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The Lotus Integrated Exhaust Manifold



Q&A with Group Lotus CEO, Mike Kimberley



Welcome

At the recent Frankfurt Motor Show green technologies were again the all-pervading topic. The breadth of technical options being pursued is mind-boggling whether it is clean diesels, electric vehicles or plug-in hybrids – a subject reviewed by Ian Adcock this issue.

Green technologies were again firmly on the agenda at the recent IMechE biofuels seminar hosted by Lotus Engineering, an event that attracted industry figure intent on driving renewable fuels forward.

For a consultancy like Lotus Engineering, you could think the diversity of technologies would make it difficult for us to know where to focus our activities. But, for us at least, it gives the opportunity to use our considerable skills for a wide range of clients and projects. Clearly, Lotus is a leader in many of the green technologies themselves. However the 'glue' that combines and strengthens our engineering capabilities is the ability to integrate technologies into real solutions and real vehicles. The integrated exhaust manifold described this issue is a great example.

I hope you enjoy this latest look at the industry and Lotus Engineering, which concludes with the recent interview with Mike Kimberley, CEO of Group Lotus, by Dave Leggett, kindly reprinted with permission of just-auto.

Peter Morgan

Marketing Manager, Lotus Engineering



Peter Morgan



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JAPAN: Nissan opens new engineering centre

Nissan Motor opened its new engineering centre, located within the Nissan Technical Centre (NTC) campus in Atsugi City, Kanagawa Prefecture. Construction started in October 2004 and was completed in September.

The new centre will focus on the development of environmentally-focused technologies in line with the company's Nissan Green Programme 2010, its mid-term environmental action plan. Nissan has pledged its commitment to offer advanced technology and products to help make real-world reductions in CO₂ emissions, contribute to cleaner overall emissions and increase the recycling of resources.

The modern and spacious engineering centre was designed to facilitate a culture of 'knowledge creation' which promotes communication and close collaboration between visiting engineers and parts suppliers. A walkway bridge connects the engineering centre to the product planning and design centre for easy access.

The centre has an environmentally-friendly turbo freezer that uses water as coolant for the air conditioning system, a first in Japan. With the all-new turbo-freezer system, Nissan will collect data to support further improvements to the system for wider industrial-scale applications. Other 'eco-technologies' incorporated into the design include use of crystal liquid ice thermal storage and heat recovery system (CLIS-HR), eco-glass, and a rain-water and waste-water heat recycling system to reduce energy consumption and CO₂ emissions.

Nissan has invested JPY90bn (US\$783m) to boost and strengthen its R&D facilities. The engineering centre is yet another significant long-term investment by Nissan. Other recent investments include NATC (Nissan advanced technical centre) completed in May, the new design centre in September, and the on-going refurbishment of the powertrain engineering centre at NTC.

In 2009, Nissan will move its headquarters to Yokohama City to further consolidate its presence in the Kanagawa Prefecture. At present, Nissan's facilities include the Yokohama engine plant in Yokohama City, Oppama Plant (vehicle production plant) in Yokosuka City, Grandrive proving ground in Oppama, and NTC and NATC in Atsugi.

Source: just-auto.com editorial team

CHINA: Nanjing launches MG7 line

Nanjing MG has finally officially launched its MG 7 sedan model line in China. The new model is a Chinese-built update of defunct UK automaker MG Rover's MG ZT, itself derived from the Rover 75 (recently updated and put into production by Shanghai Automotive [SAIC] in China as the Roewe 750).

Nanjing said the new car, built in a brand-new facility in Nanjing city (using tooling bought from MG Rover's receivers and 'lifted and shifted' from Longbridge to China), "retains the character of the former British-built MG ZT in terms of both design and quality".

Initial pictures suggest Nanjing has not made the same changes to the dashboard and rear styling as SAIC did when turning the Rover 75 into the Roewe 750. The MG7 models introduced in China include three 1.8-litre variants plus a stretched (by 200mm or eight inches) long wheelbase flagship version, named the MG7L. The photos show this lengthened version with generous extra rear legroom obviously targeting the many Chinese owners of prestige cars of this size who employ a driver.

The shorter MG7s have a 1.8-litre turbocharged I4 engine generating 160bhp, and 215Nm of torque between 2,100 and



The Nanjing MG7L

4,000rpm. The unit, based on a unit MG Rover once used, and built using the same tooling, has been upgraded with help from the UK's Lotus Engineering to conform to Euro IV emissions legislation.

The top MG7L also has an updated Chinese-built engine made with the original UK tooling – in this case MG Rover's K-series, 177bhp, 2.5-litre, V6 powerplant producing 240Nm torque at 4,000rpm. This stretched model has a higher specification, offering greater comfort and increased legroom for rear passengers. Nanjing MG's sales director, Yang Junhu, said: "We are bringing British automotive culture to our country. Until now no other car from a British marque has been manufactured and sold in China. Today customers are becoming more demanding in terms of their requirements which we will be able to satisfy thanks to the different variants of the MG7."

Chinese prices range from the equivalent of £12,600 (about US\$25,000) to £22,260.

Source: just-auto.com editorial team

US: CAFE and CO₂ set automakers for “unprecedented change”

Higher US CAFE limits and EU CO₂ rules will signal unprecedented motor industry change, a Global Insight analyst said in a research note. Aaron Bragman said the changing regulatory landscape will require serious advancements and investments in new powertrain technology and automakers will be unable to foot the bill alone in either region.

A study by Phil Gott, Global Insight's director of automotive consulting, has examined the ramifications if a bill currently under consideration in the US Congress passes. Currently, corporate average fuel economy (CAFE) standards are set at an average of 24.6 miles per (smaller US) gallon (mpg) – a combination of 27.5mpg for passenger cars and 22.2mpg for light trucks. The Senate bill calls for an increase to 35mpg combined (42.1mpg for cars, 28.7mpg for trucks) by 2020, which is generally considered by automakers and industry to be unattainable.

Bragman noted that two competing bills in the House of Representatives are being considered: HR 1506 (the Markey bill) calls for even more stringent standards, upping combined CAFE ratings to 35mpg by 2019, with a combination of 43.3mpg for cars and 27.6mpg for trucks; while HR 2927 (the Hill-Terry bill) is supported by the industry, and calls for an increase to 32-35 mpg by 2022, with provisos that permit special allowances for automakers under certain new conditions.

Bragman said Gott's study assumed that the requirement would be 35mpg combined (45mpg for cars, 30mpg for light trucks) by 2020 and determined that 35mpg was 15% better than the fuel economy of the four most fuel-efficient models available today, on average. If the entire passenger car fleet is considered, 35mpg combined represents an increase of almost 42% from the average 2006 level.

A study carried out by Global Insight director of North American research, Rebecca Lindland, determined that US consumers are not going to make a dramatic shift towards smaller cars, as they simply do not fulfil the needs of American consumers. So given the assumptions that American consumers will want to maintain their lifestyle, behavioural modification through taxation will not occur (unlikely, given the US political administration's aversion to taxation), and fuel prices will remain elevated at their current levels, what needs to happen to the vehicles themselves in order to meet the Government's likely new standards?

Gott's study concluded that nothing short of a massive shift in powertrain technologies would be required to meet the new CAFE standards. By 2020, nearly two-thirds of the US vehicle fleet would need to be powered by a direct-injection engine (either petrol or diesel), downsized from the current displacements and turbocharged. Diesel would need to comprise one-third of the market. Half of all vehicles would need to be one of the four



35mpg by 2020 would require half of all vehicles to be hybrid

forms of hybrid, and half of those hybrids would also need to be diesel-equipped. According to Gott, the variable cost impact necessary to introduce such a stunning shift from port-injected gasoline engines (the vast majority of US powertrains) to the new configurations would require a staggering amount of investment. Automakers would face powertrain costs that are a minimum of 30% more expensive than the current lowest-cost technology, costs that would very likely be passed on to consumers.

Automakers would have to make a capital investment in components to install direct-injection technology on 8m engines for the US market, invest in component plants and suppliers to make components for an additional 8m hybrids, and construct the equivalent of eight new diesel-engine manufacturing plants at a cost of nearly US\$1bn each, not including associated fuel-injection and emissions controls systems manufacturing.

Suppliers would have to be able to make up to 12m turbochargers a year, or more if two-turbo systems become more common. According to Gott, new drivetrain technologies routinely require 10-15 years before they achieve “mainstream” status in the market, such as the advent of port fuel injection, four-valve cylinder heads, front-wheel-drive, and so on.

“But the big problem is that none of the domestic automakers has the kind of cash on-hand necessary to undertake that kind of endeavour. Neither has the Government shown a willingness to foot any significant portion of the bill either,” Bragman wrote.

“This leaves the situation in limbo, with a worrying combination of a populace that resists increased taxes to bring about behavioural change, a cash-strapped domestic industry just trying to stay afloat amid stiff international competition and detrimental economic conditions, and a political body that has proven itself more than capable of creating standards meant to show action on climate change with little in the way of support for making these attainable.”

“However, the writing on the wall says that CAFE increases are only a matter of time, and action will thus soon have to be taken one way or another to pursue these new technologies.”

Source: just-auto.com editorial team

US/UK: Blind concerned about 'silent' hybrids

Petrol-electric hybrid vehicles are coming under attack from a constituency that doesn't drive: the blind, according to a US news agency report.

Here in the UK, a leading hybrid maker and a group supporting the blind and partially sighted said they were unaware if the issue has been raised.

Because hybrids make virtually no noise at slower speeds when they run solely on electric power, US blind people say they pose a hazard to those who rely on their ears to determine whether it's safe to cross the street or walk through a car park, the *Associated Press* (AP) said.

"I'm used to being able to get sound cues from my environment and negotiate accordingly. I hadn't imagined there was anything I really wouldn't be able to hear," Deborah Kent Stein, chairwoman of the National Federation of the Blind's Committee on Automotive and Pedestrian Safety, told the news agency. *"We did a test, and I discovered, to my great dismay, that I couldn't hear it."*

AP said the tests – admittedly unscientific – involved people standing in car parks or on footpaths who were asked to signal when they heard several different hybrid models drive by.

"People were making comments like, 'When are they going to start the test?' And it would turn out that the vehicle had already done two or three laps around the parking lot," Stein told the AP.

According to the AP, the NFB – the leading advocacy group for 1.3m legally blind people in the US – has made pleas to the motor industry and to federal and state agencies, with little concrete success so far.

Manufacturers are aware of the problem but have made no pledges yet. Toyota is studying the issue internally, Toyota Motor Sales USA spokesman Bill Kwong told the AP.

The report added that the Association of International Auto Manufacturers, a trade group, is also studying the problem, along with a committee established by the Society of Automotive Engineers. The groups are considering *"the possibility of setting a minimum noise level standard for hybrid vehicles,"* Mike Camissa, the safety director for the manufacturers' association, told the AP.

While Stein said she would prefer that hybrids sound similar to conventional engines, other blind people told AP they'd be fine with any sound that was inoffensive but easy to detect. Both sides reportedly agreed that it wouldn't be prohibitively expensive to outfit cars with an adequate noise-making device. The news agency noted that some think that making hybrids louder won't solve anything.



Too quiet? The Toyota Prius

"To further expose millions of people to excessive noise pollution by making vehicles artificially loud is neither logical nor practical nor in the public interest," Richard Tur, founder of NoiseOFF, a group that raises awareness of noise pollution, told the AP.

Others reportedly believe that distracted pedestrians are at greater risk than blind people from quiet cars.

Commercial vehicles here in the UK often have loud buzzers, beepers or synthesised voice systems to warn that they are reversing.

A Toyota GB spokesman said the automaker had not heard of any calls to make hybrids noisier and noted that, with annual sales of about 7,000 Prius models expected this year, hybrids still only account for a fraction of vehicles on the road.

A spokeswoman for the Royal National Institute of Blind People (RNIB) said she was unaware of any complaints regarding hybrids.

This issue is not entirely new, however. Concerns were expressed decades ago when virtually silent electric trolley buses replaced trams in some cities that pedestrians used to the noise of tram wheels on rails would not hear the much quieter buses approaching.

Source: just-auto.com editorial team

Biofuels for future transport and mobility - a review of the IMechE and Lotus seminar

As someone who has been involved in promoting renewable energy for the last 25 years, Baroness Shephard of Northwold was forthright in her view that biofuels have a key role to play in greener transport for the future. Giving her keynote address at the Institute of Mechanical Engineers' (IMechE) 'Biofuels for Future Transport and Mobility' seminar, she was critical of the level of Government support in the UK when compared with others in Europe. And she called on the automotive industry to provide leadership.

This IMechE seminar was the second to be organised in conjunction with Lotus Engineering following last year's successful Niche Vehicle seminar. The highly topical theme and a diverse set of speakers attracted delegates from vehicle manufacturers, consultancies, component suppliers, Formula 1, academia and non-Government organisations to the Hethel Engineering Centre.

Baroness Shephard, a former shadow Secretary of State for the Environment, Transport and the Regions and Chair of the East of England Biofuels Forum, was supportive of the east of England's effort in leading the way for renewable energy in the UK, stating the 8% of electricity being from renewables in Norfolk was higher than any other county. However, she did bemoan the lack of leadership by Government when compared with the rest of Europe: *"Many Governments have had in place for years strategies – Sweden, Germany and many in the rest of Europe."* This lack of clear direction she said has allowed the recent backlash against biofuels – arguments of taking land from food product, reducing wildlife habitats – to get a stronger foothold than it should. Although accepting that biofuels are not the sole solution to global warming, she quipped *"Quite soon [biofuels] will have something to do with the death of Princess Diana if it goes on like this"*

In conclusion, Baroness Shephard highlighted the important role of engineering and scientific advancement and said that she truly believes that the global problems can be solved by the right technologies.

And so it was onto the main programme, which had sessions addressing the political aspects of biofuels, fuel technologies and vehicle technologies. An impressive array of papers were presented by speakers from as far afield as South Africa and Sweden.

However, the first two speakers were from much closer to home and in many ways set the scene for the day. James Beale of



The UK's first bioethanol plant by British Sugar at Wissington

Renewables East – the agency for renewable energy in Norfolk, Suffolk, Essex, Hertfordshire, Bedfordshire and Cambridgeshire – raised the issues of global temperature change on future food production, sea levels, ecosystems and weather patterns. Quoting from the *Stern Report*, he likened the potential economic impact by the year 2050 as being similar to the two world wars and the great depression.

Going on to discuss the diminishing global oil reserves, Beale went on to review the variety of renewable technologies that are available or being developed and in particular the activities in the east of England. These included the UK's first bioethanol plant by British Sugar at Wissington, the many offshore wind and wave and tidal projects on the east coast, and developing relationships with Suntech of China, a company that is a leading developer of photovoltaic (PV) solar technology. Although China is easily accused of being a big part of the climate change problem, such is the speed of its economic and industrial development, Beale explained that it can be part of the solution. 300MW of solar energy is produced per annum by Suntech PV technology compared with a meagre 0.5MW in the UK.

Bruce Tofield of Cred, an network of partnerships based at the University of East Anglia with the ambition to cut carbon emissions, further explored carbon emissions and their effect on the planet. The recently-recorded massive drop in the extent of

summer ice in the Antarctic following a steady decline indicates the acceleration of the problem. He argued that first-generation biofuels are not a solution globally since deforestation has a greater negative greenhouse gas effect than the benefits of the agriculture for the biofuels that it enables. With these things happening on the other side of the world, it's a case of out of sight, out of mind. The priority, he said, is to reduce deforestation and transport-related fossil fuel use.

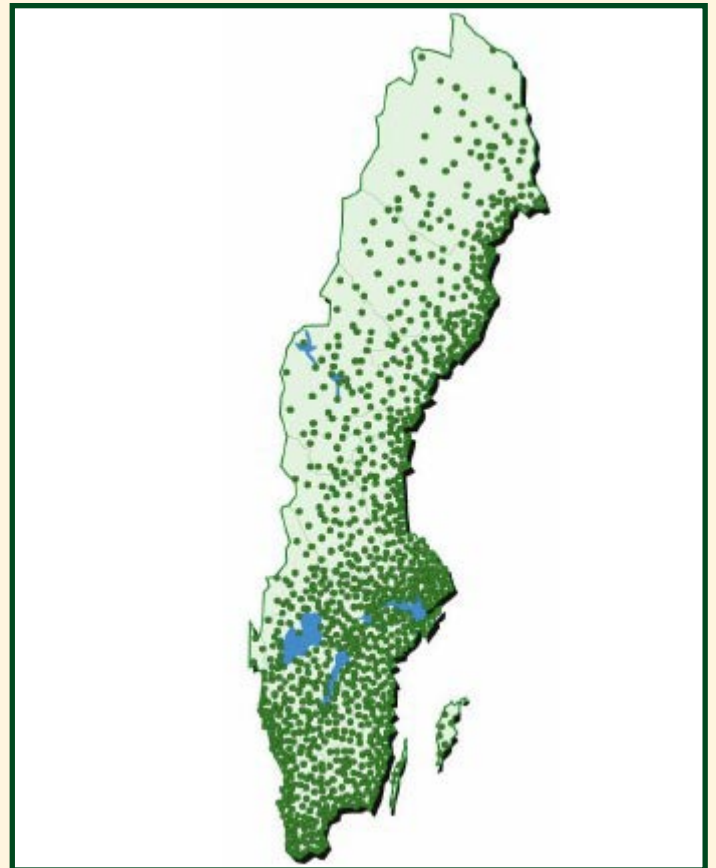
Tofield went on to say that legislation and governmental policy are often part of the problem, and not the solution – US subsidies of fossil fuels and first generation biofuels are misplaced. However, he said that biofuels can play an important role: if they are produced from waste or low intensity crops, they are 'second-generation' biofuels that utilise a larger fraction of the plant and the expected microbiology advances make BTL (biomass to liquid) fuels competitive.

Sasol, the South African fuel company, has been active in finding alternatives to fossil fuel for many years. The original driver for the South African Government, was fuel security and the desire use its own coal resources. Today CTL (coal to liquid) and GTL (gas to liquid) synfuels account for 30% of South Africa's transport fuel.

“There are now over 800 filling stations in the Sweden that stock E85 bioethanol compared to less than 20 in the UK”

Andre Swarts is the manager of Mechanical Research at Sasol Technology Fuels Research. He explained the issues surrounding the use of synthetic fuels in the South African market. Here half the vehicle population is based at high altitude and the average vehicle is 12-years-old which poses problems for the fuel companies. Introducing Sasol Fuel Alcohol (SFA) to gasoline has the effect of increasing the octane rating of the fuel which results in improvements in engine operation. Swarts showed results giving an in-depth insight into the role of alcohol fuels in suppressing knock and highlighted the fact that they are highly compatible with pressure-charged, downsized engines.

Sasol's experience in the production of synthetic alcohol fuel by the Fischer-Tropsch process has made it well placed to develop BTL fuels from a technical standpoint. However the viability of



Widespread availability of biofuels in Sweden

BTL production in South Africa is in doubt – potential for biomass production near to Fischer-Tropsch plants is low.

John Bennett of Ford Motor Company used Ford's experience of bioethanol in Sweden as a case study. The Swedish Government, with a clear strategy on biofuels, actively broke the oft-cited 'chicken and egg' loop of fuel infrastructure and supply and customer demand, said Bennett. In removing fuel duties and reducing other taxes on CO₂ – neutral fuelled vehicles, consumers are incentivised to both buy flex-fuel cars and use bioethanol. Startlingly, 80-85% of Ford Focus sales in Sweden are of the FFV (Flex Fuel Vehicle) version. There are now over 800 filling stations in Sweden that stock E85 bioethanol compared to less than 20 in the UK.

The message from Bennett was clear, as he relayed the bioethanol success story in Sweden. The fuel companies and vehicle manufacturers have done their bit developing the fuels and technologies. Governmental support is the key to the successful increase in biofuels use, particularly through influencing the fuel price.

'Projects happen despite Governments, not because of them' was the forthright assessment made by the final speaker before the lunch break. Mike Eyre, previously the design manager at

Feature



The Lotus Exige 265E Biofuel car outside the Hethel Engineering Centre during the seminar

Sizewell B nuclear power station, has been involved in a number of power generation projects in South America and South Africa during his career. He is now the managing director of Bioethanol Ltd, a company that is looking to develop the South Humberbank bioethanol plant. With planning permission granted most of the £165m investment is in place for the 250m litre per annum plant. His bullish view is that over time with changes in legislation, technology and consumer behaviour, bioethanol could sustainability replace the requirement for petrol in the UK.

After much lively debate over lunch, Jessica Chalmers of the Low Carbon Vehicle Partnership kicked off the afternoon session. The Low CVP focuses its energy on accelerating a sustainable shift to low carbon vehicles and fuels in the UK through stimulating opportunities for UK businesses. Chalmers spoke about carbon and sustainability reporting. A major challenge is that the well to wheel greenhouse gas savings of biofuels can vary massively, depending on the source material and the method of production. In some circumstances, sustainability risks can outweigh the benefits. For biofuels to be successful, sustainability assurance of biofuels is critical, she said.

Chalmers went on to explain the proposals for sustainability reporting: a series of metrics for factors such as the origin of the fuel, carbon intensity of the fuel production and the carbon impact of land use change. Reiterating a common theme of the day, she said that Governments have an essential role and she highlighted recent announcements from the UK Government: from 2010, biofuels will be reported under the Renewable Transport Fuel Obligation (RTFO) according to their carbon saving and in 2011 only if they meet sustainability standards.

Richard Pearson of Lotus Engineering took a much longer-term view of the role of biofuels. He proposed that they have an important role in the transition to a possible synthetic alcohol economy. Addressing concerns over the practicality and affordability of hydrogen as transport fuels, he went on to explain that methanol as a liquid fuel can be synthesised from biomass or longer term from atmospheric CO₂ and hydrogen. This will eliminate the massive infrastructure change that would be required for a hydrogen transport fuelling network. It has the added advantage that, since methanol is miscible with gasoline, vehicles and the fuel distribution network require only relatively



Startlingly 80-85% of Ford Focus sales in Sweden are of the FFV (Flex Fuel Vehicle) version.



Deforestation for biofuel production must be avoided

minor modification to transition to synthetic methanol. Synthetic methanol, Pearson continued, can also be used in methanol fuel cells as those technologies develop.

The final session of day was 'Vehicle technologies'. Mark Rowland outlined the Nissan Green Program 2010 and its biofuel introductions. Up until 2010, Nissan will be concentrating on direct injection with variable valve timing, clean diesels, continually-variable transmissions and biofuels. Further out, he said, hybrids including plug-ins, fuel cells and electric vehicles will have a role to play, with a recent tie-up with NEC for lithium-ion batteries part of this.

Today all Nissan vehicles are E10 (10% bioethanol) compatible globally. High ethanol content (E85) Nissan vehicles are on sale in the US with an extensive take-up in the Mid-West where farming and biofuels are widespread. The question of why Nissan had not increased the compression ratio of its vehicle to take advantage of the higher octane rating of the E85 was raised. Rowland responded that the market did not want the potential power increase.

Much of the debate during the seminar up to this point had been on the opportunities and issues for bioethanol. Paul Lacey of Delphi gave us a much closer look instead at biodiesels and their impact on fuel injection systems. He discussed the benefits of improved lubrication characteristics over conventional diesel but explained that the inherent corrosivity of biodiesel is a problem with the fuel system being "eaten away". A lack of standardisation of the fuel which has to operate at pressures of up to 2000bar in fuel injection equipment means, Lacey said, that first-generation biodiesels are a backward step in fuel quality compared with current diesels; second-generation fuels are comparable with current diesels.

Saab together with Ford is leading the way in Europe with production flex-fuel vehicles. Like Bennett earlier in the day, Magnus Nilsson, technology leader – Alternative Fuels at GM Powertrain Europe, began by discussing the lead Sweden had taken by supporting bioethanol. However, he went on to take an interesting technical look at detailed changes made to produce its Ecotec turbo BioPower engine for Saab. Saab and GM made the decision exploit the performance advantages offered by E85's higher octane number and high latent heat of vaporisation. GM has made changes to valves and valve seats, cylinder head material specification, cylinder liner, spark plugs and created unique functionality in the engine management system. A lack of any legislative requirement for running on E85 meant that GM engineered the vehicle to meet the same in-house targets as for running on gasoline. The resulting 25bhp power increase and the reduced impact on the environment has made the Saab BioPower the market-leading flex-fuel vehicle in Sweden. The demand is there if the market conditions are right.



Nissan Titan FFV – flex fuel vehicle

That concluded the presentations. In his closing remarks, Dave Taitt, chairman of the Hethel Engineering Centre, commented on the diversity and high quality of presentations and reiterated the overwhelming consensus about the role of Government in ensuring a supportive framework for a transition to renewable fuels. With this second, Lotus-assisted IMechE seminar over, many of the delegates then took the opportunity to tour the Lotus manufacturing facility. Another great success, and there can be little doubt it will be "same time next year".

Peter Morgan
Lotus Engineering

■ Plug 'n play

"Any colour you like as long as it's green", to paraphrase Henry Ford, could well have been the motto for this year's Frankfurt Motor Show.

Manufacturers were falling over themselves to promote their green credentials, whether that was VW's BlueMotion or Ford's EConetic offerings right the way through to stop-start smart's, plug-in concepts from GM and Volvo, or Mercedes-Benz's vast array of hybrid products.

Although the debate about the causes of global warming has still to be won, the motor industry isn't taking a chance that at some point in the future it will be blamed even more than it is currently.

Whilst the OEMs aren't denying their responsibility and duty to improve economy and emissions, there were murmurings from some of the big boys that the motor industry couldn't bear all the responsibility and that others, including consumers, will have to be made accountable, too.

Professor Dr Herbert Kohler, Daimler's vice president group research and advanced engineering vehicle and powertrain chief environmental officer, made the point: *"No one wants to pay for technical solutions and that's an argument we have with politicians. We have to recognise what products can carry what additional costs. Maybe the premium OEMs are a little bit more positive than the mass-market producers; an additional EUR1,000 on the price tag is a large investment. Everyone has to pay for these additional costs."*

"So, what's the alternative? A growing number of OEMs, led most aggressively by GM, are advocating plug-in hybrids as part of their strategy."



Volvo C30 Recharge

"A 1-tonne reduction on CO₂ on the traffic side is nearly EUR500 per tonne, on the household it's EUR10 per tonne and it's the same customer. We're not denying our responsibility, but the question is 'Is it better for a household to pay for extra heating etc. or more on the car side?' The affect on the climate is the same."

One aspect that has emerged from the debate is the growing awareness that there is no silver bullet solution, although whether this can be communicated to the politicians is another matter. As Kohler rightly points out, a EUR1,000 solution might be acceptable on an E- or S-class, but on a smart?

So, what's the alternative? A growing number of OEMs, led most aggressively by GM, are advocating plug-in hybrids as part of their strategy.

Much of the initiative for Plug-In Hybrid Electric Vehicle (PHEV) is coming from California. However, there is a second, political and economical agenda that isn't so loudly talked about – oil supplies, specifically to the US.

With barrel prices at their highest for some time and the US importing 60% of its oil, a figure that is likely to grow as the vehicle parc increases, Americans are slowly realising how vulnerable they could be to an oil boycott.

Some estimate that if all the vehicles in the US were PHEV (not likely, of course), it would cut oil needs by 55% virtually ending the need to import oil.

It could be argued that the first plug-in hybrid was the 1899 Lohner-Porsche, but in modern times GM's hopelessly-impractical EV1 from 1996 started the trend.

Although the likes of Audi and others showed various concept PHEV's over the ensuing years, it was really GM's unveiling of its Chevrolet Volt at this year's Detroit Auto Show that set the ball rolling, followed up by the Opel Flextreame at Frankfurt.

“Some estimate that if all the vehicles in the USA were PHEV (not likely, of course), it would cut oil needs by 55% virtually ending the need to import oil”

Based on GM's global compact vehicle structure – Astra in Europe – it has a 120kW, 370Nm electric motor driving the front wheels and a 16 kWh lithium-ion battery pack located where the transmission tunnel would be. Additionally there is a 53kW generator at the front plus a 1.3-litre CDTi bio diesel, 'range extender'.

According to chief engineer Frank Weber 75% of car owners commute up to 60kms a day and since the Flextrime has a 55-60km range on batteries then the majority of people would only drive using electric power. Being able to plug the car in at work during the day and regenerative braking etc, would further extend the range.

The big savings come, says Weber, when the vehicle is recharged overnight using low rate electricity. At today's prices, driving 100kms in a diesel would cost EUR6.84 compared to EUR1.50 for an electric vehicle.

The range extending engine is only used to drive the generator to recharge the batteries, giving the car an overall range of 800kms.

Furthermore, he maintains that 1m PHEVs could be on the roads without the need to construct any more power stations.

Test programmes start next year and will extend over “two winters and summers”, says Weber which means a production date of around 2010 seems probable. And, as the car can be built on existing production lines, manufacturing complexities have been simplified, helping to keep costs “realistic without the need for subsidies”.

It seems like the perfect solution but for a major problem – the battery pack. GM is working with LG Chemicals subsidiary, Compact Power Inc on lithium-ion batteries and with Continental Automotive Systems on A123 nanophosphate technology.

The problems with lithium-ion batteries are the need to maintain stable temperatures, realistic costs and durability. GM says it wants the batteries to last for at least a decade, but may have to resort to leasing them to customers.

Nanophosphate batteries are used in rechargeable power tools and can be recharged much faster than lithium-ion and withstand a far wider temperature operating range.

Recently, A123Systems was awarded a US\$15m development contract by the United States Advanced Battery Consortium (USABC), an organisation composed of DaimlerChrysler Corporation, Ford Motor Company and General Motors Corporation. USABC awarded the contract in collaboration with the US Department of Energy (DOE) to optimise the A123Systems proprietary doped nanophosphate battery technology for hybrid electric vehicle applications with a focus on systems that are high-power, abuse-tolerant, long lasting and cost effective.

“We are looking forward to working with General Motors and Cobasys on this programme,” said David Vieau, president and CEO of A123Systems. *“Our work with the world's largest automaker will help validate the durability, reliability, safety and value of our battery technology and the overall market viability of alternative energy vehicles.”*

The other major issue is generating the recharging electricity in the first place. Isn't it naïve to believe that the electric providers will continue to offer cheap rate off-peak power to recharge vehicles? They will simply see it as another profit opportunity.

“We have to make sure we don't export the environmental problems to developing countries,” says Volvo's senior vice president for research and development, Magnus Jonsson before adding, *“However, it's easier to clean single source of emissions at a power station than trying to clean 50,000 or whatever vehicles.”*

The Volvo ReCharge concept based on a C30, uses wheel-mounted electric motors developed by PML Flightlink and lithium-polymer battery technology to give the car a 100km range. A four-cylinder 1.6-litre Flexifuel engine drives an advanced generator that efficiently powers the wheel motors when the battery is depleted. For a 150km drive starting with a full charge, the car will require less than 2.8 litres of fuel, giving the car an effective fuel economy of 1.9 litres/100km.

With the likes of Toyota, Nissan and Honda all seriously contemplating plug-in hybrids, and Danish designer Henrik Fisker promising to reveal a concept US\$100,000 premium PHEV developed with Quantum Technologies at next January's Detroit Show, the impetus certainly seems to be with this technology. But, and it's a very big but, this assumes there will be a major breakthrough in battery technology in the very near future. Just how long have we been saying that?

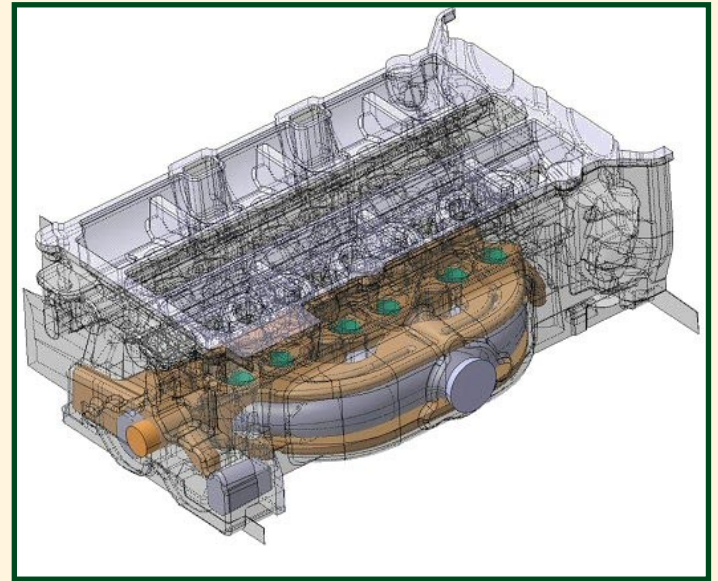
Ian Adcock

The Lotus Integrated Exhaust Manifold

At the IAA in Frankfurt in September, Lotus Engineering and Siemens VDO showed the continued progress of its collaborative Low CO₂ project with a cylinder head exhibit on the Siemens VDO stand. Amongst the technologies featured on this three-cylinder head is an integrated exhaust manifold (IEM) designed and developed by Lotus.

A future issue of proActive will look more closely at the Low CO₂ project as a whole. However, the benefits of the IEM concept as applied to modern engines are worthy of a closer look. It is an interesting example from the many engine technologies that Lotus is working on for cleaner future engines.

So what do we mean by an integrated exhaust manifold? Most modern internal combustion engines have a separate exhaust manifold, made of either cast iron or fabricated steel, to connect the exhaust ports in the engine cylinder head to the vehicle exhaust system.



CAD model of 3-cylinder head with IEM

of the exhaust manifold soon became recognised as one means of optimising engine performance and their use thus became the accepted norm.

Many characteristics of the integrated exhaust manifold, at least from a product development point of view, are not new. Although for different reasons, aluminum water-cooled exhaust manifolds have been used in marine applications for many years and there are examples of exhaust manifold integration going back many decades. More recently, Mercury Marine has applied the technology to its new generation Varado engine which also features a manifold system integral with the cylinder block.

“So why has the integrated exhaust manifold become so attractive to the modern automotive engine designer?”

The exhaust manifold usually comprises a number of individual exhaust runners, one for each cylinder of the engine, which then join together in a collector. If the features of the exhaust manifold are incorporated into the cylinder head casting, this results in the integrated exhaust manifold concept.

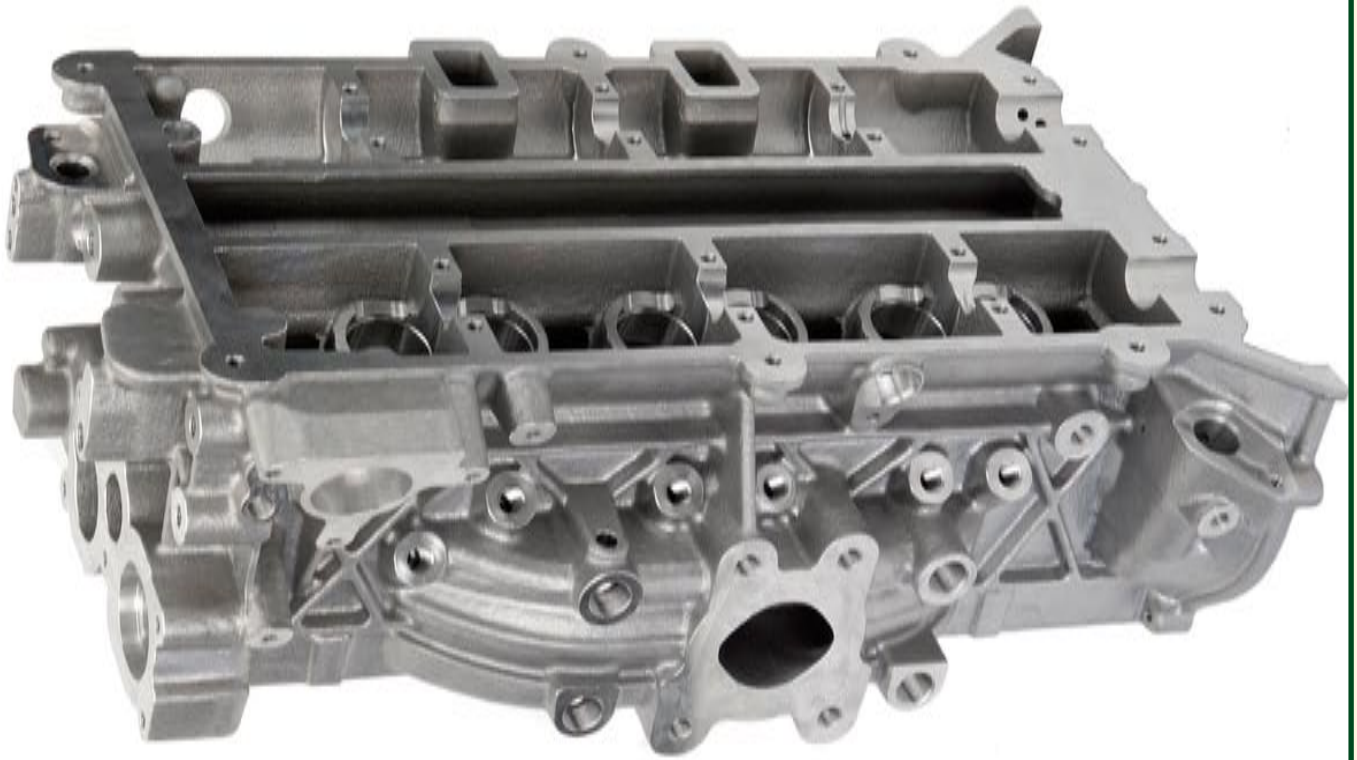
It is worth briefly discussing how exhaust manifolds, as we know them today, came to be. Through the process of product development, engineers found that with careful attention to exhaust runner configuration and with engine testing to establish exhaust runner sizes, they could maximise the fresh air charge entering each cylinder and hence improve engine performance. Tuning

“Chief amongst these benefits is a reduction in engine weight”

So why has the integrated exhaust manifold become so attractive to the modern automotive engine designer? One major change has come about through progressively tightening emissions regulations, which have forced the use of closely-coupled exhaust catalyst systems to help clean up exhaust emissions.

As a consequence of such catalyst systems, the potential to tune the exhaust runner lengths to enhance engine performance has diminished considerably.

Feature



Lotus cylinder head with integrated exhaust manifold

This is not only as a consequence of the very short exhaust runner lengths, but also because of the attenuating effect of the catalyst substrate (which also helps absorb any negative tuning characteristics that might be present). Faced with this scenario, in simple terms the exhaust runners and collector serve merely to transport exhaust gas from the exhaust port to the catalyst. Hence, for applications requiring such a catalyst system, the need for a separate exhaust manifold and the engineering effort required to ensure it is functional and durable no longer exists.

Another major change has resulted from recent concerns about diminishing fossil fuel reserves and anthropogenic climate change, which has intensified the search for reductions in engine weight and fuel consumption. By incorporating the exhaust runners and collector into an aluminum cylinder head casting, substantial weight savings can be realised. A lighter engine, and therefore a lighter vehicle, uses less fuel during acceleration and thus emits less CO₂, the principle greenhouse gas implicated in anthropogenic climate change.

Finally, an integrated exhaust manifold changes the heat flows in the engine, which offers advantages in terms of heat management as well as providing a more durable product for the customer.

The integrated exhaust manifold concept is not without its challenges but with the help of modern analytical tools to simulate engine cooling water flows, thermal loads and thermal stresses Lotus has the knowledge and understanding to integrate the exhaust

manifold into the cylinder head casting and thus realise a multitude of benefits.

Principle benefits

Reduced weight.

Reduced cost.

Reduced part count.

Lower emissions.

Lower exhaust. temperatures.

Quicker cabin warm-up.

Lower engine bay temperatures.

Chief amongst these benefits is a reduction in engine weight; however cost savings, lower emissions, improved fuel economy and better heat management all feature in this innovative concept.

Lotus' work on the integrated exhaust manifold concept has attracted much of attention within the automotive industry as other OEMs begin to see the advantages. It is a technology that has the potential to become commonplace in the coming years.

Andy Balding and Dennis Coltman

Lotus Engineering

Hethel at 40 – a celebration of four decades of manufacturing at the factory

Five thousand Lotus fans came to Hethel on 23 September to celebrate 40 years of production at the 50-acre factory. Conditions could hardly have been better: hot sun and a cool breeze. Enthusiasts were treated to demonstration laps on the test track, and then a leisurely procession of an immaculate cross-section of Lotus products was marshalled behind the control tower after a parade lap. Some models evoked memories of tough times at Hethel, while others spoke of a joyful mood. Clive Chapman, managing director of Classic Team Lotus and son of Lotus-founder Colin Chapman, and his mother Hazel glowed with appreciation at the turnout and both signed the wing of a pristine yellow Giugiaro Esprit after the parade.

The upbeat mood was sustained by sparkling commentary from the indefatigable Guy Munday of Stratton Motor Company, fielding numerous interviews with Lotus personalities such as 1960s race manager Jim Endruweit as the day unfolded. The atmosphere was entirely relaxed and convivial as people wandered through



Sussex Constabulary Exige

the displays and took in the manufacturing and engineering tours, while Vehicle development manager Nick Adams hosted a questions-and-answers session for the Lotus Club International members.

A host of mobile cafés and eateries fed the crowd, supplementing family picnics. The produce stalls proved popular, and the dedicated Lotus regalia traders did good business, with Classic



Timeless shapes of Lotus' past

Team Lotus selling their wares in the darkened hall of fame where young and old admired the dazzling array of Lotus single-seater racing cars. In the trade marquee, William Taylor's Coterie Press stand sold books on the cars and driver biographies aplenty, as a steady stream of new members signed up to Lotus Club International – including classic racer Malcolm Ricketts, who owns an example of every Lotus model.

“All’s well at Hethel after four decades of motoring genius”

Despite the ominous presence of an Exige liveried in the colours of Sussex Constabulary, there were no punches pulled as Lotus lovers indulged in flat-out circuit rides in Elises and Exiges. Aspiring pit crews took part in a wheel changing competition, and children enjoyed the funfair, face-painting and treasure hunt.

CEO Mike Kimberley and a number of Proton executives were present, and the current crop of cars on view, evidenced by the California Elise, Exige Club Sport, 2-Eleven and new Europa, were proof that all's well at Hethel after four decades of motoring genius. Here's to the next 40 years.

*Caroline Parker,
Lotus Cars*



Hazel Chapman signing a Giugiaro Esprit



The Concept Ice Vehicle (featured in proActive21) was a popular exhibit at the Hethel 40th Celebration

Q&A with Group Lotus CEO, Mike Kimberley

Steeped in Lotus tradition, having worked alongside company founder Colin Chapman, Mike Kimberley returned to Group Lotus last year as CEO and is charged with taking the company forward. Dave Leggett of just-auto.com recently met up with him.

(This interview was first published by just-auto.com in September and is reprinted with its kind permission.)

DL: How's business this year?

MK: Business this year is very significantly improved over last year. Since I joined mid-last year, we have turned the group around – I think it would be fair to say that. The car company is profitable and the engineering company is at breakeven at this stage.

DL: How many cars will be made here at Hethel this year?

MK: We made 2,875 cars last year – this year will be about the same.

DL: How does that break down by major national markets?

MK: The biggest market is the USA [accounting for just over half of all output], second-biggest is UK [around 900 units] and third-largest is Japan – where we sold over 500 cars last year and where our brand image is as high as a Rolex. That's a big part of what we're about, moving the brand upmarket, and it goes back to the decision to develop the engineering consulting business with Colin Chapman back in 1977. As was the case then, we want to take the image of Lotus upscale.



Mike Kimberley and Colin Chapman

DL: How's the US market looking?

MK: Not as strong as it ought to be. We have our own importation and distribution operation there and we are in the midst of reorganising things. We have 54 dealers in the US, four in Canada.

We have had to make the company more customer and market-driven rather than manufacturing-driven.

We have changed that over the course of the last 12 months. In the US we have brought our stocks down to an all-time low. I get telephone calls now from some of our dealers wanting more cars – which is great. After 12 months we're back into a market-pull situation.

DL: Surplus stock was a big problem in the US?

MK: A year ago the US was grossly overstocked and that is something that I am glad we have put right.

DL: And the weak dollar must be a headache on US shipments, or is Lotus hedged?

MK: We are hedged, yes, but not as much as I would like to be. The yen is also a problem, but we are at least able to offset that a little because we buy engines and transmissions from Toyota.

DL: How is Lotus Engineering doing?

MK: A small volume car manufacturer – even one like Lotus with considerable brand equity – is subject to cyclical changes in the industry. You've got to have a broader business base.

For this business there are three broad bases that we are in: the cars we produce and sell; third-party client engineering – high technology consultancy; and thirdly, mutual brand image building vehicles, cars like the Lotus Carlton/Omega.

We now have a five-year strategic business plan, signed off in March by the board and the shareholders – a tremendous signal of confidence in the company.

DL: What are the main aspects of the plan?

MK: The plan includes three new models on the car side and a global delivery model for our engineering activity.

On the engineering side we have operations in the US (the Detroit area, one in Southfield and one in Ann Arbor and there's one on the West coast also), there's the mothership here, we have an operation in Malaysia with 110 staff – we're just adding another 47 to that – and there's a facility in China (where we are planning to have 129 technical and engineering staff). I've also given an undertaking to the board to have a technical centre JV in India by the end of this year.

The idea is to form a delivery model that enables us to operate on a 24-hour basis. That can shorten time programmes and reduce cost.

DL: When did Lotus Engineering last make a profit?

MK: It made significant profits just a few years ago, but it was carrying out about 90% of its work for its parent Proton – major projects working with the Proton engineers.

Under our new philosophy, 96% of our new work is third-party, ie non-Proton work. That's the way it should be. We should never have more than one-third of the engineering business with our shareholder/parent – if it's a large shareholding. Otherwise, you become more introverted, you're not out there, you're not aggressive, not out there in the marketplace making contacts and developing the trust that you have to develop in the engineering business. The key thing is mutual trust.

You start with a small project and if you deliver it well, the business will grow. That's how I started the arrangement with Toyota. I always remember my first meeting with them in the late 1970s: me on one side and 36 of my friends from Toyota on the other. There was a small project to begin with and eventually Toyota became shareholders of this company and actually helped to save this company in 1983 when no-one else would invest in us and no-one would touch us because of the oil crisis.

We were working with Toyota, technologically, but they came in and supported us and we still have a strong relationship. Our cars today are using Toyota engines. And because of our good relationship they allow us to calibrate those engines for worldwide use.

It's an excellent relationship that we have with Toyota and if we can have similarly good relationships with other OEMs and Tier 1s, that leads to a tremendously strong engineering and consultancy business.

Since we realigned the engineering business, pumping in new blood and a dynamic strategy, the business is growing fast. We have projects ranging from complete vehicles to small technological or metallurgical projects. China is growing fast for us. I was there recently and signed off a big deal for new vehicle engineering.

All of this gives us critical mass to grow the business. As part of the process of realigning our engineering business I'm also trying to increase the number of core technologies that we have. We used to have nine and that had fallen to three or four – it's back up to six now and is rising. In 'core technologies' are things like biofuels, hybrids, electric vehicles.

DL: You mentioned three new models on the car side...

MK: When I joined the company I found a dearth of models – for me, it was a relatively empty cupboard. This is a minimum three-model company in my view – one model is not the way to go.

All credit to the people here: Lotus cars now are the best in terms of quality and reliability that we have ever had. Process control and the whole set-up with the car company looked good.

Elise/Exige/Europa are marvellous – iconic cars, there's no doubt about that. The aluminium structure and vehicle dynamics are absolutely exceptional. There's a big 'wow factor'. The exhilaration in driving the Exige S certainly gets the blood going.

But these cars are not everyday cars and I think Lotus needs more of a lifestyle type of car. When I joined, the MSC – a new generation Esprit – was on the go and still is. MSC is a fabulous car, superbly styled.

Our view was that we needed to look at where our customers are now and where they step up to, and that led us to the lifestyle 2+2 vehicle (codenamed Eagle) which is V6 mid-engine. There's room in the back for the golf clubs or a couple of small kiddies. That's more an everyday car.

And when you become an empty-nester, then you move up into supercar territory, very high status premium.

When I joined, I decided that MSC needed a reassessment and that meant some reworking – including going back to the powertrain provider to change the engine. That's added about a year to that programme.

In the light of that, the board decided to fast-track the Eagle lifestyle car.

Sales of that car will commence in early 2009. The next-generation Esprit MSC will be about a year later and further out we're planning a supercar which will be a 'jewel in the crown'.

The board has been very patient with this company. They have now signalled their confidence in the company's future by refinancing the company as of the end of March; that was another key objective I had coming in – a restructured balance sheet. Some GBP61m of accumulated debt that had accumulated in eight years was written off.

Lotus is now effectively a stand-alone business and on a strong financial base. That's good for suppliers and good for engineering clients – they know we're going to be here in five, ten years time.

DL: Where will Lotus production grow to with the new models, in terms of annual sales/production?

MK. It will be 6,000-8,000 units a year.

DL: All made here?

MK: Made here, fundamentally. We are outsourcing more. A lot of our components come from South Africa, India, there's more from China. Some come from America. We are a global player when it comes to sourcing.



Mike Kimberley

DL: How far has production come down on the car side?

MK: Two years ago, we were producing 125 cars a week and I had to reduce that down to 45 units a week. We had to bite the bullet and tighten our belt to rightsize in the last quarter of last year when we lost just over 200 people.

The result is that we are manned for 50 but are producing 65 units a week – a clear efficiency gain.

DL: Lotus Cortina, Lotus Sunbeam, Lotus Carlton/Omega...will there be something like that with Proton?

MK: Let's say we're talking about it. I would like to do it and so would the shareholders, the board. It's a question of horses for courses. What sort of car is it going to be? Which segment? Hot hatch or something different?

DL: How important are biofuel/hybrid/electric vehicle projects for Lotus Engineering?

MK: Very important and increasingly so. Client confidentiality means I can't talk about particular projects or name names. We are working on three biofuels projects at the moment – we have a biofuel Exige that we have developed – it does 0-60 in about 3.8 seconds.

We have five hybrid projects on the go and we also have six electric vehicle projects that are ongoing – not including Tesla because we are not involved on the electrical side for that vehicle.

I think we are in quite a unique position with our culture. Going back to Colin, he was 'mass-sensitive' and would take weight out of anything. He even sneaked two inches out of the passenger cab on the Esprit when my back was turned.

Colin was driven by a number of Lotus DNA factors that have stuck with us: low mass, simple solutions, elegant lines – balanced vehicles with everything in harmony for the driver.

I see us as serving a niche market – we're not a Porsche or Ferrari. I don't think we're in competition with those sorts of companies. Lotus is a different badge, with distinct attributes.

Of some 87,000 cars that we have made, we've only lost about 15,000 due to crashes or whatever. The others belong to loving owners.

One of our core strengths is offering low mass with performance. What can we offer to our third-party engineering clients? We can help them with lowering mass on their vehicles and the balanced performance that goes with that.

Our cars offer low mass and by using aluminium they are almost fully recyclable and people never scrap them by choice anyway – a Lotus is a collectors' item.

DL: What do you see as the main strengths of Group Lotus?

MK: Well, there's the symbiotic relationship of the car business with the engineering side. The cars act as a flagship for Lotus and its capabilities. We work on technologies that are visible in our cars. Similarly, in conducting our engineering activities for other people we bring back know-how that strengthens our capabilities to develop our own cars further – it's a closed loop, both areas of activity complementing each other.

It's a phenomenal opportunity for this company. And we're not a threat to anybody because we're so small. We're not intending to become a big company with high volume. All in all, it's a winning formula.

DL: Are you concerned about the condition of your parent company Proton? What about the possible implications for Lotus of Proton's search for an OEM partner?

MK: A possible arrangement with an OEM is being driven by the availability of spare Proton manufacturing capacity; it's an opportunity to get low-cost capacity inside the ASEAN trading bloc.

“One of our core strengths is offering low mass with performance”

My understanding is that a new company would be formed and that would be a matter for the board and shareholders. I'm not involved in that process and all I know is what I read in the press.

The objective is to have a new company, bring in new platforms at low cost, processes and rebuild the product line of Proton. I have always believed Proton should have at least 30% of its production being exported – it's nowhere near that.

Lotus is a separate entity and now that we are recapitalised as a stand-alone business, we have to carry on doing our own thing. It's business as normal for Group Lotus.

What our parent company does with its major manufacturing operations and new models is something that they've got to do and good luck to them. I'm sure they will be successful.

I don't see why Lotus should be affected. We're pushing the boat out wherever possible and getting the support of the board and shareholders.

In terms of the radar screens of the companies reported as negotiating with Proton, I doubt we're even a blip – which suits us fine. And as we perform better, we're enhancing our asset value to our parent, too, which is a positive all round.

Dave Leggett



Group Lotus plc

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