Warren Buffett has a stake - and greentomatocars have signed a memorandum of understanding to create London's first fleet of all-electric minicabs.

BYD, which makes hybrid and electric vehicles, will supply 50 of its electric e6 models for trial use in the UK capital.

The company greentomatocars claims to be London's 'second largest quality minicab service and strives to use the most environmentally-friendly vehicles available in its fleet of 300.'

The 50 electric cabs will be available for hire from the second quarter of 2013.

Minicabs operate under different rules to London's traditional 'black cabs' in that they must be pre-booked, usually by phone or internet, and cannot 'ply for hire' - ie. be hailed in the street.

London mayor Boris Johnson said in a statement: *"It is my aim that London's minicabs and taxis will be zero-emission by 2020 which will have a major impact on air quality. Every year the fleet is getting cleaner, making our city an even more attractive place to live, work and visit. Encouraging many more electric vehicles is a key part of this transformation, so it is great news that greentomatocars has committed to operating 50 of these super clean machines from next year."*

BYD chairman Wang Chuanfu said: *"We are delighted to supply greentomatocars with e6 vehicles that will create London's first electric minicab fleet. The e6 has zero tailpipe emissions, so it avoids contributing to the city's CO_2 levels and results in cleaner air for Londoners."*

Jonny Goldstone, managing director of greentomatocars added: *"We are very pleased to be working with BYD on this project. As a partner company, BYD has shown great leadership to challenge the status quo, innovate and electrify mass transport - principles which go to the very heart of greentomatocars."*

"As a car, we see strong parallels between the e6 of today and the then-unfashionable Toyota Prius [hybrid] of 2006. It's exciting to think that, even as a five-car start up, we played a major role in making the Prius popular; given the scale, experience and high-tech infrastructure we now have at our disposal, we'd love to 'do a Prius' with the e6, and help propel electric vehicles into the automotive mainstream - where they deserve and, for all our sakes, need to be."

BYD has also been supported in this deal by London & Partners, the mayor's official promotional organisation for London.

The five-seat e6 is a crossover said to have 'a spacious interior that lends itself perfectly to the private hire market, with substantial legroom and headroom for passengers, as well as ample luggage capacity'. It is a zero-direct-emission electric vehicle.

BYD e6 taxis are said to be 'well-proven and have already driven a total of more than 14m miles in key global markets'.

The e6 has a 75 kW motor and BYD's own Fe (iron phosphate) battery which gives the car a range of up to 186 miles on a single charge in urban conditions with a top speed of 87 mph and instant torque providing excellent acceleration. The Fe battery can be fully charged and discharged for over 4,000 cycles.

Evora 414E Hybrid

Evora 414E Hybrid exists to highlight engineering capabilities

As carmakers go, Lotus is something of an unusual company. As an OEM it's a small volume player, making sports cars that are still – as typified by the Elise, for example – the spiritual descendants of the stripped down 'light of weight' approach to design and engineering favoured by Lotus founder Colin Chapman. But Lotus is much more than a maker of Lotus sports cars. It does quite a bit of engineering consulting work – through its Lotus Engineering arm - for third parties, many of whom are big name OEMs. And Lotus has developed a considerable knowledge base and pool of engineering expertise through that work. Most importantly, the extensive working relationships and experience of working with volume makers means that Lotus understands how the bigger OEMs work and the kinds of systems and processes that they work to. It's a good exposure to have.

There is one drawback though. Lotus is not generally in a position to talk about the extensive work it has done for third parties (governed as it is by standard confidentiality agreements). The Lotus Evora 414E hybrid then, is something of a special case for Lotus. It's a concept car packed with cutting edge technologies that have been developed by Lotus for a Lotus car and therefore that it is in a position to shout about. The 414E is a working concept that shows off Lotus engineering expertise. And Lotus has naturally been keen to get journalists behind the wheel to help spread the word.

Technology Strategy Board

The background to the project that spawned the 414E (as well as the Infiniti Emerg-E concept; basically the same car as the 414E, but with a different body) is certainly interesting. The UK government's Technology Strategy Board put up 50% of the overall GBP 19m project funding with the aim of helping to develop the UK's EV technologies supply base by working with three OEMs – Lotus, Nissan (Infiniti) and Jaguar Land Rover. From the supplier industry, Evo Electric, Axeon and Xtrac were among those involved. So, the TSB wanted to kick-start a project that would get suppliers involved in EV technologies – which it sees as a big part of the automotive future and a strategic priority for the UK automotive manufacturing sector. And Lotus wanted a research project to demonstrate its hybrid technologies and capabilities. It was a good fit.

However, while Lotus and Nissan went down the series hybrid range extender plug-in electric vehicle route, JLR went off in the direction of a parallel plug-in

hybrid (the Jaguar XJ-e, also a working concept).

The experience in developing the 414E was certainly a learning exercise all round. *"We found ourselves getting much more involved with the suppliers on this project than would normally be the case,"* says Steve Doyle, Lotus Chief Engineer Hybrid and Electric Vehicle Integration. *"The nature of the technologies, and some of the start-ups we were working with, meant that we were in a very good position to advise them for the good of the project. We could find ourselves, for example, advising them on the products and inputs from their suppliers because of our better knowledge in some areas"* he says.

In terms of the engineering objectives for Lotus, the integration of a high power motor/inverter drive, a high energy battery pack and the inclusion of the Lotus range extender engine stand out. There was also quite a bit of work to do on control systems integration, safety systems and analysing torque vectoring for the independently driven rear wheels.

The result is a car that is not quite the finished article, but that shows just how close Lotus can get to making something packed with genuine technological innovation. A sports hybrid with a range extender is a pretty complicated engineering proposition. Lotus has successfully integrated a series hybrid driveline into the existing Evora, the vehicle controlled by a Lotus developed control system. And it has also, in the process, managed an embryonic supply chain. You will not be able to buy the 414E, it's a one-off concept, but it is a car that works very well and did not feel at all like a raw or rough at the edges prototype to drive. The interior was Evora, but with a few modifications – such as a dynamic display panel showing power output from battery and range extender.

Performance

The Evora 414E is powered by a pair of 201 bhp electric motors ('synchronous axial flux drive motors' to be precise), and the lithium-iron phosphate battery pack can be charged from either a plug socket or by the 1.2 litre range extender engine specifically developed for range extender applications by Lotus. The car is targeted to travel thirty miles on a full battery charge and has a range of 300 miles on a combination of battery and petrol.

Performance is not significantly different to the standard Evora. It will do 0-60 mph in 4.4 seconds and has a top speed of 133 mph. Average CO_2 emissions are estimated at 55 g/km. I can vouch for its speed around the track at Hethel; it's very quick and nimble. Weight distribution also seemed fine, despite the fact that the 414E has gained 377 kg (to 1,759 kg) over the petrol Evora. Lotus has worked on the weight distribution to make it very similar to that on the standard car. But there's no getting around it: a hybrid like the Evora has got a lot of equipment packed in, not least the battery (which takes up a fair bit of room where the rear 'plus two' seats would otherwise be). Light it ain't, but it is very quick and efficient. The additional power from the range extender engine gets you Lotus performance in a car with an estimated CO_2 rating of just 55 g/km. The range extender in the 414E kicks in seamlessly when you stick your foot down for some serious acceleration. Well, not quite seamlessly, it is quite loud, but it hasn't had the full NVH treatment.

Driving involvement

Actually, aural feedback raises an interesting issue for performance electric cars like the 414E. The buyer of a Lotus sports car – having been bred on the internal combustion engine and being something of an enthusiast - may well want a rather more aurally sensorial experience than an electric car naturally delivers. Lotus has thought of that. It is working on introducing sound ('HALOsonic sound synthesis') which includes external sound synthesis for pedestrian safety and an internal sound synthesis providing the driver with active feedback. A virtual gear shift with a simulated 7-speed paddle shift linked to the HALOsonic Sound Synthesis is also in the works. That will involve a power interrupt/regenerative breaking function to simulate gear change. It is simulation though, conceived wholly because we are hardwired for ICE sounds and feedback and we will take some weaning off it. In twenty years' time it may be something we smile about.

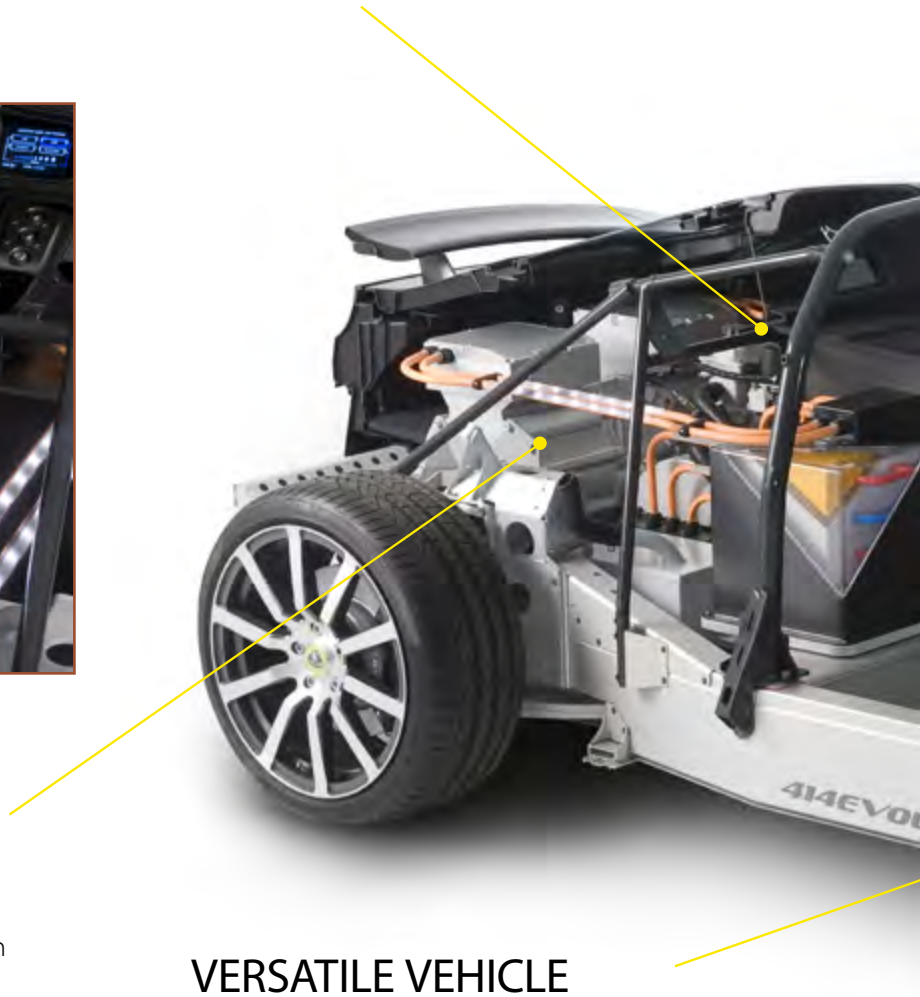
Testing

One interesting development detail was in some of the software that Lotus developed for use in the 414E project. Now, if you are developing one car, a high-tech one like the 414E, it's an expensive asset. You want to look after it, avoid prangs where possible. Real world testing brings risks, is time consuming and comes with considerable cost. Safety systems were one of the development priorities for the 414E. Lotus built a virtual car using 'carmaker' software for safety case scenarios that meant it could take the car around the Hethel circuit virtually and conduct thousands of scenarios without actually having to do them (if you see what I mean). There's a big cost saving as a result and that software investment is in place for future models. It provides one example of the long-term spin-off benefits that a project like this can help bring about.

RANGE EXTENDER ENGINE

The production Lotus Range Extender is an extremely compact, lightweight, low-cost engine and generator, designed specifically for hybrid electric vehicles. The production Lotus Range Extender will be offered in two versions with the top of the range 50 kW supercharged variant installed in the cutaway Lotus Evora.

The 1.3 litre, three cylinder Lotus Range Extender engine offers high efficiency and low mass, which will enable the downsizing of expensive batteries, whilst maintaining vehicle efficiency and range of hybrid electric vehicles.



ELECTRIC DRIVETRAIN

Each drive wheel is connected to a 150 kW axial flux drive motor with integrated inverter which allows for independent rear wheel control. The inverters convert DC voltage from the battery into three-phase voltage for the drive motors.

VERSATILE VEHICLE ARCHITECTURE (VVA)

The VVA chassis used on the Lotus Evora, is a low volume evolution of the architecture used on the Lotus APX concept and allows for the development of a range of vehicles up to a gross vehicle weight of 1,900 kg.

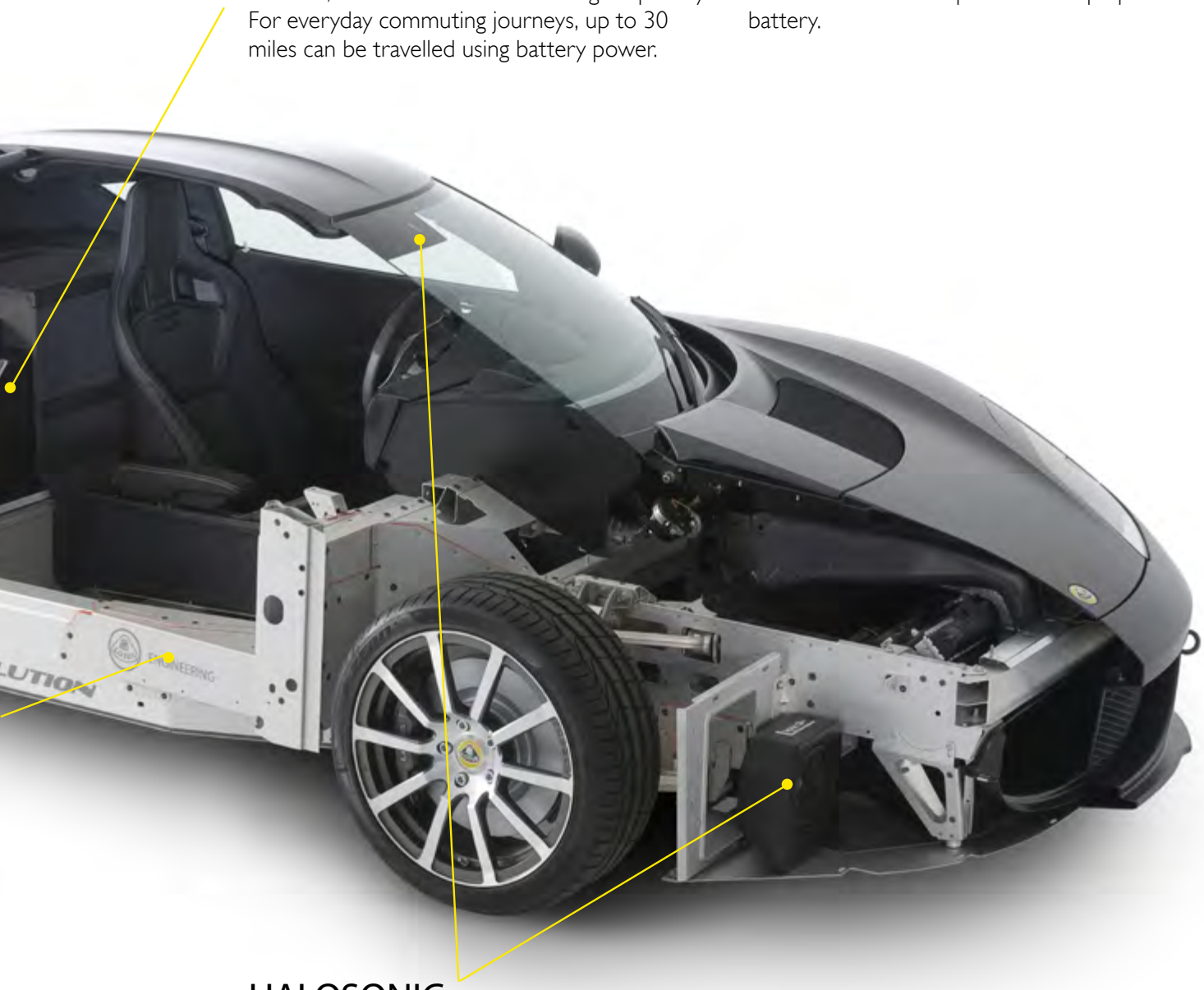
The VVA architecture has been designed so that it can be stretched in width, length and height vastly increasing the number of vehicles that could be developed from this vehicle architecture.

ENERGY STORAGE SYSTEM

The vehicle energy storage system is made up of the latest lithium polymer battery chemistry providing 17 kWh energy storage capacity. The battery pack is optimised for energy density, efficiency and high power demand, with over 300 kW discharge capability. For everyday commuting journeys, up to 30 miles can be travelled using battery power.

The battery can be charged overnight using a conventional domestic mains supply.

For longer journeys, exceeding the battery capacity, the highly efficient range extender engine is used as a generator to supply the motor with electrical power and top up the battery.



HALOSONIC

HALOsonic technology synthesises internal and external engine sounds for enhanced pedestrian safety, driver feedback and enjoyment. The HALOsonic system is now integrated with an advanced driver assistance system providing warnings to both pedestrians and the driver of potential danger.

Selectable engine sounds from the HALOsonic system combined with a simulated seven speed paddle shift transmission provide increased driver involvement.

HARMAN

Evora 414E undergoes testing in Lotus' semi anechioic chamber.

Project future

Over the next year Lotus is planning to refine the car further. There's more learning ahead and the 414E looks like a commendable project, both for Lotus, and for the UK government's efforts to stimulate a nascent UK supply chain in electric vehicle technologies. On that latter point, I sense that there is a long way to go. Automotive supplier industry might perhaps lie elsewhere these days, but at least projects like this show some capabilities and what can be achieved through smart collaborative efforts and approach. At a strategic level for the UK auto industry, learning what is difficult, or what can't be done here, can be as valuable as realising some strengths and possible competitive advantages for the future.

Moreover, Lotus Engineering can rightfully point to its successful leadership role in the development of the 414E/Infiniti Emerg-E projects. You won't be able to buy the 414E, but that's not the point. It's an impressive working model that shows what Lotus Engineering is still capable of and why Lotus remains a relevant brand in 2012

Author: Dave Leggett.

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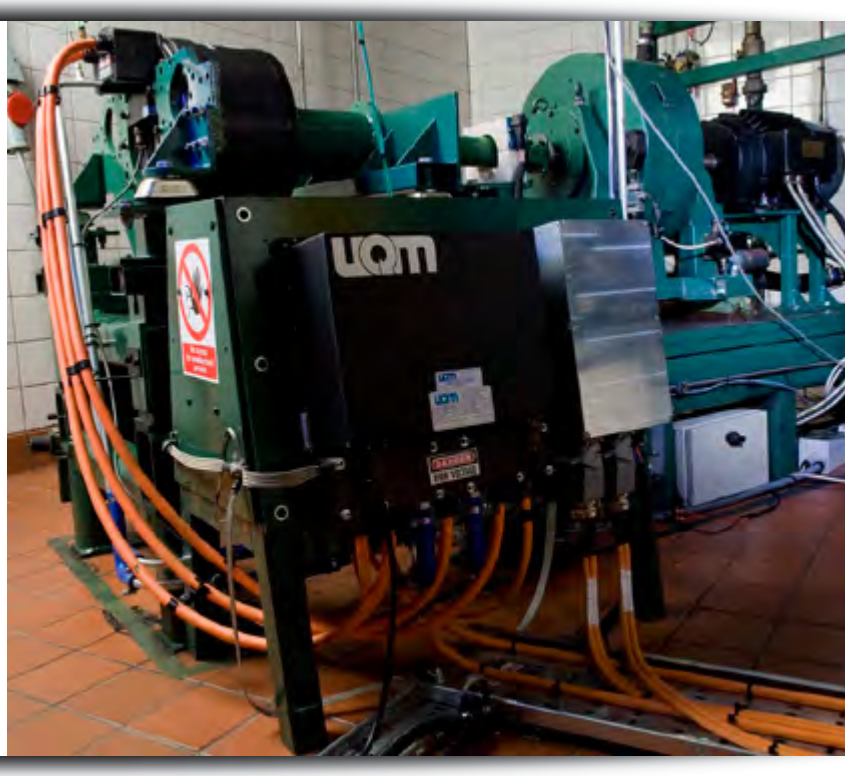


HIGHLY CHARGED DEVELOPMENT AND VALIDATION

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

As an engineering consultancy and manufacturer of premium cars designed to excite and perform, our breadth of technical knowledge is unrivalled. Our multi-skilled engineers and technicians have extensive experience in developing a wide range of electrical and mechanical drivetrain systems.

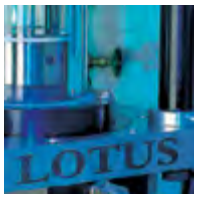
Lotus Engineering is dedicated to meeting our clients' programme objectives on time, every time.

LIGHTWEIGHT ARCHITECTURES - EFFICIENT PERFORMANCE - ELECTRICAL AND ELECTRONIC INTEGRATION - DRIVING DYNAMICS







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Series Hybrids

Real world benefits of range extended electric vehicles

The move to electrification

While electric vehicles (EVs) are potential solutions to vehicle CO_2 emissions the current high battery costs and a lack of charging infrastructure is limiting their market growth. Hybrid vehicles which have an electric motor drive and a conventional engine working together to power the vehicle can overcome many of these concerns.

Different arrangements of battery and engine systems offer different advantages and disadvantages, but so far the market has been dominated by the parallel hybrid solution (such as the Toyota Prius). Lotus believes that the medium term solution could lay in the series hybrid which forms a practical stepping stone to the longer term ideal of a non petroleum based transport system powered by electric and hydrogen fuel cell vehicles.

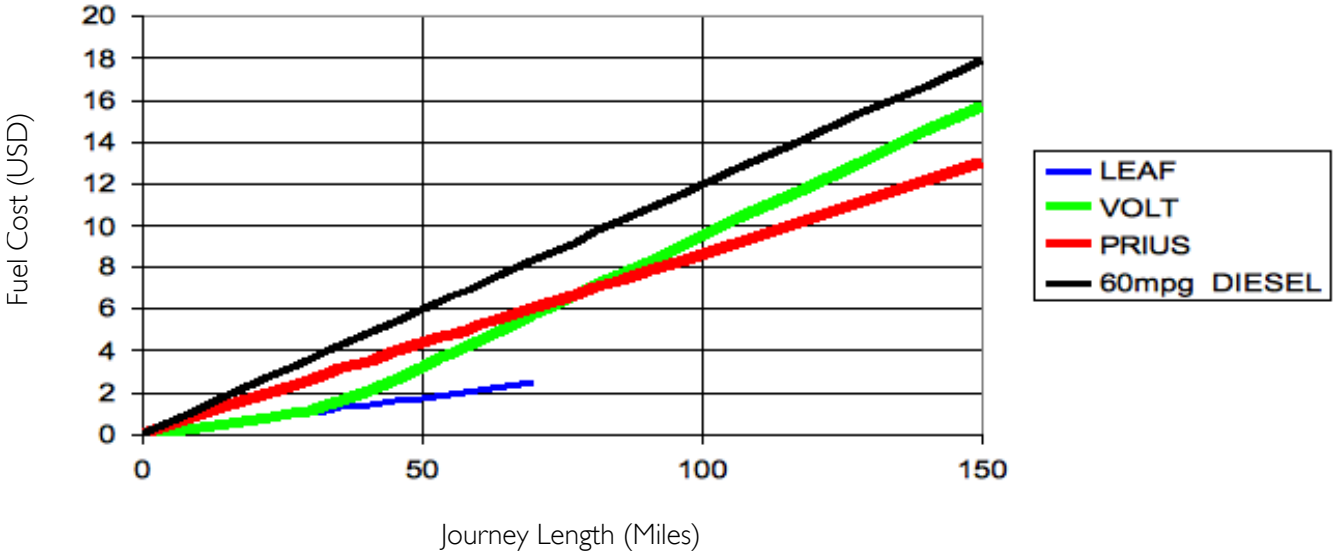
Just how green is electric?

As the present measure of a vehicle CO_2 production is based on emissions from the tailpipe all the vehicles that are powered by electrical energy from the grid seem to represent an ultimate zero emission solution but it should be remembered that this energy is only as green as the original source of production. Nuclear energy creates energy with minimal CO_2 (but other obvious environmental concerns) while gas and coal generate electricity with a higher CO_2 figures. The low CO_2 credentials of renewables such as wind power have more recently been brought into question. The current UK average for domestic electricity supply is around 0.5 kg CO_2/kWh. This means that many of the current EV vehicles in reality are producing 'hidden' CO_2 at a rate of 100 g/km.

Average fuel cost for different EV solutions

Using real world economy data compiled in the USA by consumerreports.org - the expected total fuel cost can be plotted against length of journey. This shows the relative costs of a conventional diesel engine, a parallel hybrid (PEV), range extended electric vehicle (REEV) and battery electric vehicle (BEV). However this also shows the finite and limited range of the BEV. The series hybrid has all the low cost benefits of the BEV up to 30-40 miles but when the on board generator is used it becomes more expensive to run due to

Table showing the cost of a journey per mile for a Nissan Leaf (BEV), Chevrolet Volt (REEV), Toyota Prius (PEV) and a diesel car



the compromise in efficiencies of the series hybrid arrangement. For journeys less than 75 miles the series solution in this example has lower fuel costs than the parallel hybrid.

In sizing the battery for a hybrid vehicle the key issue is the expected EV range available, which is generally proportional to battery size, cost and weight. Ideally typical vehicle usage should exploit the low cost/low CO_2 potential of the EV mode as much as possible without carrying around excess cost and weight of unused battery capacity.

What is the optimum electric only range for hybrid and electric vehicles?

The data below was collected in the USA and recorded total daily mileages for a range of users. It shows the percentage daily journey length in 10 mile bands, so for example 21.6% of daily journeys were between 10 and 20 miles. By combining the first three bands we can calculate that 57% of the average daily use was under 30 miles, and similarly 77% of daily use was under 50 miles. For this reason the majority of journeys could be completed by a hybrid vehicle at very low running costs using a 50 mile electric only range. These low costs more than compensate for the more expensive operation at higher daily mileages as this is very seldom required. Based on these costs and the typical usage profile an annual fuel cost can be projected for the average user. Using this projected usage profile and current UK costs for off peak electricity and petrol results in an average fuel cost for the Prius at GBP 0.0875 per mile which is a very competitive figure, however the Volt average fuel cost would be just GBP 0.036 per mile. This is the real benefit of the series hybrid range extender over the standard parallel hybrid solution.

Any opportunities for additional charging during the day extends the electric only range and could reduce the running costs. But it is also worth considering if the vehicle would be used later that day as the daytime electricity rate during the day is typically twice the night rate.

If a vehicle owner has an untypical requirement, for example a 60 mile each-way daily commute with no opportunity to recharge before the return journey then a BEV will not be the best option. However for users with no requirement for a daily journey over 40 miles then a BEV may be a more suitable choice.

The new Tesla model S has an interesting solution to this issue. The vehicle will be available with three different batteries which provide 160, 230 or 300 mile range from the buyer specified 40, 60 and 85 kWh battery systems available. The largest battery option costs $20,000 more than the smallest one.

Customers historically have an acceptance that there is a premium price for enhanced power, acceleration and speed for a given model of vehicle and while it is true that the top speed and acceleration of the large battery option is 15 mph faster and 0.9 seconds quicker from 0-60 mph than the smaller battery option, the main benefit being purchased is the additional 140 miles range.

Comparing electrification solutions

Toyota Prius is a parallel hybrid vehicle

Nissan Leaf is a pure battery powered electric vehicle


Chevrolet Volt is a series hybrid

Parallel hybrid
All drive energy comes from the combustion of gasoline which uses existing fuel infrastructures. The downsized gasoline engine directly drives the road wheels supplemented by a relatively small battery system that can in parallel boost the mechanical drive through an electric motor. This system also provides a very limited electric only range (from power stored in the batteries). Parallel hybrids simply create a more efficient internal combustion (IC) engine solution by smoothing engine demand and regenerating some braking energy back into the battery.

Pure battery powered electric vehicle (BEV)
The battery is charged from the power grid via an electrical outlet. A battery in isolation always has a limitation on range due to extended recharge times and a charging infrastructure still in its infancy. BEVs have lower running costs, but for an acceptable range of around 70 miles the larger battery leads to a higher purchase price.

Series hybrid, also known as range extended electric vehicle (REEV)
Main drive is through electric motors, using the Chevrolet Volt as an example the vehicle has an electric only range of 30-50 miles (less than a Leaf). This smaller range from the batteries is mitigated by using a simple IC engine acting as a generator to power the motor when the battery is depleted.

This gives most of the benefits of the EV but without the infrastructure constraint on range. The generation of electrical energy to drive motors from the engine is always going to be less efficient than a direct mechanical coupling from the engine. But the key point is that for the majority of journeys this is not required and the much lower cost grid energy is used from the battery. The key point is that unlike the pure BEV the effective range of the vehicle is unlimited as the range extender substantially increases the range and in any case the fuel can be replenished quickly and easily from any existing fuel station.

EV 'range anxiety' is exacerbated by 'range uncertainty'

The concern that a BEV vehicle has a finite range and could become stranded with a flat battery away from a suitable charging point has been shown to result in owners of these vehicles being very conservative in their use and recharging at every opportunity.

The phrase 'range anxiety' has been coined to describe this fear and this subsequent behaviour. A further issue is that the real world range of a BEV is not simply proportional to battery charge, hence range is very difficult to predict in absolute terms.

The power to propel a vehicle forward disproportionately increases with speed and total energy use increases if auxiliary systems are used (air conditioning or heating, lighting, audio etc). These other consumers of energy are sometimes called 'hotel loads' there for the comfort and convenience of the occupants.

The hungriest of the hotel loads is for thermal comfort, especially heating and air conditioning (note that in a standard vehicle heating is provided free by using heat from the engine).

While these issues (except for the range penalty for heating) are the same for a conventional vehicle the range issue is not at the forefront of the customers thinking when the car can be easily refuelled when required.

Tesla themselves quantified some of these effects. The Tesla source data was updated by Rob van Haaren to include the difference a constant 2 kW load would make to the Speedster range.

Interestingly the maximum range with air conditioning is higher when running at a higher vehicle speed than not running at a lower vehicle speed. This is because covering more miles at a faster speed equates to a shorter journey time, hence the total energy consumption by the air conditioning is reduced as it is consuming power for a shorter time.

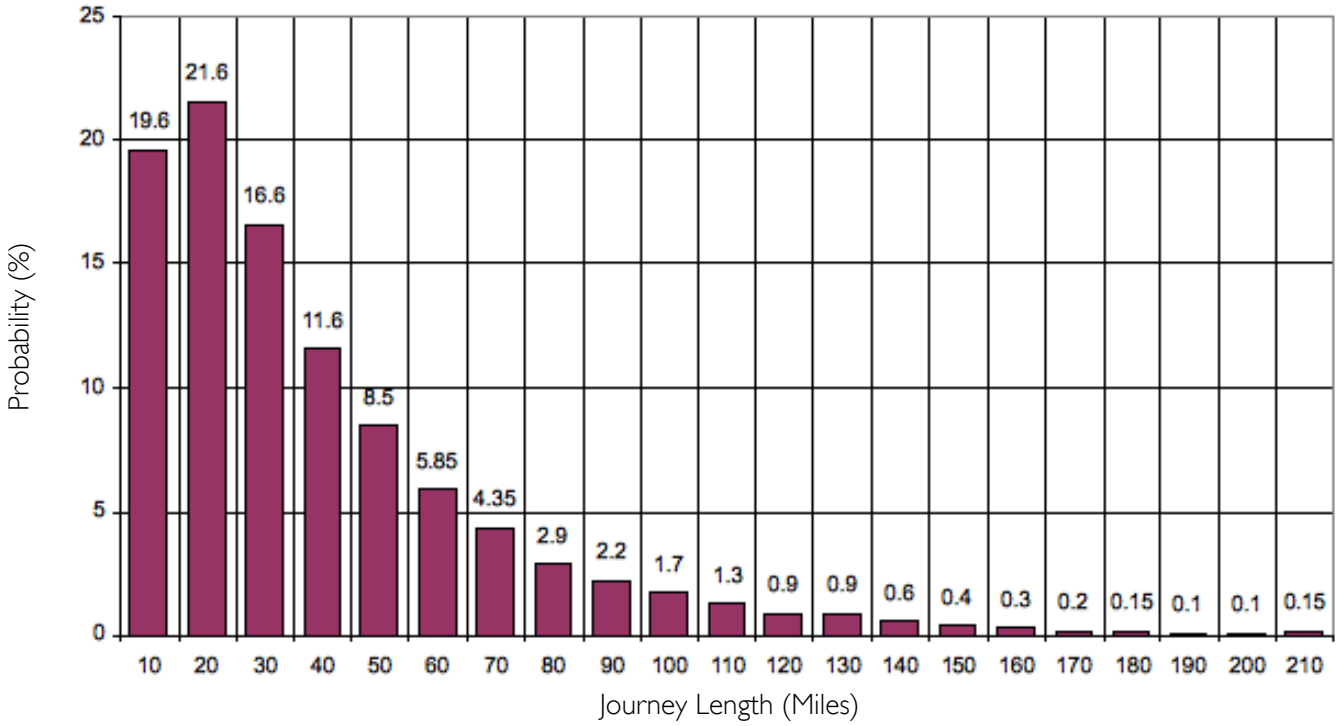
However, driving faster has its own limitations. At higher speeds the power used to propel the car is dramatically increased and the range drops from over 400 miles at 20 mph to just 75 miles at 120 mph. As a consequence the influence of the 2 kW load from the air conditioning becomes minor on its effect on range.

Given all these factors there is no simple answer to the question "*what is the range of my EV?*".

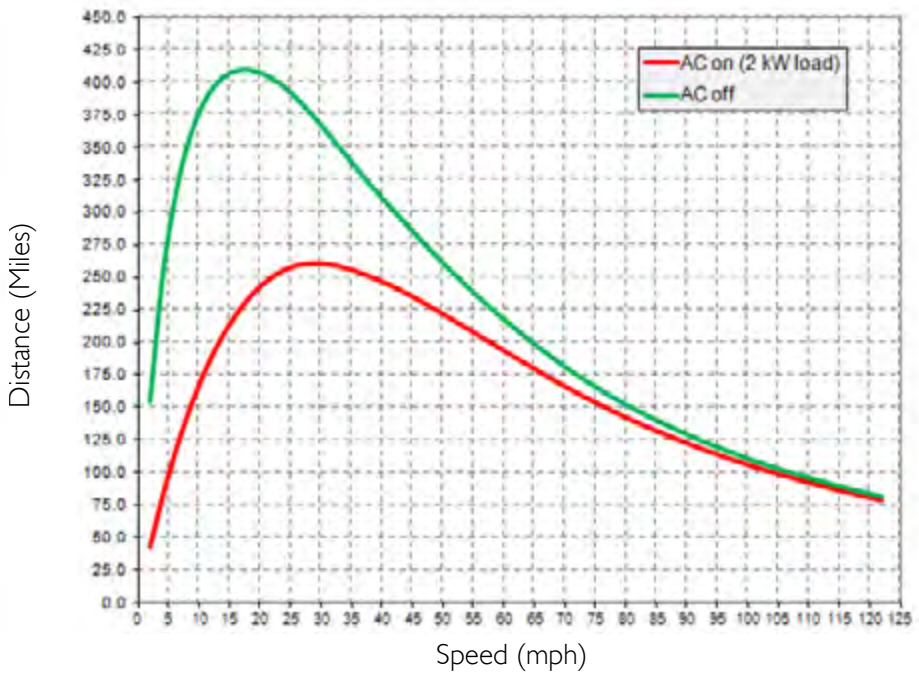
Any predicted range the vehicle may display could be dramatically altered by a change in speed or hotel load demand.

A series hybrid with a range extender gives the benefits of a BEV whilst effectively removing the limitations and potential anxieties over battery capacity and vehicle range.

Graph showing the average daily mileage based on a US study



Graph showing the range of an EV at varying speeds with and without AC



What is the optimum performance requirements for a hybrid vehicle?

It is our observation that for performance vehicles the obsession with maximum speed is largely the result of the derestricted autobahn.

What the majority of drivers outside of Germany require and value (and actually use!) is acceleration performance for a sporty feel and overtaking ability.

This requires high power but in relatively short bursts which is an ideal match to a series hybrid capabilities.

On the other hand a requirement to maintain a speed of over 150 mph, is as the Tesla data shows, disastrous to range and in the case of a HEV will require an oversized battery capacity.

The Evora 414E REEVolution has deliberately been limited to 130 mph (the standard IC Evora S has a top speed of 178 mph), however the acceleration is quicker.

The Evora S has an already impressive 60-100 mph acceleration time of 5.8 seconds, the Evora 414E is over 2 seconds quicker with a 60-100 mph time of just 3.6 seconds.

It is clear that the 414E will have the best performance feel for most drivers, outside of a racetrack or on an autobahn.

Battery life and replacement costs

There is a further issue with battery systems in that the overall life expectancy in terms of years, miles, discharge cycles is again a function of customer use, environment and difficult to predict. In many cases manufacturers are reluctant to declare future prices for replacement batteries as battery technology is constantly changing and future costs are expected to be lower than current prices.

Most manufacturers are therefore offering 8 to 10 year battery warranties to reassure potential customers on the longevity and resale value of their vehicles. This may turn out to be an unavoidable gamble if real world life falls below these limits and manufacturers are forced to replace a high proportion of batteries, especially when it is reported that a battery for a Nissan Leaf costs around USD 18,000.

It is clear that the larger the battery the larger the cost will be so a hybrid using a smaller battery will almost certainly have lower battery costs.

SMMT data published this July has revealed that the average age of vehicles on the UK roads is increasing as a direct result of the recession and now stands at 7.44 years.

One in six cars in the UK is 12 years or older so it is reasonable to predict that most hybrid and electric vehicles would require one battery replacement during their life. If this is prohibitively expensive this could curtail the vehicles viable economic life and influence its residual value.

The case for a series hybrid (REEV)

Determining whether the series hybrid is the most energy efficient vehicle for any consumer will depend on their intended profile of use.

The beauty of a series hybrid is that the flexibility of use is maintained and provides the benefits of both EV (lower running costs and emissions) and IC (no range anxiety, established fueling network) worlds.

The REEV provides lower CO_2 and energy compared to the parallel hybrid for the majority of everyday use from its electric only range (provided by optimised battery capacity, charged from the mains overnight), unlimited driving range provided by the range extending IC generator, high performance capability and lower costs for replacement of batteries compared to an EV.

The future

The battery electric vehicle represents the future for shorter range urban driving, as battery technology evolves and costs reduce these vehicles will become more commonplace in our cities. But unless new battery chemistries evolve to slash the cost, weight and volume of battery systems then a hybrid solution of some form will more likely be the basis of long distance personal transport.

The parallel hybrid represents the current evolutionary peak of efficient motoring powered by the internal combustion engine, and has performed the valuable task of introducing and making acceptable to the customer the idea of electrification of mass personal transport. It has also driven the development of high voltage technologies required to achieve this.

Unfortunately the conversion of chemical energy in the internal combustion engine is only in the region of 30% and as oil depletes, the world will prioritise use of petroleum products for other purposes such as air transport and materials reliant on petrochemicals (e.g. plastics). Oil will simply become too valuable (and expensive) to burn in engines. But until this time the IC parallel hybrid with varying levels of electrical assist will hold a strong position in the market.

However the series hybrid, powered electrically and supplemented with an auxiliary source of electrical power has to represent the longer term and ultimate future for unrestricted range personal transport. A series hybrid powered by a range extending engine coupled to a generator is simply the precursor to the paradigm shift away from oil based transportation. As new technologies develop the range extender internal combustion engine can easily be upgraded to alternative sources of electrical energy such as the fuel cell - which is already nearly double the energy conversion efficiency of an internal combustion engine.

Author: Colin Peachey

Getting Connected

Between the personal and automotive world

The seamless integration of personal communication/ mobility between the home and car is the next big issue facing the automotive world, writes Vanessa Scholfield.

The challenge is not just impacting on the automotive sector, but is attracting the attention of infotainment suppliers, telecoms providers, consumer electronics companies, vehicle manufacturers and systems integrators alike. While the obvious question is how will all these players and their expertise mesh together to provide the ultimate solution, what is not in question is the fact that tomorrow's passenger cars need to embrace digital technology and focus on people-centric mobility systems. What remains to be seen is just how the individual companies involved will approach this significant development and who will emerge as the major players that will influence how personal connectivity/mobility is delivered both at home and in the car of the future.

ABOVE: The infotainment system of the Opel ADAM allows the owner to use new media sources such as smartphones, MP3 players, iPods and tablets. When the car is stationary, passengers can enjoy a video or personalized slide show on the seven-inch, high-resolution and full-color touch screen. © GM Company

The Opel ADAM provides premium technologies from upper segments, including the new IntelliLink onboard infotainment system which integrates the owner's smartphone in the car (Android and Apple iOS) and thereby makes selected internet-based applications available in the cabin. © GM Company

New players enter the fray

Already we are seeing new, non-automotive service and hardware providers enter the market with an array of different technologies and approaches that are greatly influenced by what is going on in the consumer/mobile electronics sphere. The recent upsurge of interest in smartphones and the way they are beginning to shape people's lives being a good example.

The overwhelming success of the Apple iPhone has set the benchmark and many others have followed. Having the ability to take your personal nomadic device (PND) and connect it to your car is becoming a customer requirement rather than merely a desirable option. At the recent Paris Motor Show, it was clear to see just how important seamless personal connectivity is for vehicle manufacturers. Even in the lower market segments car manufacturers are offering customers the ability to plug their smartphone into the car and personalise their infotainment experience. As an example of just how widespread the influence of the smartphone has become, one only need look at Opel which offers this in the Adam, its newly launched emerging fun/fashion segment vehicle positioned to compete against the Fiat 500. Using a USB connection the iPhone or smartphone can be instantly connected with the vehicle's operating system and linked to a visual display screen located in the dashboard. In this way the driver can listen to his/her chosen form of entertainment, plan a route at home and download it into the car, make phone calls and manage time in the vehicle in a way that suits his/her lifestyle.

BMW uses a combination of rotary dials and buttons for its infotainment systems

Embedded or brought in services?

The debate over the way in which connectivity will be enabled within the car is on-going and will doubtless continue for some years to come. The choice for the vehicle manufacturers is whether to go for an embedded system with a SIM and built-in modem or to choose the brought in option. The latter involves either a built in modem and brought in SIM, or both being brought in to the car. This option has been gaining ground in recent times and the rapid popularity of the smartphone has displaced the traditional mobile phone to a large extent. Consumers can now enjoy access to the internet, social media and other applications while in the car. Looking into the future, cloud computer services will gain traction with drivers as they seek dynamic selection of the server in real time, based on the expanding variety of apps becoming available in the car.

Plugging a smartphone into the car will not be a favoured solution for all consumers/drivers and in the main this approach will be favoured in the mid and lower segment vehicles. Drivers of premium and high-end cars will likely want an integrated user experience.

Embedded systems on the other hand are more likely to be used for safety critical services such as the e-call emergency call service and vehicle diagnostics. They are also attractive to the vehicle manufacturers as it will enable them to maintain control over the customer in a way in which is not the case with a smartphone. In practice, we expect hybrid systems to be the preferred route in the short to medium term.

Touch screens are becoming the norm

The Human Machine Interface (HMI) provides vehicle manufacturers with the opportunity to differentiate themselves from the competition and to offer user friendly systems that mirror those found on today's mobile phones and tablets. The first real breakthrough came with the touchscreen in PNDs which rapidly found favour in other consumer devices such as iPad's and other tablet computers. These in turn have influenced

the way in which consumers require access to personal mobility services when inside the car.

Today, touch screens have migrated to the passenger car and more car companies offer this technology since it is seen to enable customisation and flexibility in the provision of information and user inputs. In the luxury and premium segments touch screens are being offered in conjunction with rotary dials and knobs. This combined approach is favoured by the German manufacturers in particular, and the likes of BMW and Mercedes offer their in-house suite of infotainment and services in this way. Audi has introduced a touch pad incorporating handwriting recognition in its A8 luxury model. For these manufacturers clearly the HMI will be used as a product differentiator.

Mass market vehicle manufacturers will all be keen to offer touch screen technology in their best selling model lines and ultimately to offer it in some shape or form across their entire vehicle ranges. Larger touch screens are popular in mass market vehicles with 6-8 inch screens rapidly becoming the norm.

Driver distraction is a major concern

Driver distraction, however, is a major issue confronting drivers, vehicle manufacturers and legislators alike. The proliferation of devices within the vehicle and the ever increasing complexity of managing driver information has led the road safety lobby and legislators to take a closer look at the implications of driver distraction and its causes. Among the areas being investigated is the use of smartphones and PNDs within the vehicle as well as touch screens that require the driver to glance at the screen while driving. Ford has gone some way to addressing this with its MyFord touch. This has an 8-inch screen located in the centre console and two smaller screens located adjacent to the speedometer in the dashboard.

Using a combination of speech recognition and five-way controllers on the steering wheel, Ford is striving to reduce and minimise the driver distraction of Ford Sync. Tactile feedback from the touch screen is also seen as a useful attribute and is increasingly seen as a must for the HMI. It gives the user comfort in the knowledge that the service has been activated and reduces the number of times a driver feels the need to glance at the screen. However, these systems are high cost at present and are likely to be restricted to high-end vehicles for the foreseeable future. One such system is used in Cadillac's Cue and the technology is expected to roll out over more GM models in the future.

Insurance companies are also becoming increasingly alarmed at the number of accidents that can be attributed to distracted drivers and usage-based insurance is emerging as a whole new industry in its own right. Driver behaviour apps are being developed and trialled which measure the driving habits, braking and acceleration style and cornering. Using telephones and touch screens while on the go is a common cause for concern and steps are being taken by the car companies to limit what the driver can do while the vehicle is moving. Legislation in this regard cannot be far off.

Driver distraction from phones and infotainment systems is becoming a real concern.©NHTSA

Apple and Google to battle over car connectivity

Apple recently announced that it has signed deals with eight vehicle manufacturers to integrate Siri voice control technology into cars. Audi, BMW, Jaguar, Mercedes-Benz and Toyota are thought to be among those that have signed up. This move is being seen as something of a sea-change for Apple whose involvement with the automotive sector has hitherto been seen as rather limited. Apple's system will only work with Apple products and relies upon Siri's cloud computing interaction to respond to customer requests as per the iPhone and iPad.

Integrating iPads or tablets in the vehicle cockpit as the main infotainment interface is being assessed by most vehicle manufacturers. Large, interactive and flexible screens in vehicles are gaining momentum. There are already examples, such as the Tesla S, where such screens are in use. Using an iPad, for example, as a central dashboard offers all the new ideas that smartphones and iPads embody while at the same time, potentially, helping to de-clutter the dashboard itself. Tablets and iPads also lend themselves to the provision of rear seat entertainment and open up endless possibilities with regard to interacting with passengers as well as the driver.

Where next for Apple?

Many in the industry think Apple's Siri is just the first move by Apple which is thought to be considering an automotive platform. Keeping consumers within its ecosystem is key for Apple and the screen HMI in the passenger car is one area where Apple could use its influence and success with consumers to encourage customers to stay with Apple and not move to Android.

Apple has also recently decided to drop Google maps on its iPhone. Both Apple and Google licence map information and GSI and then build their interface on top. The battle lines have been drawn in this area and one has to wonder if longer-term Apple has its eyes on the iCar. Google has already demonstrated its autonomous car and Apple must be watching this development with considerable interest.

Could the iCar become a reality?

Given the extraordinary power of the Apple brand and its near cult status among its many customers, the idea of an iCar is not as far fetched as it may at first seem. Indeed the role of the car is changing and as Microsoft has said *"the car is a mobile node in a network"*. Taking this a step further, it is entirely possible that Apple could design a highly stylish car that embraced all the very best innovations in consumer electronics and telecommunications and which would have enormous consumer appeal. With the advent of the electric car this is the one industry segment that would lend itself to this approach as it opens up the market for new players to take the lead. We are already seeing utility companies, mobile phone operators, telematics service providers as among those looking at entry into the electric vehicle market, so why not Apple? Furthermore, Apple could buy in the technology it needed and act as the systems integrator/final assembler, a business model it follows today through its contract manufacturing arrangements in the portable devices field.

When was the last time we can remember people queuing all night outside car dealerships? This is just a fanciful dream for most car companies but with an iCar Apple might just – one day pull it off.

SPAIN: FIRST WIND-POWERED EV CHARGE STATION INSTALLED

What is claimed to be the first integrated wind-powered electric vehicle recharging station has been installed at the global headquarters of environmental services company Cespa near Barcelona.

The Sanya Skypump was developed by Urban Green Energy (UGE) and GE. It pairs UGE's vertical wind turbines with GE's electric vehicle charging technology.

The companies said more Skypumps will be installed later this year in the US and Australia at shopping malls, universities and other locations.

"Since launching the Sanya Skypump, we have received inquiries from companies around the world that are looking to embrace sustainability," said Nick Blitterswyk, CEO of UGE. *"The Sanya Skypump is one of those rare products that enable institutions to demonstrate their commitment to the environment while providing a really useful service as well."*

Charles Elazar, marketing director of GE Energy Management's industrial solutions business in Europe, said: *"GE is launching a family of electric vehicle charging systems in Europe offering domestic and commercial users a range of easy-to-use, flexible systems to help make electric vehicles a practical, everyday reality."*

AUSTRALIA: CUSTOMS ASBESTOS INTERCEPT LEADS TO CHINESE VEHICLE RECALL

The Australian Competition and Consumer Commission is monitoring a recall of approximately 23,000 Great Wall and Chery motor vehicles with engine and exhaust gaskets containing asbestos.

The Chery J1 model and newly imported stock of both brands are unaffected by the recall, the commission said in a statement.

The asbestos is bound into gaskets in the engine and exhaust system and does not present any risk to passengers during use of the vehicle. However, the commission warned, "*consumers should not perform do-it-yourself maintenance that might disturb these gaskets*".

ACCC deputy chair Delia Rickard said, "*Asbestos is a prohibited hazardous substance and these engines and exhaust systems should only be worked on by qualified personnel using appropriate safety procedures.*"

The commission said importer Ateco Automotive had instructed all Chery and Great Wall dealers to 'stop sale' of affected vehicles, recalled gaskets that were distributed as spare parts, ensured all newly supplied cars and replacement gaskets are asbestos-free, arranged to directly advise car owners that gaskets should be replaced by authorised mechanics when replacement is required, arranged for warning stickers to be placed in the engine bay of affected cars, ensured that warnings and instructions for the safe handling and disposal of gaskets are provided with all spare parts that include an affected gasket and prepared a safety training video and other materials for automotive repairers.

"*The automotive service industry is experienced in managing this risk, as cars sold in Australia before 2004 often had gaskets that contained asbestos,*" Rickard said. "*However, consumers and automotive repairers must be made aware that the risk may be present in these much newer vehicles. This is the focus of the recall campaign.*"

"*All affected consumers will be contacted directly by Great Wall and Chery. In addition, they will provide training, warning stickers and safety advice to repairers. The ACCC will monitor the recall and Workplace Health and Safety Authorities will monitor the workplace safety issues,*" Rickard added.

The government acted after Australian Customs and Border Protection officers detected asbestos in imported spare parts, triggering a safety investigation.

The importation or use of asbestos has been prohibited in Australia since 2004.

An Ateco spokesman told Reuters the company was disappointed with the finding and had been assured by Great Wall and Chery that production had been halted and measures put in place to fix the problem.

"*We do have a letter of apology from the most senior levels of Great Wall management*" the spokesman said.

US: FORD FUSION ECOBOOST ENGINE USES SPACE SHUTTLE MATERIAL FOR DURABILITY

The new Ford Fusion equipped with the 2.0 litre EcoBoost turbo engine includes technology shared with NASA's Space Shuttle.

To prolong turbo life and combat thermal fatigue, powertrain engineers for the new Ford Fusion, in conjunction with a team at supplier BorgWarner, went to the upper limits of commercially available turbo materials when deciding on the turbine wheel for the turbocharger fitted to 2.0 litre EcoBoost variants.

The same material has been tried and tested in outer space, as a version of it was used on the Space Shuttle main engine's high pressure fuel turbo pump and the blades of its high-pressure oxidiser turbo pump.

The upper temperature limit for the turbine wheel used on the 2.0 litre EcoBoost engine in Edge and Explorer is 970 degrees Celsius (1,778 degrees Fahrenheit). But in the sporty 2.0 litre EcoBoost for Fusion and Focus ST, the addition of tungsten and cobalt gives the alloy an upper temperature limit of 1,050 degrees Celsius (1,922 degrees Fahrenheit).

The benefit of using such high temperature alloy is that Fusion 2.0 litre drivers can enjoy enthusiastic and spirited driving for the life of the car without degrading turbo reliability or its

mechanical integrity, Ford claims.

The BorgWarner K03 turbocharger features both water and oil cooling; when the engine is running, it is primarily oil-cooled, but after the engine is turned off, the water cooling system creates a thermal water siphon to help draw heat away from the turbocharger.

Ford claims that the Fusion 2.0 litre turbo's performance is further strengthened by an integrated exhaust manifold design that combines the cylinder head and exhaust manifold into one casting; this allows the creation of smaller internal passageways (reduced plenum volumes) that direct more exhaust gas energy into the turbo more quickly than a separate head and manifold assembly.

The Fusion turbo, they also can claim, is designed to run safely at speeds up to 190,000 rpm, and is the same turbo used in the new, high performance Ford Focus ST.

INDIA: MAHINDRA OPENING DETROIT TECHNICAL CENTRE

Mahindra & Mahindra, maker of utility vehicles, tractors, SUVs and owner of Ssangyong, is opening a technical centre near Detroit to supply engineering services to the huge US car industry.

Rajan Wadhera, Mahindra's chief executive for automotive technology and product development, told news agency AFP the new centre in Tory, Michigan, run by Mahindra Engineering Services, is the group's first such centre outside India.

They aim to have about 100 employees in the next six to eight months, company officials said.

"*Because of its ties to the automobile industry and motor sports, Detroit is known as the motor city around the world. We wanted to be part of that culture*" he said. Mahindra has already signed up General Motors, Navistar, Volvo and Bentley as clients for its engineering services, he added.

"*The company also discovered southeastern Michigan is very competitive in terms of property costs and is the home to a very deep pool of engineering talent*" he said.

Wadhera told AFP the company focus is on a "*frugal*" approach to engineering services. "*We are able to innovate while designing in value*" he said.

Other companies from emerging Indian and Chinese markets, notably Tata and Shanghai Automotive Industries Corp, also have set up offices around Detroit, pursuing a growing business in selling their engineering services to the big US automakers.

Mahindra, which started in the 1940s building copies of the World War II era Willys Jeeps, is a leading auto builder in India, selling about 500,000 utility vehicles annually in India and other markets.

"*We want to become one of the world's top 10 automotive brands by the end of the decade*," Wadhera said.

Mahindra already has a tractor plant in Texas. But an effort launched four years ago to build a network of dealers and begin selling its own utility vehicles in the US market never went ahead, angering a number of the dealers.

UK: 3D PRINTING TECHNOLOGY ATTRACTS GOVERNMENT INVESTMENT

The UK government is to encourage innovation in 'additive manufacturing' (also known as 3D printing) via a GBP7m investment in R&D.

Grants for collaborative R&D projects in 3D printing, will be awarded through an open competition to be managed by the Technology Strategy Board (www.innovateuk.org), the Engineering & Physical Sciences Research Council (EPSRC – www.epsrc.ac.uk), the Arts and Humanities Research Council (AHRC – www.ahrc.ac.uk) and the Economic and Social Research Council (ESRC – www.esrc.ac.uk).

Universities and Science Minister David Willetts David Willetts said: "3D printing technologies offer huge potential for UK businesses to compete successfully by embracing radically different manufacturing techniques that could be applied across a wide variety of global market sectors, from aerospace to jewellery.

"We believe this new investment will help UK companies make the step change necessary to reach new markets and gain competitive advantage. Building on GBP 20m of previous Technology Strategy Board support for additive manufacturing innovation, it will help secure more of this game-changing high value activity for the UK, driving economic growth and enhancing quality of life."

Iain Gray, Chief Executive of the Technology Strategy Board, added: "*We are delighted that this important initiative is supported by three research councils. By working together to stimulate innovation in this exciting and challenging area, we aim to accelerate the transition from fundamental research to the creation of new design, production and supply chain competences, capitalising on work we have previously funded. We want to make the UK a world leader in 3D printing. We are setting our sights high."*

The 'Inspiring New Design Freedoms in Additive Manufacturing' competition is focused mainly on innovations to help businesses bring components and consumer items made by additive manufacturing more quickly to market. It aims to help innovative UK companies take the next steps to accelerating the adoption of additive manufacturing technologies, overcome remaining technical barriers and explore new business models.

The competition will open on 3 December 2012 and further information will be available at the end of October.

Paul Pywell

Head of UK Operations for Lotus Engineering

Paul Pywell is Head of UK Operations for Lotus Engineering. Interview by just-auto's Dave Leggett.

What are the main areas and responsibilities that come with the role of Head of UK Operations for Lotus Engineering (LE)?

I am responsible for the day to day management of all areas of LE in the UK except Sales and Marketing. This covers all our technical groups, workshops, facilities and project management, each of these areas being headed by a Group Chief Engineer or Senior Manager. In addition to ensuring delivery of projects to our engineering customers this also includes R&D projects and other activities focussed on maintaining and growing capabilities. We have about 200 engineers here at Hethel supplemented by a string network of sub contract engineers who we call on when necessary

Describe a typical day (if there is one)...

As you may expect, there is no such thing as a *"typical day"* although there is a pattern. The day will normally start with a check on emails that may have come in overnight, either from our colleagues in North America and China. This allows me to set or adjust priorities before joining the senior technical team and sales managers in a start of day review of new opportunities. This ensures that we maintain a clear focus on emerging customer requirements and that we get the right focus onto dealing with them. As a rule the rest of the morning is spent dealing with project related issues, either specific project reviews or resolving issues such as resourcing. The afternoon is generally taken up with reviewing sales documents with the technical and sales

teams, any outstanding project or resource issues and staff matters. This of course doesn't include those days where I am visiting customers, supporting visits on site at Hethel or reporting into or working with the senior management.

How much project work takes place off-site - for example, working very closely with the client, wherever they may be?

Our engineers are regularly required to work at the customer's premises – whether this is for review meetings, development testing or vehicle optimisation and validation sign-off. This might be in the UK, Europe or Asia. We also have staff based at the customer's site for longer periods to support key phases of a programme.

The majority of our projects however are delivered from Hethel.

The UK auto industry seems to be faring relatively well at the moment. So how is the LE business doing this year?

LE is a part of Group Lotus so I am unable to give any financial figures related to our performance. Suffice to say that all of our engineers have been fully employed on either customer or part funded R&D projects in the past year. We usually have about 70 to 100 live projects on the go at any one time. We are also very supportive of the government's initiative to promote and invest in innovation in the UK and we are fortunate to be part of two worthwhile and high profile Technology Strategy Board projects, REEVolution and Ultraboost, which have not only enabled us to deliver worthwhile projects amongst other UK OEMs but also to help bring the vitally important high technology supply chain industry to the fore.

Is it a diverse mix of projects that LE is undertaking? Can you give me an idea of the kinds of projects that you undertake?

LE is always engaged in a diverse mix of projects, that's what makes it such an interesting place to work. We have a very broad range of skills that mean our projects can range from relatively small services or consultancy projects to full scale product development

In this respect we have the advantage that Lotus is a manufacturer which means that we have, or have access to, all the skills and competencies we need to deliver such a broad range of work. We've most recently been working on the build and development of 414E and the build of hydrogen powered taxis. We developed the turbo charged Campro engine for Proton, which went into production last year. We regularly undertake concept studies on powertrains as well as vehicle. Our chassis engineers are working on a number of ride and handling projects for customers in China as well as chassis design and suspension development for an exciting new sports car. The 414E project is a well publicised example of a part funded R&D project but we work on others, Ultraboost for example. We conduct engine testing for a number of engine manufacturers as well as EMS and engine calibration. On the lightweight architectures front we are working on a project with a major OEM to develop a composite crash structure.

And the client base...mainly OEMs, suppliers?

We have a very wide client base at present ranging from OEM's in the UK and Asia to Tier 1 suppliers in Europe and the UK.

We also have strong R&D relationships with a number of universities which continue to develop our capabilities and hence the business opportunities which we can pursue.

Do you do much work for non-automotive firms?

Occasionally, when the right opportunity arises. These would either be projects that are a little off beat but interesting or those where we can bring the disciplines of engineering production solutions to an innovative environment. It is always interesting to see how we can apply automotive techniques and technologies to other areas, and vice versa.

How does Lotus manage its engineering capability and how has it changed over the last ten years?

Our core capabilities in powertrain and vehicle engineering have been developed and maintained through continuously working on new projects over the years. This can be a bit reactive so we have, in the past year taken a more detailed view on our current capabilities and where we want to be in 5 years. This has been guided by the technology roadmaps we have developed to drive our R&D focus. Our relationship with our global client base as well as working with such bodies as Automotive Council and TSB gives us confidence that the technology roadmaps are realistic. We have developed plans for filling the gaps that are built around a combination of R&D, targeted projects, facilities development and staff development.

I think that the biggest change in our capabilities in the past 10 years is in the EV/HEV area.

What are the biggest challenges facing LE?

Ensuring that the services and technologies we offer continue to be relevant and competitive. Costs of delivering engineering projects are always under pressure, particularly with the growth of capability in India and China, while at the same time we need to deliver mature OEM technology and techniques to projects overseas.

Are there issues in hiring certain sorts of engineer (given general reports of skill shortages)?

Thus far we haven't had any issues with this. If and when we do need to grow headcount I would anticipate that certain skills will be harder to find than others, Software and calibration engineers, for example, are always in demand. We have always had the advantage that the strength of the Lotus name together with the variety of work has drawn in good talent. Our location in Norfolk also offers some benefits in terms of it not only being a great place to live, but also enjoys lower costs of housing etc.

What of the future? How are you planning for growth and do you see the focus of the engineering work carried out by LE shifting?

We've discussed the way we're planning our capability growth and development. Our growth in facilities is planned to be on the Hethel site, although I don't think we would rule out opening alternative office locations to support growth and get us closer to our customers, although that's not featuring in any of our plans right now. I think we'll see our work shifting in two ways, the first will be an increase in the work that we do that is electrical/electronic rather than mechanically biased - for example more calibration, integration of control systems, particularly with hybrid powertrains. I would also expect our work to be even more prominently led by analysis. All this will be augmented by our conventional core skills and experience.

What is the relationship with Lotus Cars Product Engineering team and Lotus Engineering teams?

We work pretty much independently of each other, although we can and do share resources when it is mutually beneficial and supports the flexibility on which we pride ourselves.

Why is there this separation between the two Engineering teams? It wasn't always like that was it?

The separation came about a couple of years ago. Previously all the engineering staff were in a single division. Current Engineering, i.e. Maintaining existing product was always pretty much embedded in the Lotus Cars organisation but new products were developed by engineering product teams formed out of LE. Separating the two meant that we in LE could focus wholly on delivering our customer programmes and did not have the risk of disruption from product demands. For the Product Engineering team the separation allowed them to remain focussed on their plans.

Lotus is in an enviable position where it can oversee the state of the automotive industry. What are the consistent fears of your clients and how does Lotus go about solving these issues?

I'm not sure about fears, from my perspective our clients continue to have the same concerns and drivers with respect to cost, time to market and quality. Apart from these givens the dominant issue is emissions. The technologies and techniques that we are either developing or being involved in are taking us down a number of the alternative carbon reduction paths, i.e. Engine downsizing, alternative fuels, light weighting, and hybridisation.

Our background and experience of working at whole vehicle level both as an engineering business and as a manufacturer means that we tend to take a holistic rather than just a system based approach.

Paul Pywell

Paul Pywell is Head of UK Operations for Lotus Engineering. He joined Lotus 26 years ago after working in the Defence industry for about 10 years. Immediately prior to his current job he was Head of Project Management, following a number of project and management roles. These included delivering projects for customers in North America, Korea and Malaysia as well as working on Lotus products. Paul is a Chartered Engineer with degrees from Loughborough University and the Royal Military College of Science.

Innovative Vehicle Testing

The Lotus design approach utilises efficient and innovative integration of sub-systems and components to create fully optimised solutions. Driven by system level engineering and pragmatic best practice methodologies, Lotus can truly demonstrate 'right first time' solutions. These industry leading skills lead to faster to market products facilitating faster access to revenue and reduced program costs.

One of Lotus' fundamental philosophies from the very beginning of the company has been to continually push the envelope on innovation. This pioneering approach has led to a position of technology leadership in our core competencies - lightweight architectures, driving dynamics, efficient performance and electrical and electronic integration.

Fundamental to our full service supplier status is our extensive testing and validation capability. Lotus has recently invested in upgrades for the engine and vehicle semi anechoic chambers at Hethel. These are now equipped with new Matadyne cones. Further investments are planned for the emissions lab to compliment the recent investment in a particulate counter and the equipment required to get to EURO 6 Certification Level.

A number of test beds have been modified and have new equipment to support hybrid/electric system development utilising battery simulators and HiL systems. These are being developed by the controls group which can then support the move from test bed to vehicle all delivered from one area with experience of delivering the complete package. Lotus believes these additions demonstrate our commitment to supporting sustainable transportation objectives well into the future.

Our testing and validation team provides class leading best practices and state of art technical methodologies that ensure Lotus can provide robust data and results that our clients can trust to comprehensively support their product development.

Lotus Engineering based at Hethel, Norfolk, provides confidential comprehensive engineering services and facilities, including:

Engine test beds capable of supporting 10 to 500 kW engines, steady state, transient, for calibration, development, validation programs with the full support services on one site to deliver the project.

Air flow lab, metrology, engine build and strip, electrical workshop, instrumentation lab, vehicle and component rig test, machine shop, fabrication, battery build, FIA approved test track.

A variety of test fuels including gasoline, diesel, alcohol, as required.

Vehicle emissions lab with soak space for 12 vehicles, 2 sets of chassis rolls and 2 sets of emissions analysers, particulate counting and filter weighing room.

Vehicle development utilising vehicle workshops with a variety of ramps to suit different vehicle and function needs. Specialist equipped electric vehicle areas.

Kinematics and compliance rig area supported by the vehicle dynamics team. All the facilities are backed up by engineers and technicians from a variety of disciplines with many years experience from across the industry.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Winter Tyres

Benefits of winter tyres and managing the compromises

This article looks to expound the available data, explore some of the oft' quoted myths and to establish if winter tyres really are of benefit to the average motorist.

The first and obvious thing to point out is that tyres are the only points of contact between the vehicle and the road surface. As such they have the final, crucial influence on the dynamic performance of the vehicle: no matter how expertly tuned the anti-lock braking (ABS) and stability control (ESC/ESP) systems may be, they are only as effective as the level of grip provided by the black, round pieces of rubber! Hence the safety and mobility of the vehicle, and the occupants inside, is ultimately down to the performance of the tyres.

The primary functions of the tyre include the requirement to both transmit and react the forces generated by acceleration, braking and cornering. This can be simplified as the level of grip provided by the tyre. Often the attributes and features of the tyre required to maximise grip can be in conflict with the requirements to meet other functions including reduced rolling resistance (improved fuel economy), improved NVH (reduced noise levels), reduced mass and vehicle styling aids. In addition there is the need to meet these diverse requirements over a wide range of both climatic and road conditions, covering a wide variety of vehicle classes. So, as with many aspects of driving dynamics, the performance and design of the modern tyre is all about 'managing the compromises'.

Wide range of tyres

If you are in the market for replacement tyres on your car - as well as the large selection of manufacturers to choose from, you will be presented with the option of a number of different types of tyre, based on their application: all season, summer and winter. One popular misconception, especially here in the UK, is that winter tyres only provide performance benefits in snow and/or ice, and hence are often mistakenly referred to as snow tyres.

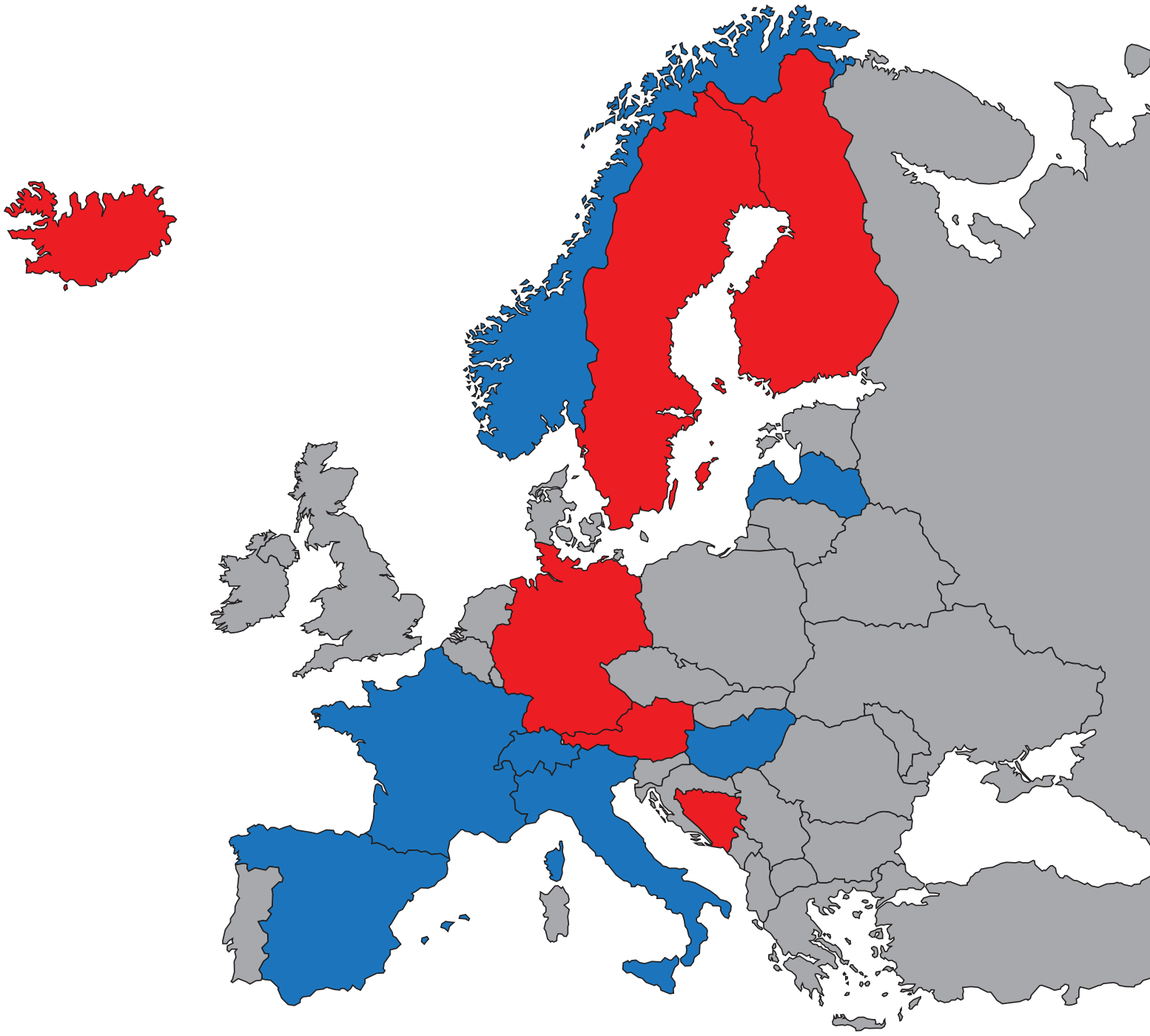
Winter tyres are also often confused with studded tyres. These misconceptions are not helped by what may be considered both confusing labelling and inadequate standardisation. This may help to explain why there was such a low take-up of winter tyres in the UK (less than 1% of motorists), as the number of days where snow covers the ground is very low and hence can't possibly justify the investment in a second set of wheels and tyres for those rare occurrences. As we will see from the data presented below, perhaps it would be more accurate and representative to term them 'cold weather tyres'.

Winter tyres are either completely mandatory or mandatory within a specific time period.

Winter tyres are either recommended or compulsory under certain conditions or on designated roads

In these countries there is no formal legislation regarding winter driving

Note: In some countries snow chains may also be required.. Drivers should check for the latest requirements of the countries they are travelling to.



2WD and 4WD

Another common misconception is from drivers of the increasingly popular compact and crossover SUVs plus other 4WD vehicles, who mistakenly believe that 4 wheel drive will provide them with added safety measures when driving in adverse weather conditions and on snow and ice, hence negating the need for winter tyres. Whilst it is true that the 4WD system will provide additional traction to get you moving, and provide some benefit during cornering, it will be no better than a 2WD vehicle in braking and stopping performance.

It is the tyre grip that we are interested in. This grip, and hence the tyres ability to generate traction, is in particular a function of the tyre's tread design, which in turn is defined by the chemical composition and mechanical construction. The winter tyre is actually designed to work optimally in cold, wet conditions, with or without snow or ice on the ground. In fact the deciding factor on when to change to your winter tyres should be based solely on the ambient temperature, with the threshold set at 7°C (44°F). This is why the legislation that is in place generally applies over a set period, typically November through to April, when the average day time temperatures are at or below this level. So how do the manufacturers optimise the winter tyre design to work in these conditions?

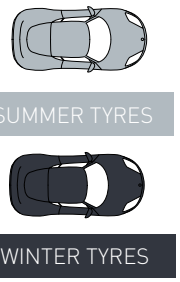
Tyre Composition

Looking first at the composition there are some important changes required to the chemical make up of the winter tyre to enable it to provide improved performance over summer and all season designs in cold and wet conditions. The improvement comes from the winter tyre's ability to maintain the elasticity and flexibility of the tread, at low and even extreme sub-zero temperatures. This flexibility enables the tread to adapt to the contours of the road surface, maintaining the contact and hence grip. Although manufacturers are not keen on disclosing their unique recipes it is possible to simplify down to a combination of rubbers (natural and synthetic) with additional fillers (including carbon black and silica) and additives. To maintain flexibility at low temperatures, the manufacturers increase the ratio of natural to synthetic rubber and replace carbon black with increased amounts of silica. The increased silica content also has the added benefit of both lowering the rolling resistance and improving the wet grip of the tyre. The compromise for the tyre manufacturer is to optimise the rubber flexibility at low temperatures, and hence maximise the grip, whilst minimising the increase in wear rate that may be experienced when the tyres are used in conditions above the threshold temperature.

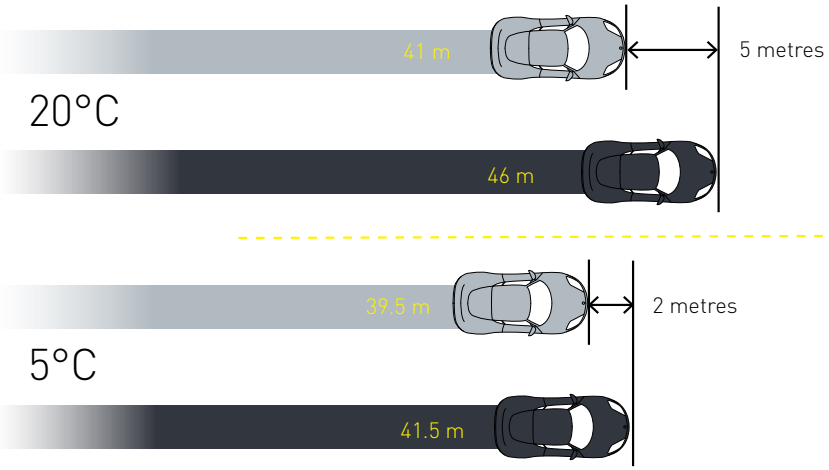
The changes in mechanical construction of the winter tyre tread are rather more obvious to see, when compared to your normal, summer tyre. Typically the tyres have a directional pattern (making them uni-directional), with more blocks and with deeper grooves. This improves the pumping capacity of the tread, and hence reduces the chances of aqua-planing. The increase in the number of tread blocks also increases the number and length of leading edges presented to the road surface. This feature not only improves the grip and traction, but has particular benefit in improving the braking performance. This is further increased by the addition of multiple 'slits' in the tread blocks. These so called sipes (named after their inventor John Sipe, who back in the 1920's introduced them on the rubber soles of his shoes to improve the grip on wet floors) can increase the total length of leading edges on a winter tyre to in excess of 80 metres (even for a 16'' tyre). The sipes also aid in the dispersion of water between the tyre contact patch and the road surface, further improving the grip.

Exige winter tyre on the left compared with Exige summer road tyre on the right.

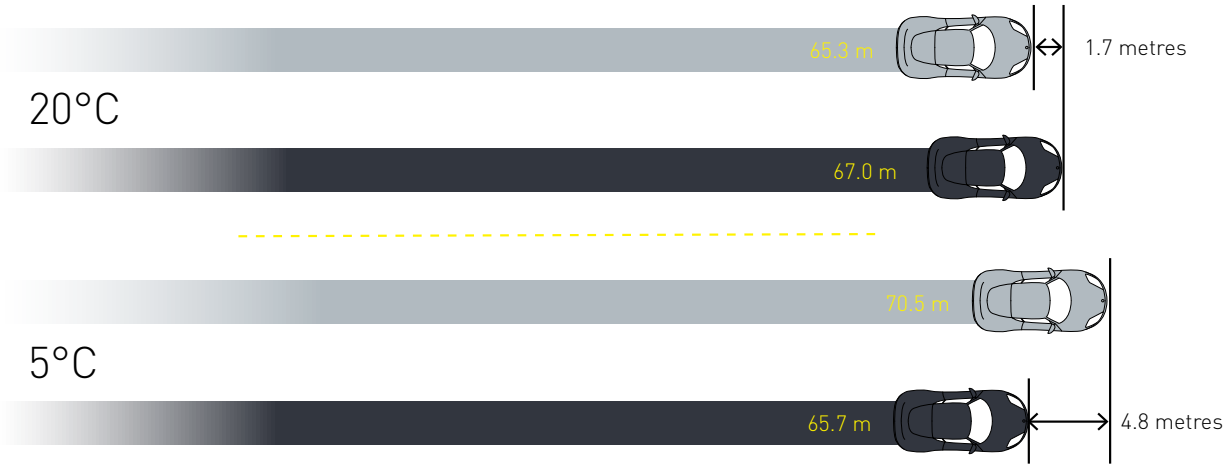
Graph comparing the stopping distances of summer and winter tyres at different temperatures and road conditions.



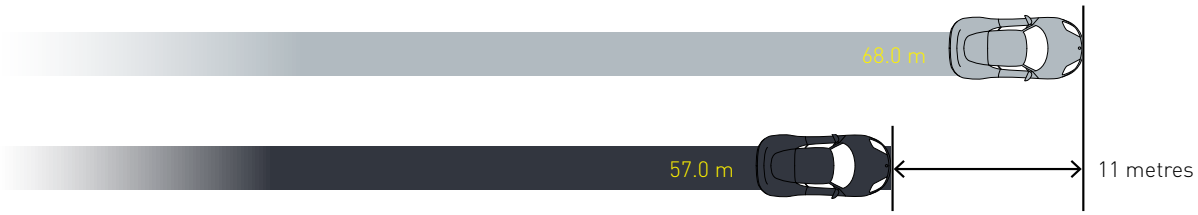
BRAKING ON DRY ROADS FROM 62 MPH



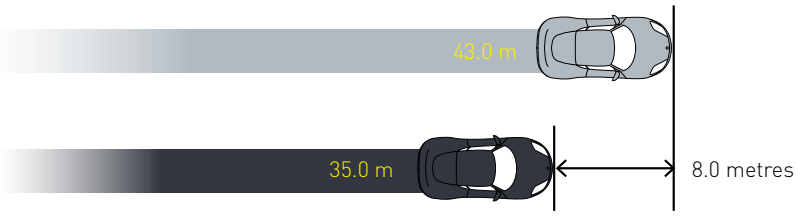
BRAKING ON WET ROADS FROM 62 MPH



BRAKING ON ICY ROADS FROM 20 MPH



BRAKING ON SNOWY ROADS FROM 30 MPH



An additional benefit of the increased number of tread blocks and depth is that the movement of the blocks under load generates temperature in the rubber, which helps to maintain the flexibility of the tread. This movement also helps remove debris from the grooves.

A compromise that then has to be managed is the balance between improving traction through the increased number of tread blocks and sipes, against the loss of steering feel due to the movement of the tread relative to the sidewall of the tyre. This can give a disconcerting and disconnected feel between the steering wheel and the road surface.

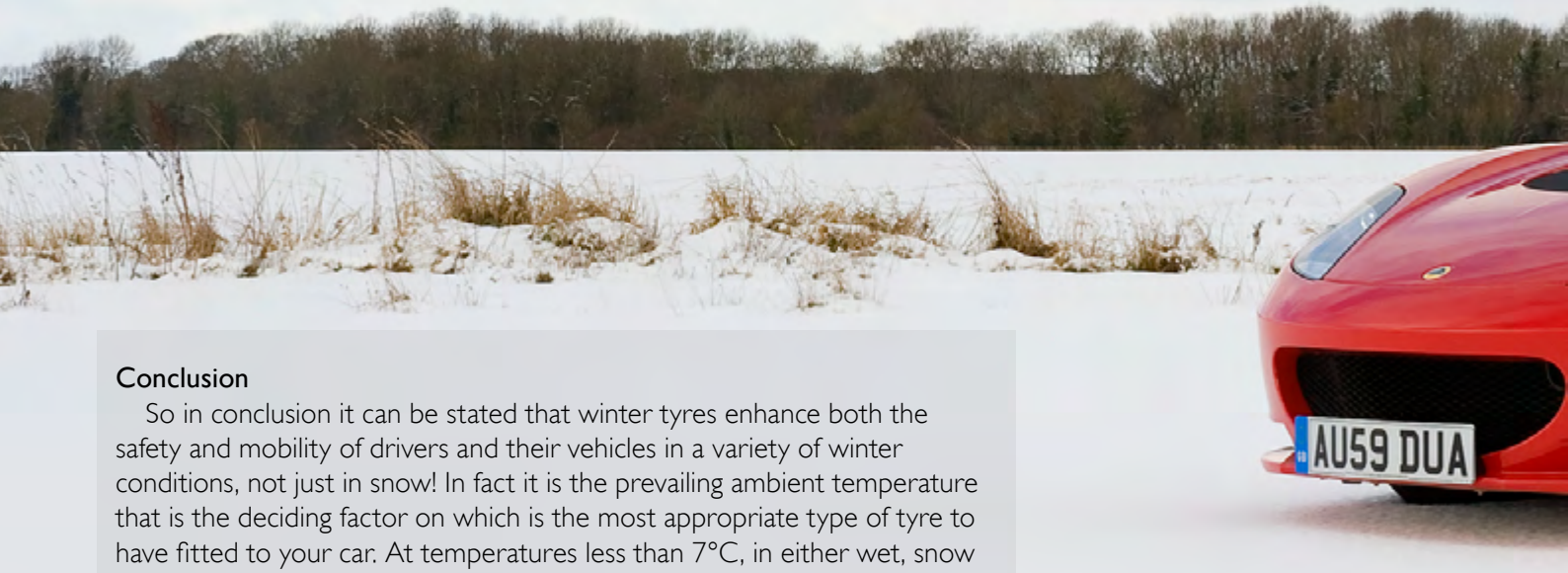
To overcome this issue manufacturers are introducing designs where the tread blocks and sipes interlock with increasing lateral load and hence improve the steering feel especially when cornering on a dry road.

So what do these advances in composition and construction mean for the safety and stability of your vehicle when fitted with the latest winter tyre? This is probably best demonstrated with a graphical representation of the comparison in the stopping distance performance between summer and winter tyres in a variety of different conditions.

There are numerous published results for winter tyre testing available, many including handling as well as braking tests in the various conditions, and all show the same trend: as soon as the temperature drops below 7°C, on anything other than a dry road, the winter tyres offer a distinct advantage in performance.

Tyre labelling

So, now that you've been convinced by the performance gains achievable, what should you be looking out for to identify the winter tyres when you go to buy them? Unfortunately this is where it gets a little less precise! As referenced earlier, both current legislation and tyre labelling are not well defined, in the European Union (EU) at least,



Conclusion

So in conclusion it can be stated that winter tyres enhance both the safety and mobility of drivers and their vehicles in a variety of winter conditions, not just in snow! In fact it is the prevailing ambient temperature that is the deciding factor on which is the most appropriate type of tyre to have fitted to your car. At temperatures less than 7°C, in either wet, snow or icy conditions, winter tyres have been proven to show a marked benefit in performance over your regular summer tyre. The tyre manufacturers have achieved this through developments both in the chemical composition of the materials used and in the mechanical construction of the tyre, primarily in the design of the tread.

Now that it has been demonstrated that tyre manufacturers have been able to manage the compromises in design and construction of winter tyres it is down to the end user to manage the compromises of having two sets of tyres, summer and winter.

although this is about to change. Sidewall markings for winter tyres have historically shown 'M+S' (mud and snow) but although this defines what a winter tyre should look like (tyres with a tread and structure designed to provide better handling characteristics in slush and fresh or melting snow than normal tyres), it is based on a manufacturer's declaration with no form of testing. It also takes no consideration for the change in tread compound required to ensure operation at reduced temperatures.

New EU Legislation

To address this issue the EU will shortly implement, from November 2012, a new regulation updating the definition of a winter tyre. This is based on the current North American standard and requires the tyre to be tested using an ASTM testing procedure, and achieve a traction index equal to or greater than 110 (where 100 is a standard reference tyre performance). On achieving this rating the tyre is able to carry the 'snowflake on the mountain' symbol on the sidewall.

In summary whilst tyres marked only with the 'M+S' symbol may have improved performance over a summer tyre in snow and slush, they should not be taken as the definition of a winter tyre, which is indicated by the 'snowflake on the mountain' symbol.

Tyres bearing this symbol will provide superior winter (and snow) performance. Currently most, if not all, winter tyres are marked with both symbols.

Author: Pete Studer

Derek Crabb

Vice President for Powertrain Engineering at Volvo Cars

Derek Crabb oversees Volvo Cars' powertrain engineering and is also executive director for the company's motorsports activities. He's been with Volvo since 1998 and he tells just-auto editor Dave Leggett about the company's current powertrain strategies.

DL: I guess there's a pretty rich history with Volvo and powertrains, not least because the firm has a long history of being independent?

Yes, that's right. When I first came here Volvo was an independent company and we were aggressive in our own powertrains, developed our own petrols and diesel. Then we went into Ford ownership for a ten year period. We shared lots of Ford engines and stopped developing our own engines and we also cut back engineering resources for engines and so on. Now, as we have emerged from Ford, we have had to be self-dependent in engines again. We are now very aggressively developing our own engine programmes. So we have to grow the competence internally, both through recruiting and using consultant house, we use a mix of our own test facilities and some that we rent in.

DL: How does that play into what you see as the big trends in the industry with respect to powertrain?

Well the big trend is downsizing and down speeding and we have to get onto the back of that trend. We are developing a modular engine family with petrol and diesel engines, all four-cylinder. We have our own factory two hours from here that was already designed to do modular engines when I first came here. At that time we had 4-, 5- and 6-cylinder engines and were starting to develop a similar 4-, 5- and 6-cylinder diesel family. We got as far as 5-cylinder. So we're going back to that base with a whole new engine structure.

DL: And that means you won't be doing anything larger than 4-cylinder?

That is correct. We have a 6-cylinder at the moment which we take from Bridgend [Ford] in the UK, but we will eventually stop taking that. When that time comes, Volvo will also have a new platform – a platform of our own, a large car platform – and that will be ready for the future, particularly electrification. It will not be capable of taking anything more than 4-cylinders.

DL: Will that be problematic in the US market?

Short-term perhaps, but it is more a time issue. But when you look at the predictions for growth for 4-cylinders and reductions in 6-cylinders, you'd be a brave man to invest in 6-cylinders at the moment. The period in the middle of this decade may be problematic for us. We need to consider the wishes of Volvo customers and they don't seem to want absolute sporting performance at that end. You can fill in on top of 4-cylinders with a degree of electrification and get 6-cylinder equivalent performance. The technology is available and the question then becomes, can you balance the business case?

DL: That all sounds impressive and obviously comes at a cost. Some OEMs are opting to collaborate on powertrain projects. What are the main advantages in going it alone?

A major advantage is that we had a factory in place to do modular engines. We are not having to reinvest in a whole new factory. We can do about 500,000 engines a year, which meets Volvo's immediate needs. That makes the business case work.

But its not just about the plant.

If we take 'total powertrain', it's not just the engine, it's the transmission, the fuel system, cooling systems, it's all the calibration. By taking all the Ford engines from different sources with different designs, with exhausts at the front, exhausts at the back, we worked out how

much money we were spending on application activity – so many different types of fuel tanks, exhaust systems – and we futured that and we compared that to doing a modular engine with a much reduced range of exhaust systems and cooling systems. Again, the business case was evident. It's about control of complexity and commonality moving forward.

DL: As far as Europe goes, do you think we will see more gasoline engines?

Yes, but there's a real conflict coming up. Gasoline engines are a negative in terms of fuel economy compared to diesels, but if we start to go into real-world emission measurements then diesels could get pushed out or made more expensive. I think we are going to go into more gasoline, but I don't think it will be as dramatic a shift as when diesels came in, but I think it will drift in that direction.

DL: Diesel plug-in hybrids appear to be a technology focus for Volvo. How significant do you think they will be for Volvo?

I think they will be significant. Our 5-cylinder diesel and 5-cylinder gasoline are built off the same facility and have many features in common, so for us it's a fairly easy mechanical process to change from one to the other. We're protected in both directions.

DL: And what sort of increase for Volvo hybrids do you see?

I think it will be gradual over the next ten years. What we are doing at the moment is introducing them, watching the market reaction, controlling the volumes and seeing the evolution of the business case. It's about preparing for the next platforms to really make this thing work for us.

DL: And gasoline hybrids for the US?

I think that's inevitable and not just the US. China is another market with a strong preference for gasoline.

And there's a reality with all these new developments at Volvo that we have to fund this. We're at the stage of prioritising to get the business base stable and then we can grow into new areas as the business allows.

DL: Why do you think diesel hybrids have taken so long to emerge?

The building blocks are straightforward – diesel engine, hybrid technology, ERAD – but the control technology that links it all up and meets all the customer demands, what happens when you start the engine, controlling NVH... that's all quite complex. In essence we end up with three buttons on how you drive the car but there are lots of permutations on how you control the combination of diesel and hybrid. That's where the biggest challenge has been, making sure that it is a fault-free experience for the customer.

DL: What's your view on the international emissions regulations that you have to work to?

They are converging to a certain extent and they are not as aggressive in terms of the step changes as they used to be.

CO_2 is the big issue for us now. The legal demands are there, but competitive pressures are actually greater than the legal demands. The planning long-term is really important. If you are stuck with the wrong architecture or engines, you are not going to get to where you want to be in the long-term.

DL: So how are you meeting that CO_2 challenge at Volvo?

In the short-term I think most brands are offering a low CO_2 derivative. We have driveE which offers a low CO_2 variant. We do lots of work on real fuel economy. The new model architectures – on engine and vehicle - have lots of CO_2 actions, frontal area, aerodynamics, weight-saving. On the engine we ensure that it has low frictional losses, the right combustion chambers, right after treatment. It's about lots of things and about lots of details. If the architecture is wrong and the weight reduction is absent, you're never going to get there.

DL: It's a holistic approach...

Correct. There's not one magic solution.

DL: And I guess turbochargers figure quite significantly?

Yes, it's turbochargers on everything. It's just a question these days of how many turbochargers you can fit on an engine.

DL: A few years back – and there was something of a focus on this in Sweden – biofuels were seen as a positive growth area. There was a fair amount of excitement on prospects in this area in Europe, but it's gone quiet in the last few years. What's you take on that?

There is very little work on that going on here. Demand seems to have fallen away for things like E85 fuel. There are some customers but nothing major in terms of development. For flex-fuels, we use an external house to convert our cars now. It is very low profile for us at this moment. There are other priorities.

DL: What about Volvo and electric cars?

There is already a fleet of C30s running around that are pure electric. We've got some in Sweden and some in China. So our first development is in a trial. We have produced just short of 300 of these cars now. The C30 electric has been in fleet use for about a year.

DL: Are there many technical tie-ups or synergies emerging in the powertrain area with [parent company] Geely?

It's an interesting question. At first we assumed there would be huge demands on us for technical assistance in one way or another, cooperations and supplier stuff. But Geely started off by saying: Volvo is an independent business and we'll manage you at the bottom line level; we'll put investment in and we want a return on investment; how you wish to cooperate is up to you.

So there were no deep demands like we have seen with other companies where you have to do so much percentage share of in-group parts, for example. It's a very mature management style.

Obviously we knew we have to start selling in China, so we built our own test facilities and R&D facilities in China. At the moment I have just under 50 engineers in Shanghai working for me on doing application and calibration work.

We have had talks with Geely to discuss areas we could explore together and maybe future engine architectures is one area, but at the moment those discussions have not gone very far at all.

DL: You're being left to your own devices...

Volvo and Geely are very separate entities both financially and also from the point of view of having very different brand images. You don't want to disturb one with the other. Geely could not afford our cost base, we couldn't afford their image on our cars. The Geely top-level approach has been very dogmatic about that.

DL: Will Volvo engines be made in China?

Inevitably. At the moment we are building an S80 long-wheelbase for China. We were building in China out of a Ford plant before, so building in China is not unique for us. If we are going to push our volumes up in China, we are going to have to build engines in China. We are looking at an engine plant too.

DL: And the same modular approach for engines in China?

Yes, we need to be able to flex on engines. And we have to have some degree of complexity control and commonality – and sharing - to justify the huge sums we are investing in powertrain at the moment.

DL: How quickly do you see the production economics for electric cars – generally – changing so that the cars can have a lower price tag and get more share?

We have been gathering data on driving patterns and you start to realise that a lot of customers can live with electric cars. Therefore there has to be some sort of business model on how fast the battery costs come down, how many customers are there really out there. There are still a lot of uncertainties. Beyond that, I think range extenders are a potential way forward.

DL: And Volvo could go down the REEV route?

There are several ways of doing it and we are building three different prototypes at the moment, with Swedish government money, in this area.

DEREK CRABB

Derek has held the post of Vice President , Powertrain Engineering Volvo Car Corporation since 1998. He has managed over1000 staff based in Sweden and China. Responsible for engines, transmissions , control and calibration plus all application components such as exhaust and cooling systems. Derek is also Executive Director, Volvo Motorsports responsible for the Volvo Polestar Team in Sweden and other local market motorsport events

- From 1984 to 1998 Derek held various positions in Rover Group leading to Director for Powertrain Engineering for Rover, Land Rover and Mini brands. The first years were in deep cooperation with Honda but the last period involved integration with BMW.
- During 1982 to 1984 Derek was a Project Leader Lotus Cars. Development of a competition engine for an external company
- 1979 to 1982 Development Engineer, Rolls Royce/Bentley working on advanced engine projects
- 1975 to 1979 Research Assistant Imperial College London working on combustion processes
- 1970 to 1975 Engineer, Perkins Diesels , Peterborough

Qualifications: PhD in Combustion Fluid Dynamics and BSc in Mechanical Engineering

DL: How do you think the powertrain split will look in twenty years' time?

I delivered a lecture twenty years ago and was asked the same question. I was actually roughly right. But I think 2032 is very hard to see. There will be combustion engines around, but the split is difficult to call. Fuel cells are an interesting one. There is more focus in that area now.

One thing I'll say is that if we are laying down vehicle platforms now to start in say 2015, they will run for 15 years as most vehicle platforms do, so we're talking 2030. Some of the stuff we are laying down now has to cover for that period.

DL: There's much more life in the combustion engine yet...

I think so.

DL: Just to pick up on fuel cells, some manufacturers are talking about 2015 as being a key year and claiming that they will have fuel cell production vehicles by then...what's Volvo doing?

In the Ford period we did nothing, the parent company was making some investment in that area. Since we have been independent we are starting to go more seriously into it. We see some advances coming forward that we can't ignore.

Full Acceleration

Electric Versus Combustion Engine for In-vehicle Performance

Comparing the acceleration of the high torque single speed electric powered 414E Hybrid with 6 speed combustion powered Exige S

A clear dynamic benefit of electric traction for vehicular use, especially in comparison to internal combustion engines is that they produce very high torque from zero rpm. Additionally electric motors do not need a clutch to move a vehicle off from stationary and also, in theory, can function without the need for a gearbox with changeable ratios, thus saving weight and cost of several major components found in a conventional vehicle powertrain. These advantages, combined with their potential to improve noise, vibration and harshness (NVH) of a vehicle, make them attractive, especially with the environmental benefits of zero tailpipe emissions.

Electric motors provide high torque

In concert with the general characteristics of electric motors, many electric motor-propelled vehicles are implied to have high performance due to the very high installed torque quoted. This is especially the case with 'wheel' and 'hub-motor' configurations. An example is the Lotus Evora 414E REEVolution, a range extended electric vehicle (REEV), which has individual motors with a single-ratio reduction gearbox for each driven rear wheel, these motors each producing 500 Nm and 150 kW (combined they produce 1,000 Nm and 300 kW).

Both the motors are bolted to a single transmission housing, and from this it could be imagined that the motors are coupled together directly, in fact they have completely separate single-stage reduction gearsets and therefore each wheel is individually driven (hence the use of the term 'wheel motor'). This negates the requirement for a differential and facilitates the use of torque vectoring via direct motor control as a vehicle dynamic control strategy. Together with the deletion of a stepped ratio transmission, this vehicle therefore has a much simplified drivetrain from battery to wheel.

To illustrate the attraction of an EV or REEV drivetrain, Fig. 1 shows the maximum performance torque curves for the Evora 414E and a production Evora S, which has a 3.5 litre supercharged V6 engine with 400 Nm and 258 kW (345 bhp).

In Fig. 1 the shape of the electric motor performance curve from 2,900 rpm onwards is a rectangular hyperbola: the motors each produce their maximum power of 150 kW (300 kW combined) from this speed up to their maximum rotational speed of 8,000 rpm.

The electric motors installed in the 414E together produce more torque over the entire speed range than the combustion engine, and from this one might imply their performance in vehicle would be far superior, having as they do 1,000 Nm over a very wide speed range versus the 400 Nm that the spark-ignition engine produces at its peak.

However, reality is somewhat different. The historical development of the internal combustion engine (ICE), and with it the necessary transmission technologies to provide driveability, means that the real situation is much

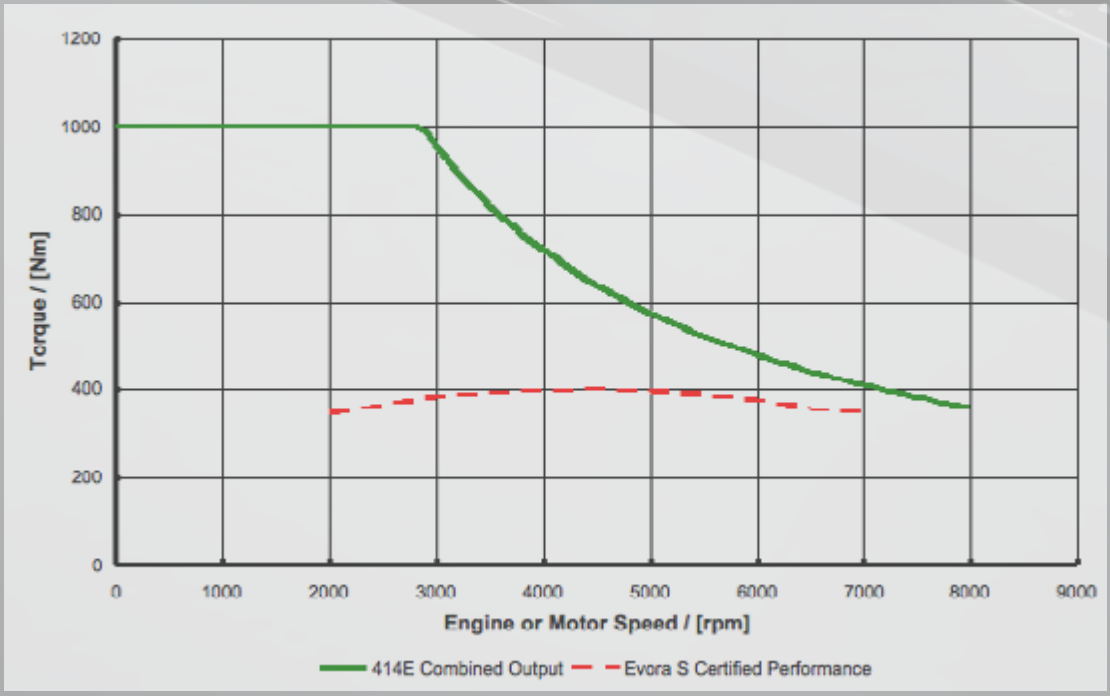


Fig. 1: Combined torque output from Evora 414E electric drivetrain versus certified performance for Evora S internal combustion engine

more complicated. The effect of employing changeable gear ratios is to increase the torque delivered to the wheels (at the cost of reducing the vehicle speed range that the gear can be used over).

If one plots the so called 'cascade curves' for the two vehicles, which take into account the individual gear ratios, final drive ratios and the tyre rolling radius for each, a better comparison can be made. Such cascade curves give the thrust (or tractive force) available at the wheels for each gear versus the associated vehicle speed, shown in Fig. 2.

Fig. 1 shows that in 1st gear and up to 40 mph (64 km/h) the Evora S produces more thrust at the wheels than the 414E. One can also see an illustration of a more general point about in-gear performance insofar as, for the Evora S, there is always more thrust available in a lower gear (if it is safe to use it), and so for maximum performance the engine should be fully revved-out; conversely if the curves were to cross, it would be worth changing up to gain more thrust (and hence acceleration). From this, one can readily discern how tuning an engine for more high speed power at the expense of mid-range torque generally produces better standing-start performance in a vehicle. More specifically for the case under consideration, as soon as the driver has to change out of first gear in the Evora S, the 414E potentially has better performance, a situation compounded by the time taken to disengage drive using the clutch, change gear and reengage drive, a process which necessarily incurs a time penalty in a standing-start acceleration run.

Thrust

It is thrust which pushes any vehicle along, and this metric of course allows road vehicles to be compared with boats or aircraft. The latter case is interesting because power is a function of force times velocity; thus, while a jet engine produces thrust it requires the aircraft to be moving for it to produce power. While this may seem a technicality as far as road vehicles are concerned, it is interesting to note that an aircraft with its brakes on producing maximum thrust for take-off is actually producing no power; similarly, doubling the speed of an aircraft for any given thrust doubles its power.

Gearing allows a road vehicle's power to be converted into thrust and an easy connection to be made between the two. However, as far as performance is concerned, one has to bring in the effects of mass, and dividing the thrust by the mass provides a better metric for in-vehicle performance. Although it is accepted that since it ignores drag, rolling resistance and gradient this is a somewhat simplistic approach versus full vehicle performance modelling, it does at least permit an important vehicle attribute to be factored in. The mass-corrected cascade curves for the cases under discussion are shown in Fig. 3.

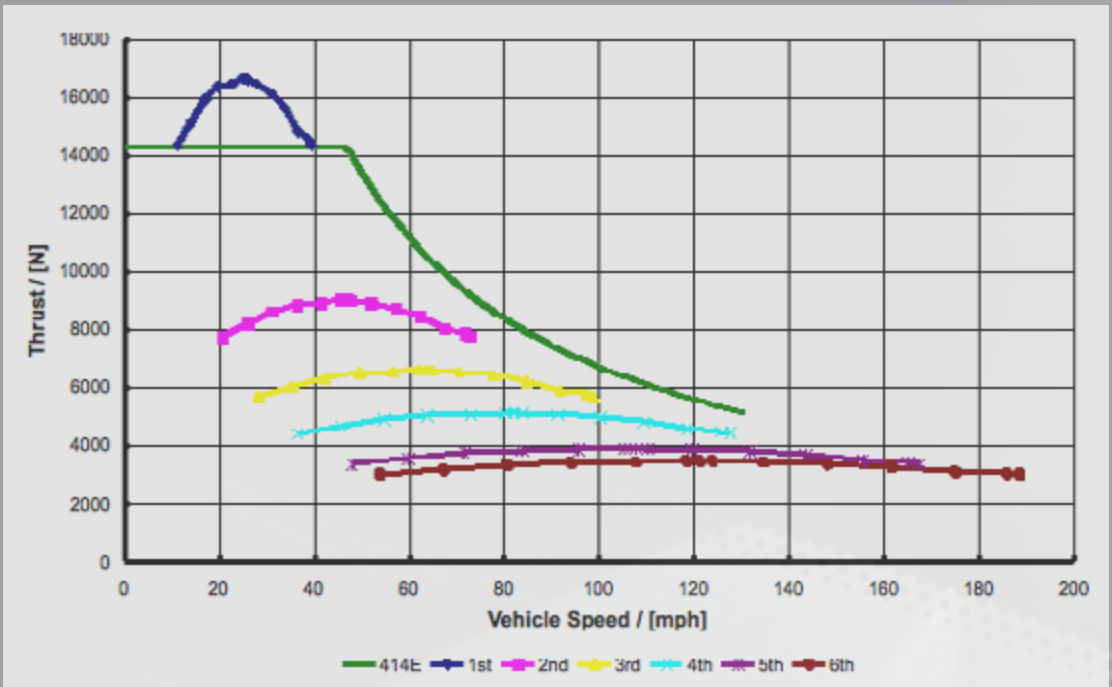


Fig. 2: Cascade curves for Evora 414E electric drivetrain versus Evora S with internal combustion engine and stepped-ratio gearbox

Single ratio gearing on electric motors

In Fig. 2 and Fig. 3 the corollary of an important early choice during the 414E project is evident. The vehicle effectively 'runs out' of gearing at 131 mph (211 km/h) while having surplus power – this is illustrated by the fact that the maximum speed of the Evora S is 178 mph (287 km/h), the two vehicles have fundamentally the same aerodynamics, and the 414E has an additional 20 kW. One can 'correct' this by altering the reduction gearbox ratio from 4.588 to 3.377. The effects of this theoretical change are shown in Fig. 4, where the 414E now reaches the same maximum speed of 178 mph as the Evora S. However, the maximum thrust has been reduced and now the comparison is much closer (excepting that 1st gear in the Evora S now provides almost twice the thrust per unit mass). Note that the position of the rectangular hyperbola is the same, since the motors produce the same power; the difference is that the motors now start producing peak power at 64 mph (103 km/h) instead of 47.5 mph (76.5 km/h).

These observations explain why EVs sometimes use two speed gearboxes in order to minimise the amount of installed torque necessary to accelerate the vehicle at low speed. Such gearboxes also help with gradeability: another reason for IC-engined vehicles having low 1st gears is to allow them to produce the thrust necessary to move up steep gradients. This is a requirement which EVs will also have to meet in the marketplace. Of course, adopting any form of change-ratio gearbox will put cost back into the vehicle, but since motor prices increase as they provide higher torque, the cost benefit ratio could easily still be favourable.

The final point to make is that often the torque and power quoted for an electric powertrain is the maximum it can deliver before it has to down-rate due to thermal issues, which could be due to the motor, battery or power electronics. This is the reason why the 414E is geared as it is: at a certain point dependent on time, temperature and power generated, it down-rates, and in fact maximum vehicle speed is delivered at that condition. Assuming a down-rate of 25%, the cascade curves of Fig. 4 become those of Fig. 5. Here the performance of the vehicle drops below that of the Evora S essentially throughout the speed range (if the engine is being revved out). Once temperatures have stabilised, the full performance becomes available again.

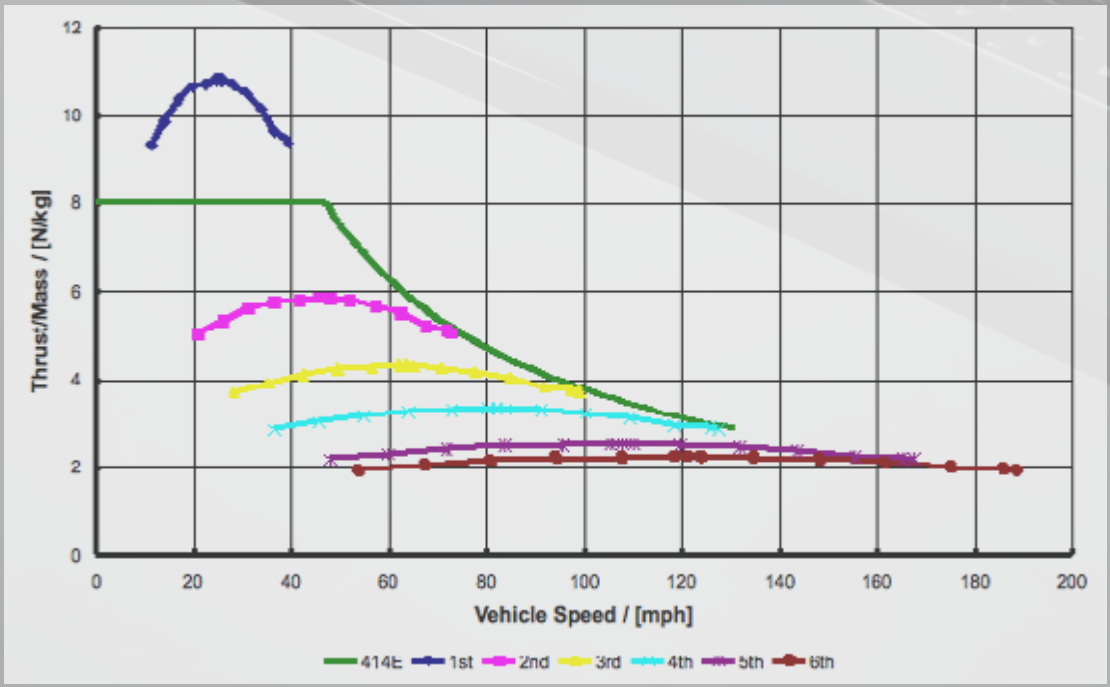


Fig. 3: Cascade curves of Figure 2 corrected for vehicle mass

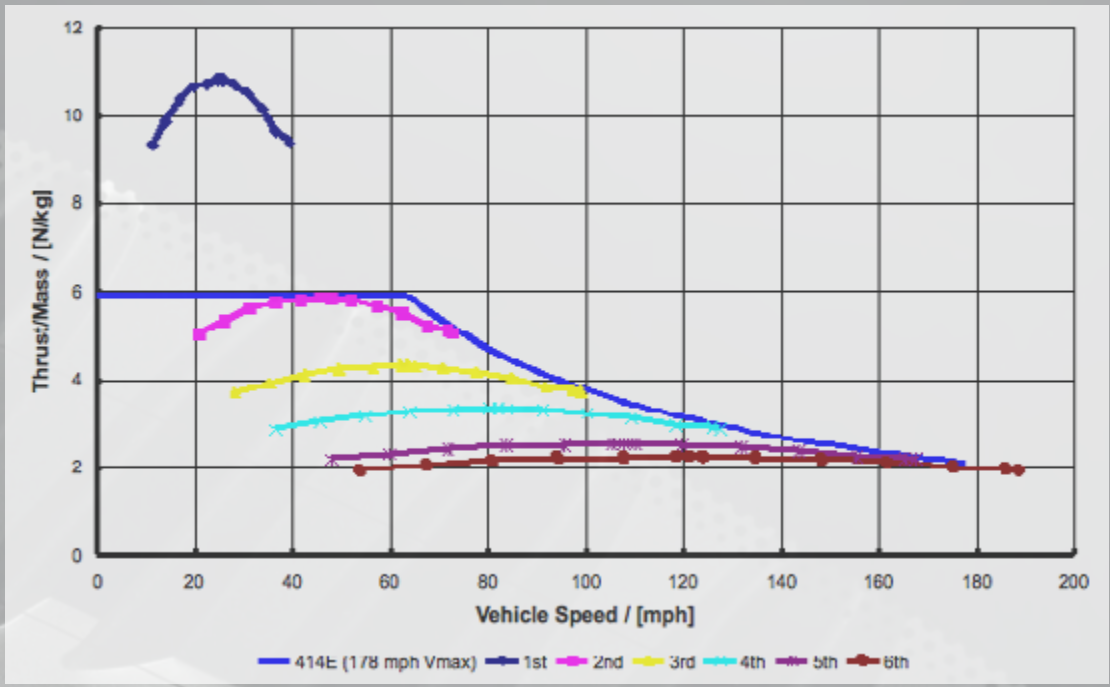


Fig. 4: Mass-corrected cascade curve for 414E adjusted to permit the same maximum vehicle speed as a production Evora S

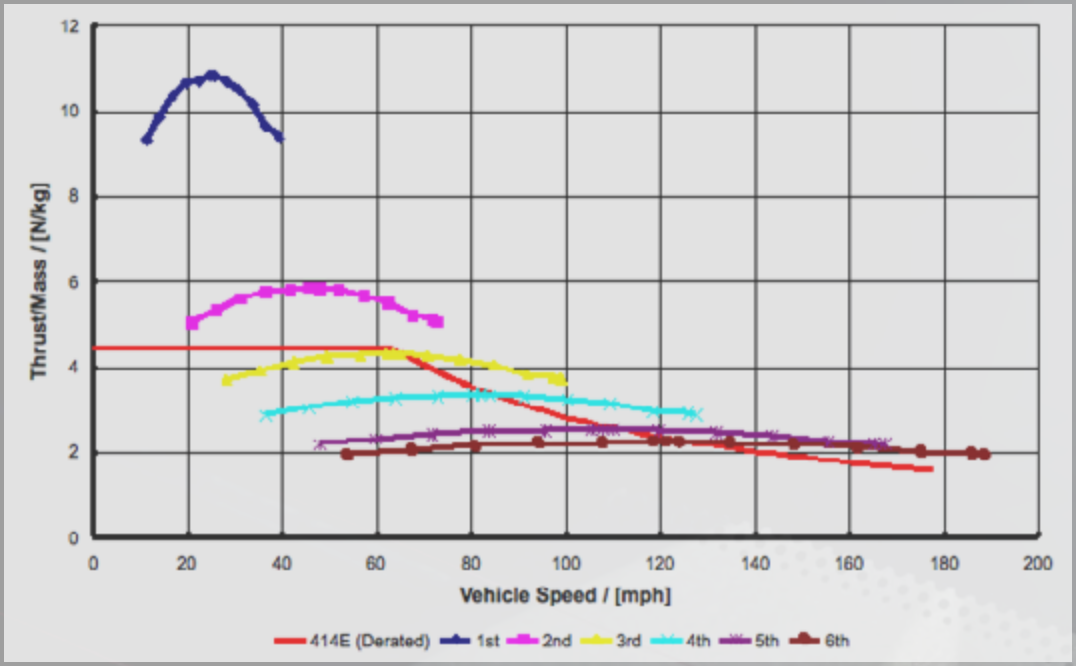


Fig. 5: Mass-corrected cascade curve for 414E adjusted for 25% derate compared to production Evora S

Summary

While some turbocharged ICEs now offer 'overboost' functions where for a short period of time extra torque is available, the certified performance is usually the minimum available, and so is the opposite situation of what is claimed for electric drive trains. This is where the true advantages of combustion engines come to the fore: the engine of the Evora S will deliver the same performance as long as there is fuel in the tank and it also takes less than five minutes to refill. Doing this, with modern durability sign off criteria, the ICE will deliver full performance for literally months. Decarbonising the fuel permits this to be done with carbon-neutrality and at a final vehicle cost that the customer can afford. This is why ICEs will continue to be the primary propulsion in the automotive scene for years to come, with EVs having a specific role to fill in short distance, urban environment situations, and REEVs permitting longer journeys to be undertaken unencumbered by range anxiety.

Author: Jamie Turner

ENGINEERING

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Lotus Engineering is at the forefront of efficient performance and clean fuel technologies, and leading the way in hybrid and electric vehicles.

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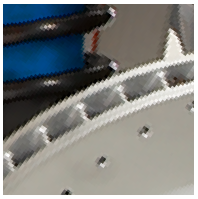


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