proActive

The official industry newsletter of Lotus Engineering

Issue 8
May/June 2005

Tightening NOx emission rules could boost hybrids at diesels' expense says Lexus

Powertrain developments

Welcome

In a world where client satisfaction and time to market is paramount, testing becomes increasingly important. Every component is tested to ensure it's fit for purpose and complies with the relevant legislation and regulations.

Customers expect when they purchase a new car that it has a life expectancy in terms of mileage and time, depending on the way the vehicle is treated and used. To this end powertrain manufacturers have to undertake testing that will give them and prospective customers confidence in their products.

Lotus Engineering and its powertrain division work with various clients around the world as part of its global operation. This can take the form of a simple component test or design to production of a family of engines, with all the supplier and test work being conducted by Lotus and its Powertrain Test Group.

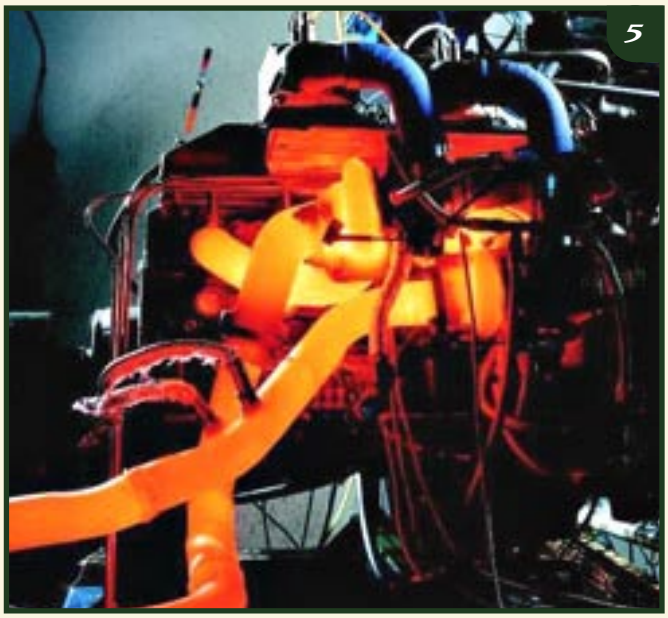
With OEMs now driving component testing in the direction of Tier 1 suppliers the client base is changing, with some Tier 1 suppliers investing in their own test equipment and developing their own competencies. The world of powertrain testing is changing and Lotus is amongst the leaders facing change.

I hope Issue 8 of proActive provides an insight into the powertrain testing work Lotus Engineering is involved in, as well as other powertrain issues currently at the forefront of the automotive industry.

We've also got a provocative piece on the drivers for automotive engineering and we'd welcome your thoughts on what stimulates the industry.

Philip Hughes, Engine Test Facilities Manager,

Group Lotus plc



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GERMANY: Auto industry is worried about meeting CO_2 targets but praises London's congestion charging

Negotiating the next CO_2 reduction target for exhaust emissions is the toughest environmental challenge facing European automakers and legislators, according to Ford Europe's head of regulatory affairs.

Europe's automakers have a voluntary commitment to reduce CO_2 emissions to 140 grams per kilometre by 2008.

"But political demands are going beyond this," Wolfgang Schneider, Ford Europe's vice president of legal, governmental and environmental affairs, told Automotive News Europe.

Referring to discussions for a further reduction of CO_2 emissions in the period 2010 to 2020, Schneider said: *"Our main concern is how we do this, in what time frame and what our contribution will be versus that of other stakeholders such as oil companies, governments and consumers."*

By year-end, a joint European Commission-auto industry group is to outline priorities for the next 10 years on auto emission and safety legislation.

Schneider said CO_2 emissions is the main environmental issue facing the CARS 21 (Competitive Automotive Regulatory System for the 21st Century) group, which is preparing the report.

Schneider said *"the industry does not want to walk away from its environmental, safety or social obligations. But Brussels legislators need to be more balanced on automotive regulations."*

In an interview at Ford's European headquarters, Schneider said:

- European legislators are asking carmakers to move too quickly on pollution-control and safety matters.
- London's congestion charge is *"an innovative way"* of dealing with inner-city traffic problems.
- *"Green"* credentials are important in automaker competitiveness in Europe.

Although automakers are more burdened by regulations than ever before, Schneider said Brussels regulators are now keenly aware of the need *"to keep Europe a viable business proposition."*

"Now people are as concerned about jobs as they are about environment and safety issues," he said. *"They now recognise the need to keep Europe competitive."*

Source: just-auto.com editorial team

GERMANY: Bosch produces first throttle body in composite material

Bosch is claiming a worldwide first by starting production of a throttle body for petrol engines produced from composite material. The new component weighs 25 per cent less, as well as being more economical to manufacture than traditional metal throttle bodies.

Bosch says other benefits of this innovation are more accurate control of the opening angle of the valve; easier adaptation to different engines and vehicle models as well as superior performance in a crash - composite material will shatter into multiple small parts under sudden impact.

The throttle body is the central actuator to control the airflow intake in the electronic throttle control system (ETC) thus determining the power output of the engine.

The new component weighs 25 per cent less than traditional metal throttle bodies

"Optimising throttle body geometry with a composite compatible design allows for even more precise control of the air volume that can have a very positive effect when the engine is running at idle or with a small load," said Dr Elmar Huber, project manager composite throttle body, Bosch Gasoline Systems Division.

In addition, connection to the cooling system of the vehicle becomes unnecessary as the low heat conductivity of the composite material reduces the risk of icing considerably, Bosch says.

The new generation of throttle bodies, to be known as DV-E8, have the housing as well as the valve produced in a long-life stable glass reinforced thermoplastic material that is claimed to be highly temperature and wear resistant.

The flexible structure of the throttle body design makes it very adaptable to whatever the requirements of the OEM, Bosch says.

Source: just-auto.com editorial team

Tightening NOx emission rules could boost hybrids at diesels' expense says Lexus

Increasingly strict NOx emissions standards will make diesel cars more expensive and hybrids more attractive, a senior official at Toyota's luxury vehicle division Lexus told just-auto's deputy editor Graeme Roberts.

"All car manufacturers will have some form of hybrid very soon or are planning something," said Karl Schlicht, vice president of Lexus Europe, as the automaker launched the hybrid RX400h luxury SUV to European journalists.

"I think it's fair to say that Lexus' dedication to hybrid technology and our early success has surprised some of the established manufacturers. It is evident that when NOx standards start to bite, diesels will become more expensive and hybrids even more attractive.

Lexus RX400h engine

"The NOx issue has been avoided in Europe and this needs to change. There is a reason why, in other markets, such as North America and Japan, NOx standards are stricter than in Europe. Level the standards for particulate emissions globally and hybrids become very attractive. Add the performance dimension offered by the RX 400h and the proposition becomes even more interesting," he added.

"When you consider global economies of scale, this again tilts the balance towards hybrids. Simplify the standards and take NOx into account, then let the consumer decide .

"Hybrids will represent a core technological advantage for Lexus."

The RX400h went on sale in the US last month - with 18,000 confirmed orders already on hand - and reaches dealers in the UK, Lexus Europe's largest single market, in June. Already, without any promotion other than word of mouth, deposits have been taken from *"over 1,000"* retail customers and Lexus UK sees no problem reaching its target of 1,625 units in 2005.

"We're already looking at a waiting list of six months in the UK," another Lexus official told just-auto, adding that high demand in other European markets has already resulted in projected delivery dates extending into 2006. Although some petrol-powered RXs are made in Canada, all hybrid models come only from Kyushu in Japan.

Across Europe, Lexus expects the 400h to account for 4,000 of this year's 14,000 total RX SUV model line sales, rising to half of the 16,000 it expects to sell in 2006.

The hybrid-powered model will attract competitive benefit-in-kind taxation rates for British drivers running the SUV on their company's nickel and Lexus GB expects that 65% will be bought by 'corporate' customers. It is after 3,850 sales in the first full year, 2006, and expects volume to settle at around 4,000 annually thereafter.

"Diesel or die" is an appropriate mantra for luxury brands in the UK and Europe, because, without some oil-burning engines in the range, obtaining a decent share of corporate and fleet sales is impossible. Business buyers of luxury cars in the UK prefer diesels for their fuel economy and tax benefits - over 60% of Mercedes S-class and BMW 7-series sales are diesel models and Lexus has so far lagged way behind its European rivals.

Lexus RX400h UK

But it is now hedging its bets and going with both options - its first-ever diesel engine option for the upcoming redesigned IS compact sedan line (a BMW 3-series rival) but hybrid power trains for the luxury RX SUV line and upcoming GS450h (a rival for the BMW 5-series and Mercedes E-class).

No numbers were forthcoming but Lexus officials are clearly optimistic diesels and hybrids will boost European volume from last year's Europe-wide 28,000 units (up 12% on 2003).

Source: just-auto.com editorial team

Powertrain testing - from concept to production

Test facilities play a vital role for every type of manufacturer, whether its product is a single component or an entire engine, and it is only through powertrain testing that an engine company can prove reliability and robustness and confirm that the product meets with legal standards for the target market.

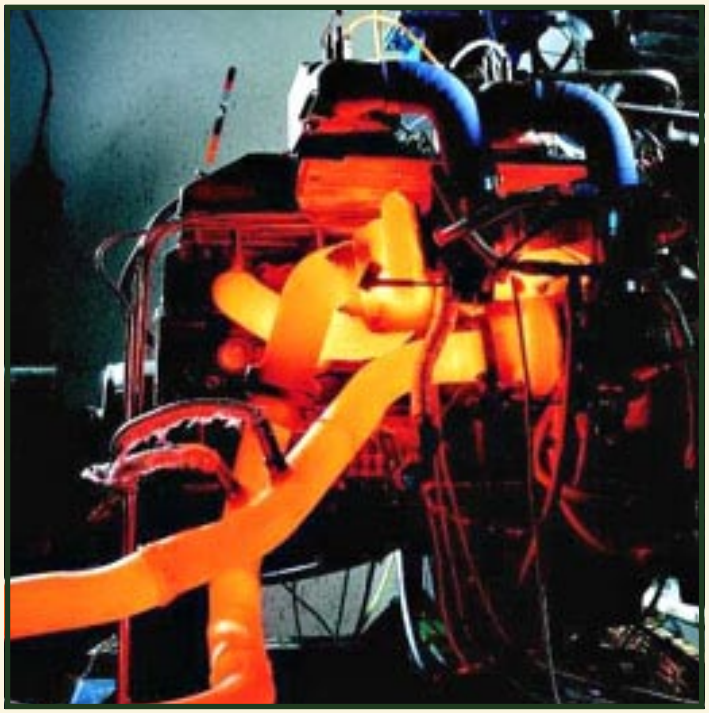
Lotus Engineering's powertrain division operates in the global market place and boasts comprehensive engine test facilities at both Hethel in the UK and Ann Arbor in the USA. The facilities at both these locations compliment and overlap each other and allow testing work to be carried out for many clients across the globe.

Having suitable test facilities is important, but the key is to understand the aim of the test and desired outputs, and having the ability to perform it to the clients criteria, within the required timescale and budget. Comprehensive reports are provided to the client and full feedback given; understanding the results of the test is of more importance than the results themselves, for example if a component fails it is more useful to know the cause of failure.

understanding the results of the test is of more importance than the results themselves

Powertrain testing is used in the automotive industry for a number of different applications, including:

- New product development
- Technology advancement
- Cost down initiatives
- Problem solving
- Integration into a new vehicle
- Performance improvement
- Economy enhancement
- Emissions legislation compliance
- Lack of OEM / Tier 1 facilities



In each case, whether a simple component is being tested or a complete engine is having its engine management set up, the test should be performed using a structured approach.

Testing of various components or complete engines with all ancillaries fitted requires the support of highly skilled engineers, of various disciplines. Dependent on the specific requirement, this can range from designers, through to engine management engineers and Lotus can cover all disciplines in depth.

One example of this is that in some instances simulation programmes are used to help reduce actual test time. For this Lotus Engineering Software can be used to develop the simulation which is then used in conjunction with actual tests. The information is then fed back to the software development team to make the procedure more robust for future tests.

OEMs over the past years have increasingly kept cutting edge development of their products in house, leading to a greater investment in their own test facilities and less demand for that type of work to be outsourced. This has led to consultancies such as Lotus Engineering to look into different market places and at more exotic testing, to be more flexible and versatile in the type of test that the test house will take on.

Increasingly, tests being conducted are closer to real life applications such as urban and town cycles, and cycles based on taxis, delivery vans, tractors, motorcycles etc. Where specialist equipment has to be made to conduct these tests Lotus Engineering draws upon the skills of the Facilities Engineers and support areas such as fabrication, machine shops, electrical engineering and instrumentation.

Another key area requiring an abundance of testing is that of fuels, lubricants and emissions. Today this is of increasing importance as manufacturers are aiming to sell engines and vehicles in a wider number of market places. Emission regulations vary dependent on the region, as do many fuels, so having the versatility to provide fuel in small or large batches is vital.

With the growth in diesel fuel usage, having emissions equipment that can measure both gasoline and diesel emissions is important for development, and to be able to certify all vehicle emissions in the emissions lab opens up new markets. A recent investment by Lotus in a diesel emissions suite and particulate measurement system has allowed Lotus Engineering to take on more work in these areas.

With many companies looking to use alternative fuels for their future vehicles, these fuels not only have to be available for engine test, but the infra structure must be in place to support them for future development programmes.

Not all clients require an entire engine to be set up on the test bed. Rig testing using electric motors can reduce test costs and time by testing components or part of an engine without needing the whole engine; you only test what you need to test.

Lotus Engineering is constantly looking to the future and at ways to meet clients' needs

Applications when this is used include thermostats, oil and water pumps, and valve trains. Lotus Engineering also has motor driven tilt rigs which allow the study of oil and coolant flow around an engine at different angles and speeds.

Temperature extremes and how this affects components, engine management, and emissions are also areas of interest. Cold chambers and chillers are used to replicate the harshest of environments using control systems and data acquisition to monitor tests.

With clients' needs changing and evolving, as a test provider Lotus Engineering is constantly looking to the future and at ways to meet clients' needs.

With all testing what you are left with at the end of the test is a series of test results and reports, from which decisions and recommendations can be made. Therefore the results and reports have to be as clear and accurate as possible in the format the client has specified and to the quality standards that are in use in the industry at that time.

Powertrain developments

More than a century after the first simple petrol engine spluttered into life, the technology which would go on to mobilise mankind on land, sea and in the air is on the brink of a period of development the like of which it has never been through before.

The basic principles of 'suck, squeeze, bang, blow' might remain unchanged – although there are those that would even argue about that – but how that is going to be achieved will be markedly different from the engines of four decades, never mind 100+ years, ago.

Forcing the pace of this change has been, and will continue to be, consumption and emissions, whilst the principle enabler won't be mechanical at all but electronics empowered by the ubiquitous microchip now present in every aspect of our daily lives.

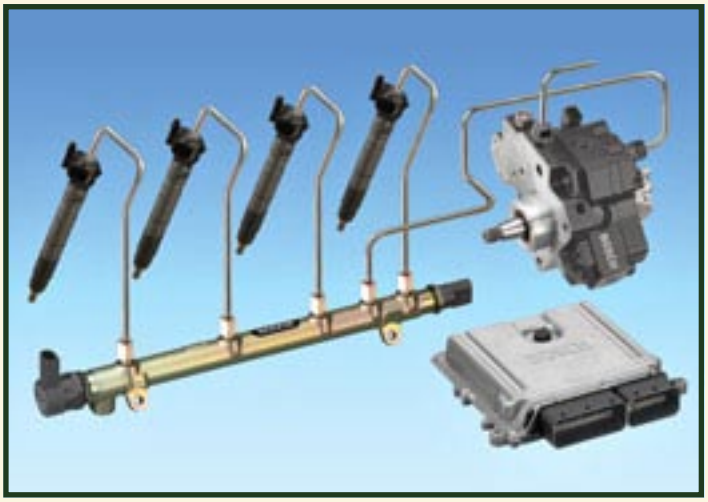
it could be argued that vehicle manufacturers as a sector have done more to clean up their products than others

Although road transport accounts for only about a third of emissions, and it could be argued that vehicle manufacturers as a sector have done more to clean up their products than others, vehicles will continue to be targeted by the legislators with increasingly stringent demands for reducing emissions. This becomes ever more challenging when the same legislators are demanding other measures that add mass to vehicles, the direct opposite of what engineers would ideally like to achieve through less weight.

The engine technology road map is governed by future legislative requirements, particularly reductions in diesel particulate and NOx emissions; the need for ultra low emission vehicles for use in urban areas and continuing reduction in CO_2 and corporate average fuel consumption requirements. And, of course, all this has to be achieved whilst retaining the 'fun to drive' factor and without driving up costs to an unacceptable level, either to the OEM or their end customers.

Such a challenge would be easier to achieve if the three main vehicle producing areas of the world – North America, Europe and the Far East – could agree on a common set of rules governing emissions. In the near term this is unlikely given Europe's predilection for diesel and an equally strong dislike for it in Japan and the USA, although that might change in the States as low sulfur fuel becomes more widely available from 2007 onwards.

Similarly, whilst American consumers have taken hybrids to their heart there is considerably less enthusiasm for them in Europe. In engineering terms they aren't the simple solution that so many breakthroughs are and are only likely to find favour and acceptance as delivery or commuting vehicles in large conurbations that impose congestion charging.

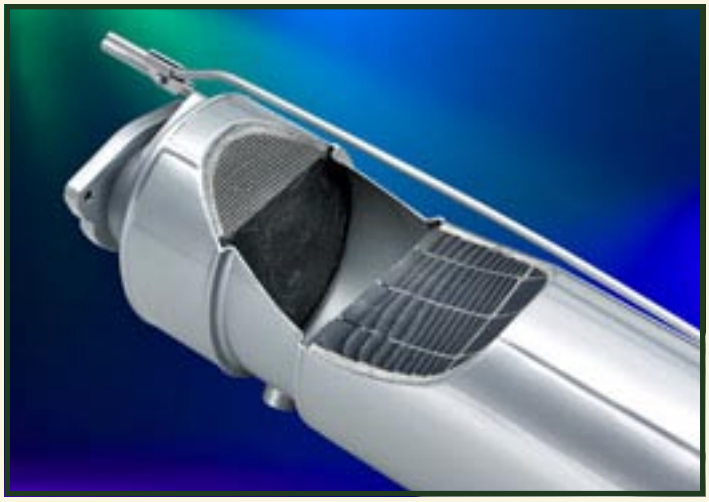


Bosch's third generation common rail system
Source: Bosch

Whilst vast amounts of money are being invested in fuel cells, the case for hydrogen-powered vehicles has yet to be proven. Although favoured by politicians and sectors of the popular media, the technical and financial challenges that still need to be overcome are enormous and no one has truly addressed the daunting obstacle of producing hydrogen cheaply with no environmental impact, never mind distributing it to the point of sale.

Given this scenario then the future of the diesel and petrol engines seems secure for the foreseeable future, unless, that is, someone has a 'Eureka!' moment.

Nevertheless, the industry cannot afford to be complacent and must continue in its pursuit of cleaner and more efficient power units.



ArvinMeritor's diesel particulate filter
Source: ArvinMeritor

Whilst many of the solutions promulgated for the future are theoretically elegant, it is in the execution and application where the complexity becomes apparent.

Past examples of this include multi-point fuel injection systems and high-pressure fuel pumps which have taken time to perfect. Complex engine management systems and innovative combustion strategies require extensive CAD and CAE work and simulation before achieving significant results.

However, what is tending to happen is a merging of spark ignition and diesel engine technologies. This is happening through higher compression ratios for petrol engines and lower for diesel with common rail systems and direct multi-injection under continuous development for both.

This is not as fanciful as it first appears: Mercedes-Benz board member responsible for research, technology and development, Dr. Thomas Weber, is reported as saying he can envisage a turbocharged, spark plug-free engine with a compression ratio between today's petrol and diesel engines, running on synthetic fuel.

Similar thoughts were expressed by Audi's Axel Eiser, head of V6 engine development predicting that a spark-free engine would appear between 2015-20 featuring a variable compression ratio between 12 and 20:1 with active cylinder management and a self-learning programme capable of predicting the valve timing, compression ratio and fuel/air requirements for individual cylinders.

Before then the power and torque density of diesel engines will improve markedly towards 70kW per litre. To satisfy future legislation in 2010 and probably, again, five years later Diesel Particulate Filters (DPF) to lower Particulate Matter (PM) will have been standardised aided by enhancements in common rail systems and low temperature combustion for NOx improvements.

The first step in this direction will be taken with the early adoption of multiple injections combined with cooled Exhaust Gas Recirculation (EGR) and DPF.

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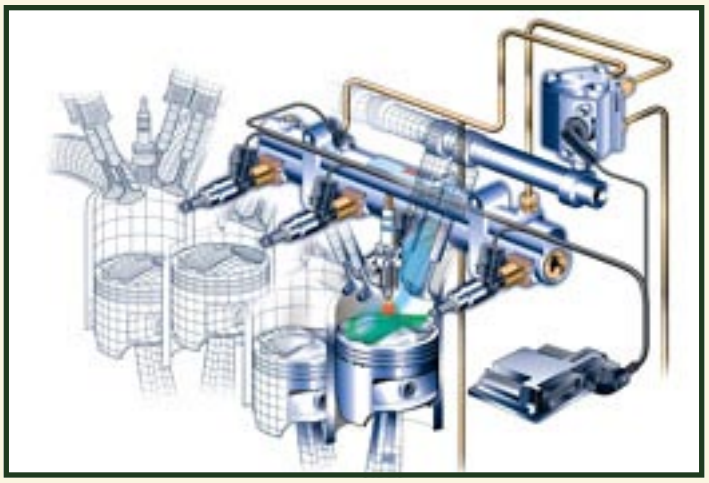


Bosch's gasoline direct injection DI-Motronic system
Source: Bosch

By the time Euro V legislation is on the statute books, modular injection will have been added together with further EGR enhancements and, in some instances, improved combustion strategies. Move on a further five years and lower pressure EGR, electronic valve control and across the board use of better combustion processes will be appearing.

One of the biggest challenges ahead is the development of electronically managed valve trains. Current electro-mechanical systems can offer up to eight per cent fuel efficiency gains, but they're relatively slow to react, are costly to manufacture and only offer blanket control of all the cylinders. They are also only really applicable to gasoline engines because of a general requirement to be 'free-running' reducing compression ratio and their relatively low force authority.

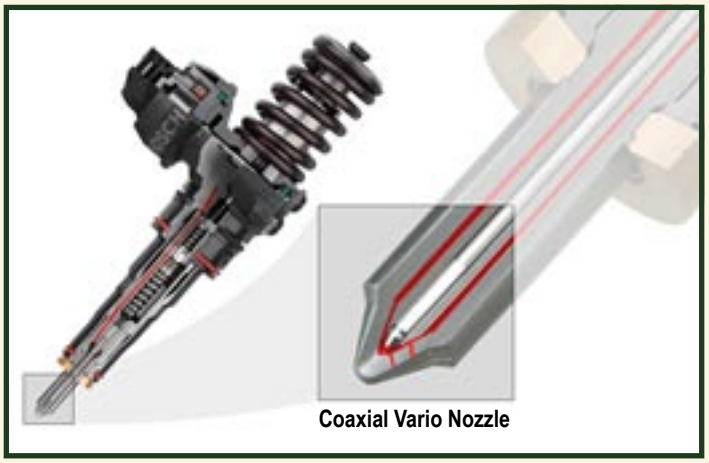
Electro-hydraulic systems are ready for industrialisation and because they offer individual control of valves and cylinders can offer a 12-18 per cent gain in fuel economy for the same price as the electro-mechanical systems.

The search for the Holy Grail of electro-magnetic valve trains hasn't progressed much further than the test bench and seems destined to remain there for some time to come unless issues over high energy consumption, noise vibration, harshness and cost can be met. Moreover, unlike the electro-hydraulic system they're less suited for diesel applications and as OEMs seek new means of amortising costs and systems across a wider product range this could mitigate against the technology.

Amidst all of this diesel development, the spark ignition engine is undergoing a serious makeover. Most industry insiders predict a downsizing in engine capacities with the lack of cubic centimetres compensated for by increasingly responsive turbochargers or other intake systems that speed up the flow, and amount, of air into the combustion chamber. With Fully Variable Valve Train (FVVT) and air control for individual strokes reducing response time during transients, responsiveness should be maintained whilst achieving fuel consumption gains in the region of 20-25 per cent. Air hybridisation, where the engine is run as an air compressor to perform regenerative braking with the stored energy being used for an idle-stop or launch strategy, can offer even greater benefits, but only if a suitable FVVT is fitted to the engine.

Furthermore this type of engine architecture lends itself to using more than just petrol as an energy source. By burning natural gas, or hydrogen, EZEV levels of emissions can be almost achieved together with extremely low levels of CO_2.

Visteon's SpeedStart12™ system can be fitted to almost any vehicle engine, and as the name suggests, runs on 12-volts
Source: Visteon



Bosch's 4th generation Unit Injector System
Source: Bosch

Most industry insiders predict a downsizing in engine capacities with the lack of cubic centimetres compensated for by increasingly responsive turbochargers

Whilst we have concentrated on engine developments, strides in transmission systems offering greater number of ratios and more intelligent use of gear changing strategies to maintain optimum efficiency according to driving conditions will also have a role to play. In fact, Ford has stated it believes that for each Dollar invested there will be greater savings in emissions and consumption if the money is spent on developing transmissions and not engines.

Additionally, stop-start or stop 'n' go systems, such as those developed by Valeo and Visteon, will be a valuable tool for reducing emissions during city driving cycles for engines up to three-litres.

The rate of development in vehicle powertrain technology and systems is faster than at any time in its history, and of two things we can be sure, it will quicken even more rather than slow down and the internal combustion engine certainly won't stagnate.

By Ian Adcock

The drivers for automotive engineering

What makes a company decide to undertake engineering? Why do companies retain huge numbers of engineering personnel and spend vast sums developing new and improved products?

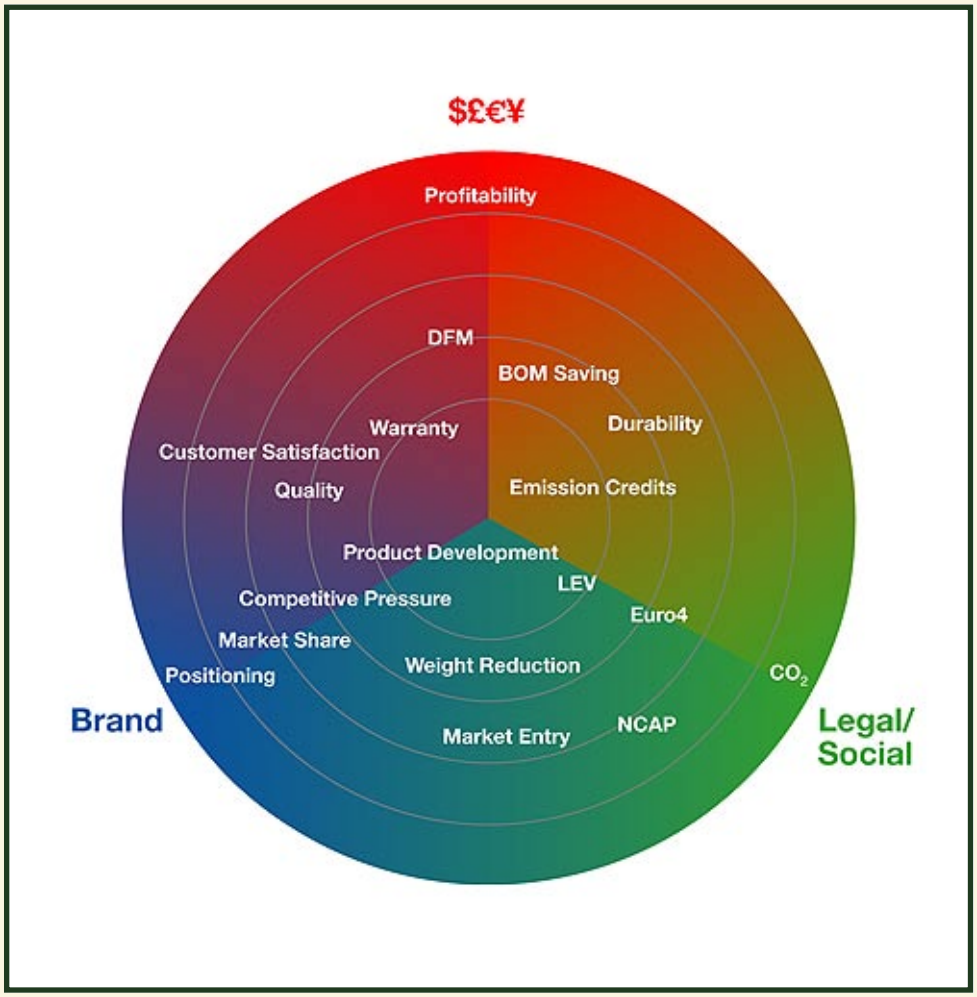
Is it to keep large numbers of skilled people gainfully employed? Or could it be that the companies feel a social responsibility?

Of course not.

Organisations undertake engineering because, for one reason or another, they have to.

The drivers for engineering activity are varied and at times complex, but an analysis undertaken at Lotus Engineering suggests that there are 3 main drivers, under which all market drivers can be classified.

The following figure illustrates the thinking at Lotus Engineering.



Current thoughts centre around 3 main constructs – Brand, Financial and Legislative/Social.

For example, virtually all markets of sale require continual improvement in the vehicles that are sold, whether it be legally mandatory, such as Euro 4, or socially 'required' like EuroNCAP. The OEMs need to respond and therefore need to engineer products that comply with these requirements.

Likewise there are competitive forces deriving from Brand considerations. OEMs continually undertake engineering programmes to improve their market offerings, develop new products, expand markets of sale and seek new segments. Those who ignore or cannot afford these particular demands do so at their peril, witness recent high-profile company failures.

Financial demands also contribute to the need to engineer. For instance cost savings derived from Bill of Material savings, warranty improvements and efficiency gains are all generated on the back of financial requirements. Some have associated brand rub-off, of course, which leads us to engineering activities that have multiple drivers.

Warranty and Quality go hand in hand. Whereas one is viewed as a financial gain, the other is seen as a customer requirement, or even a given. Likewise with weight reduction, there is a cost consideration (be it saving or penalty) as well as emission (legal) and performance (brand) elements.

There are many additional and complex drivers present, some of which are mapped in the diagram.

Of course, mapping out the market drivers is not an exact science, and this item is offered as a discussion piece and not a definitive view of engineering market drivers.

Your feedback and comments are positively encouraged. We'd love to hear your views, additions and counterpoints!

Please comment at:
proactive@lotuscars.co.uk

Lotus engine controllers

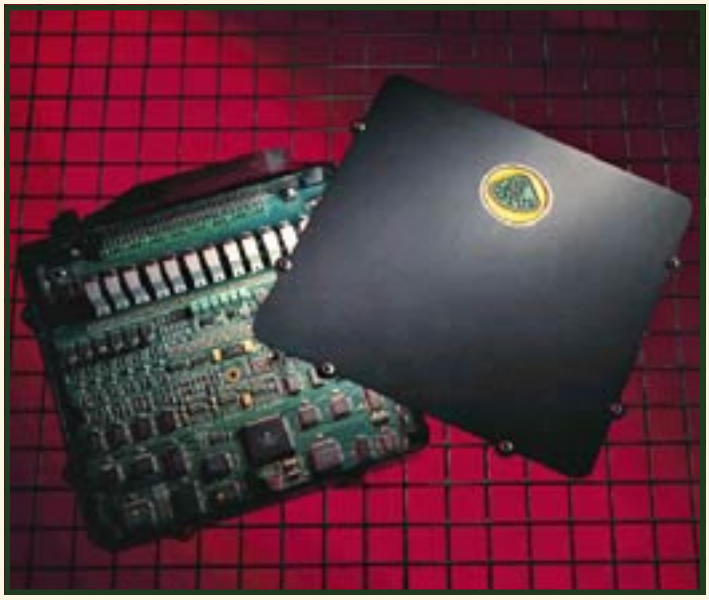
Lotus V8 controller

Lotus' need to create its own bespoke controller started with the introduction of the Lotus Esprit V8 destined for the US market. The low production volumes made it difficult to find a supplier from the established Tier I suppliers.

The solution for Lotus was to team up with a specialist supplier with a background in producing ECUs for motor sport, including Formula 1, and ultra low volume cars.

Lotus Engineering worked with the supplier to produce a bespoke controller enabling the 350hp 3.5 Litre V8 twin-turbo to meet Federal Tier I and CARB TLEV emissions, and provide OBD II diagnostic functionality.

Using Lotus Engineering's experience in software, algorithms, diagnostic strategies and calibration, along with its supplier's experience in hardware design and control systems, the Lotus Esprit V8 launched in 1996. This was the start of a long and successful relationship between the two companies.



Lotus V8 controller

This controller was then adapted to control special vehicles derived from the Elise; the Lotus 340R and the Lotus Exige with 179PS and 195PS versions of the Rover K Series engine.

Lotus K4 controller

The next step in the evolution of the Lotus controllers was on the Lotus Elise with the Rover K-Series engine. Although the original Elise was launched with the Rover MEMS engine controller, the introduction of Euro III and EOBD legislation in 2000 required a new controller calibrated specifically for the Elise.

Again working with the same supplier, Lotus Engineering developed a bespoke controller that was interchangeable with the Rover MEMs controller. The Lotus K4 controller has been used on all variants of Lotus cars using the Rover K-Series engine from 2000, which include:

- Standard Elise
- Elise 111S
- Elise 135R
- Elise Sport 190

Lotus K4 controller

The solution for Lotus was to team up with a specialist supplier with a background in producing ECUs

Lotus T4 controller

With the launch of the Elise into the US an alternative engine was needed. The chosen engine is the high performance 2ZZ-GE engine from Toyota.

Again due to the low volume, the existing engine controller could not be used. This led to the creation of a new controller specifically for the Toyota engine - the Lotus T4 controller.

The installation of the Toyota engine was completed for the Euro IV and US markets in 15 months and 19 months respectively in 2004/5.

Lotus T4e controller

The development of the Lotus controller is ongoing and the T4e controller moves the technology forward significantly and will enable future models to meet LEV II.

Along with the introduction of the electronic throttle control for the Toyota engine, the controller is now based off a state of the art Power PC architecture allowing much faster operation.

R & D controllers

The use of Lotus controllers has not been limited to Lotus products but has also been a major tool in Lotus Engineering's powertrain research and development programmes for third parties.

Due to the strong working relationship between Lotus and the supplier, and with Lotus' ability to write the software and algorithms in house, Lotus controllers have been adapted to run a wide variety of engines. This approach saves both time and money on special development programmes.

Below are some examples of R&D applications for Lotus controllers.

Cylinder deactivation demonstrator

A Lotus V8 controller has been used for two development programmes to evaluate the benefits of cylinder deactivation on V8 engines for North American clients. All the control strategies and software were developed in house by Lotus Engineering.

CNG demonstrator

Due to the flexibility of the Lotus V8 controller, this was the basis for the controller used for the Lotus Elise CNG demonstrator. A single controller was used to control the gasoline and CNG fuelling.

Gasoline direct injection demonstrators

Gasoline experience is not limited to port injection with a Lotus controller being used for the much more precise fuelling requirements of GDi engines. Again, the software and algorithm development was carried out by Lotus.

Performance demonstrator

For a client wanting to produce a one-off performance demonstrator in 9 months, the Lotus T4 controller was the perfect solution.

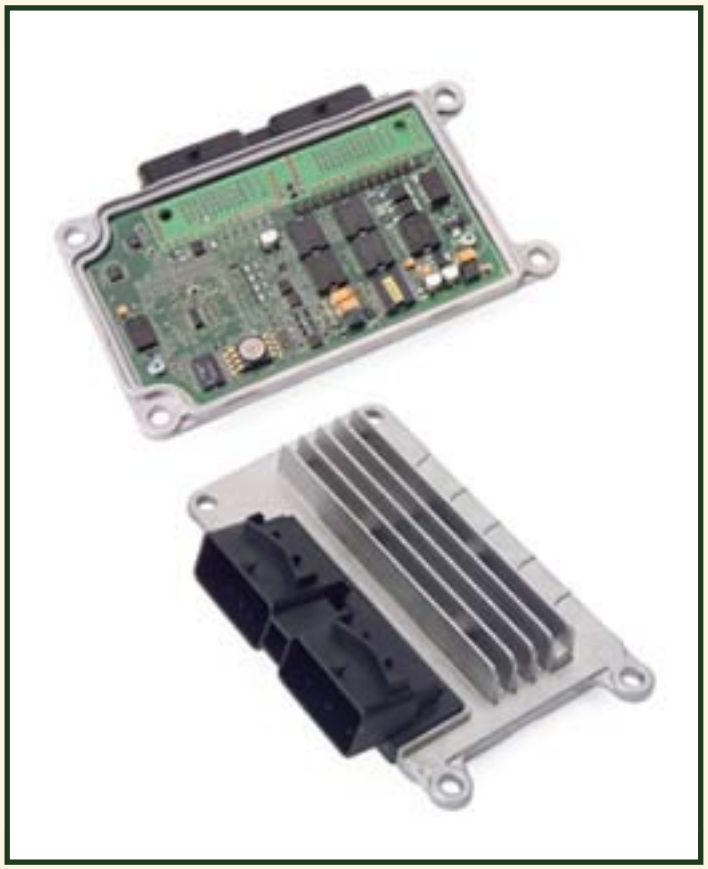
Packed with performance enhancing features, the engine was up-rated by Lotus from 145PS to over 200PS. The features controlled by the Lotus controller included intake and exhaust cam phasing, cam profile switching and a variable intake manifold.

Prototype V6

For a new family of V6 engines being developed by Lotus, a new state of the art controller was developed, the Lotus N6.

Being developed for LEV II and OBD II compliance, this controller has formed the basis for the Lotus T4e controller to be used on the LEV II Elise.

The high feature content of the Naturally Aspirated and Supercharged engines makes the Lotus N6 controller suitable for most gasoline engines up to 6 cylinders.



Lotus T4e / N6 controller

The V6 family includes features such as:

- 4 cam phasers
- 4 stage variable intake manifold
- 6 ignition coil drivers
- 4 lambda sensors
- 2 knock sensors

Diesel engine development

Showing the flexibility of the Lotus controllers, with a minor hardware change, the Lotus N6 control is currently running a V8 diesel engine. The controller has been adapted to control electronic throttle, oxidation catalyst, particulate filter, de-NOx catalyst and exhaust fuel injection.

From receipt of the specification from the client, the engine was running on the revised Lotus controller in just five weeks.

Lotus R & D

In addition to supporting client programmes, Lotus controllers have been used to support Lotus' own research and development. For example Lotus' patented Single Lambda Sensor OBD II control system was developed using the Lotus V8 controller, and of course, Lotus controllers are used on the Active Valve Train research engines.

What next with Lotus controllers?

The potential for Lotus controllers is huge. With the T4e and N6 controllers, Lotus has two state of the art controllers capable of meeting the most stringent emissions and diagnostic requirements for high feature I4 and V6 engine applications at low to medium volume.

In addition to the potential associated with production engines, the hardware flexibility and in house software and algorithm development means these systems are ideal for any R & D opportunities. This is especially true where flexibility, speed and cost are important to the customer.

As well as developing the hardware and software, Lotus Engineering has also been developing its processes. By using Mathworks Simulink, Lotus is now designing and developing algorithms faster than ever with the auto-coding functionality further reducing the time to first engine run.

For the existing production controllers, Lotus is also investigating low cost high volume manufacturing opportunities. With the move in the developing markets towards Euro III and Euro IV emissions levels with EOBD on board diagnostic requirements, Lotus sees huge potential for its Euro IV capable controller.

Backed up by an experienced team, who can tailor the hardware, software and calibration to suit a particular customer's requirements, a Lotus controller is a very attractive and versatile proposition.

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