pro **Active**

The official industry newsletter of Lotus Engineering

Issue 3

July / August 2004

Taking the Elise to America

Logan: Renault's 'world car'

Lotus Engineering *Change the Rules*

Welcome

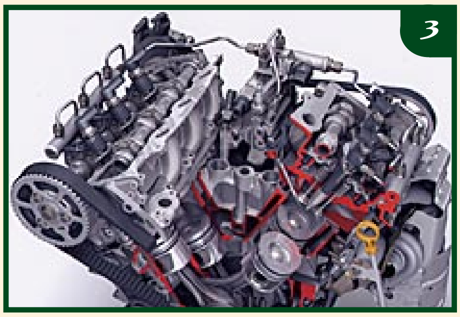
I'm very proud to bring you the third issue of proActive, Lotus Engineering's commentary on the automotive industry. Our first two issues have been very well received by you and we're finding that there is a very high pass-through rate, with many clients forwarding their copy to colleagues and friends. Not only that, but several Lotus car-owners clubs have picked up the thread and are finding that the content is appealing to the end consumer.

This issue is titled 'Engineering: A Global Business', an area that is very close to my heart. As Managing Director it is my responsibility to ensure that Lotus Engineering is able to meet its customers needs across the globe. It's tough for suppliers to keep pace with the OEMs in terms of market expansion. Some might call the installation of new facilities as taking a strategic view, but in my experience most times it requires extreme bravery, available capital and a steady nerve.

I don't need to tell you that the automotive industry is a fast moving place. Agility is key. Developing the right products to hit the right markets at the right time is crucial to the generation of profit. Witness the scramble to have a presence in the Chinese market, fuelled no doubt by reports of GM and VW typically enjoying much higher unit profits than in more established marketplaces. Quite how the rush to produce vehicles in China will end remains to be seen. Many analysts are predicting over-capacitisation as local sales don't grow as fast as installed capacity. The most likely outcome is that manufacturers will seek to export from China, perhaps to other Asian territories initially, but indigenous OEMs are sure to have an eye on Western Europe and North America. Tomorrow's Chinese companies are likely to be a mixture of indigenous OEMs and transplant operations with local flavouring. Pretty much like Europe, Japan and North America today.

It's during the global transition phase that 'growing pains' are experienced and additional assistance is required. And that's one of the areas where consultancies such as Lotus Engineering excel. Not only can companies such as ours bring technology, niche product know-how and extra resource, but they can do it in an agile fashion. Furthermore by being global, Lotus Engineering can minimise design, development and testing investment by leveraging cost-effective engineering talent. And that ultimately gives customers such as you the best opportunity for profit around the globe!

Albert Lam - Managing Director Lotus Engineering



Contents

July 2004

news

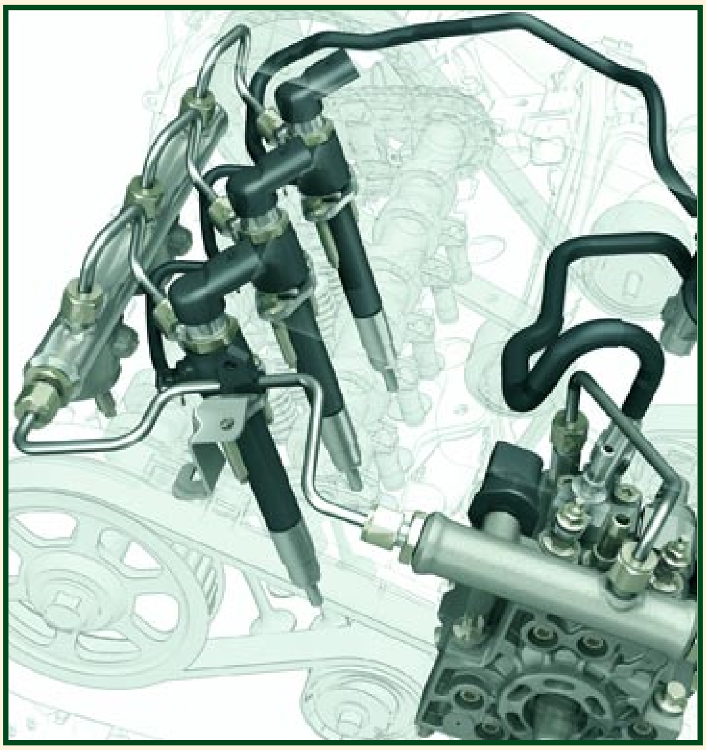
features

Jaguar's new V6 diesel impresses

Few engines have attracted quite as much speculation during their development period as the new 2.7-litre V6 diesel from the PSA/Ford alliance. After the project's announcement in 1998, both sides remained tight-lipped about the premium diesel's precise specification. Now Jaguar's version, the AJD-V6 engine, has finally appeared beneath the bonnet of the 2004 model year S-Type Jaguar.

The 'Lion' engine gives a maximum of 206bhp and 320lb ft of torque without using overboost. The engine block is made from CGI (compacted graphite iron) providing a good proportion of the weight advantage achievable with aluminium but without compromising noise suppression. So light is the new engine at 202kg, it outweighs the petrol V6 by only 15kg, while even outstripping the 4.2-litre V8's maximum torque.

At the beginning of the project, Ford had been investigating electrical assist turbocharging for diesel engines generally, but since the start of what has been a four-year project, the new Jaguar has the latest technology, turbochargers which overcome the usual problems of low speed response. The inertia of the compressor turbines has been considerably reduced compared to earlier designs and the variable nozzles are electronically, rather than mechanically, actuated. On the injection front, Siemens VDO's piezo-injection common rail system provides 1,650 bar pressure and enough performance to deliver up to five injections per cylinder, each cycle.



For the time being, Jaguar's powertrain remains unfiltered, manual installations conforming to Euro 4. Automatics meet Euro 3 although Jaguar says the engine is Euro 4 capable when necessary.

Diesel oil is delivered to the high pressure, three-piston radial pump by two low-pressure pumps, all three under the control of an ECU. Fuel to the high-pressure pump is precisely metered according to demand, providing the minimum pumped volume at any given time. The result is lower inertia in the fuel system and therefore minimum power consumption by the high-pressure common rail pump.

The ECU takes advice from 23 sensors (including two knock sensors) and, giving orders to 20 actuators, it handles the opening and closing of flaps in the sophisticated inlet port system to optimise flow and swirl through the engine's entire operating range. The ECU also acts as the EGR controller – responsible for reducing combustion temperatures and therefore NOx – as well as being responsible for the VNT turbochargers and the electronic throttle's management of shut-off shake.

Most of the development work, says Jaguar, was carried out between engineers at Ford's research centre in Aachen, together with engineering teams at Jaguar's, Whitley Engineering Centre. The engine will be built at Ford's new Dagenham Diesel Centre, initially at the rate of 100,000 to 150,000 units a year. Investment costs of €350 million included provision of an on-site engine block machining facility and allows room for expansion as more Jaguar, Land Rover and PSA models come on line. No doubt, we'll get PSA's side of the story when the engine appears in the 406.

Source: just-auto.com

News

SWITZERLAND: China is the new competitive reality according to Lutz

China is like *"a freight train driving down on us,"* according to Robert Lutz, General Motors vice chairman and the firm's unofficial 'car czar'.

Lutz said the *"young tiger"* domestic China automakers such as Geely, Great Wall and Chery will soon start exporting to the west.

"They are the new competitive reality. We have not yet begun to see how they will affect international competition," Lutz told the Automotive News Europe Congress in Montreux.

Lutz said the Chinese auto industry is developing far faster than he anticipated.

"The process towards auto mobility that took 20 years in Europe has happened in China in just two years", said Lutz.

"In 2000 the streets of Beijing and Shanghai were filled with bicycles. Now the bicycles have been replaced by Passats and Buicks."

Lutz warned that Europe is vulnerable to Chinese competition because it is becoming less competitive as an auto production base with its high labour costs and shorter working hours.

"The way the European economy is run is worrying. It is slow to adapt to the international environment and it lags behind the US in capital investment."

Lutz said GM's recent reorganisation of its loss-making European arm to integrate its Opel, Vauxhall and Saab operations more closely will not be at the expense of those brands.

"Opel, Vauxhall and Saab will thrive far more together than they would as individual entities," said Lutz.

GM Europe lost $US504 million (about €417 million) last year, following losses of $1 billion in 2002 and $765 million in 2001.

Former Opel chairman Carl-Peter Forster was appointed as GM Europe president. He is charged with reducing duplications in areas such as product development, engineering, design and marketing.

Source: just-auto.com

GM

SWITZERLAND: European car makers demand less regulation

Europe's carmakers don't need to be told by lawmakers how to regulate their industry, according to Ivan Hodac, secretary general of ACEA, the European auto manufacturers association.

Hodac told the Automotive News Europe Congress in Montreux that the motor industry could achieve breakthroughs on issues such as safety and air pollution without new laws.

He highlighted technological innovations including anti-lock brake systems (ABS) and electronic stability programs (ESP) that have helped to cut the numbers of road accidents in recent years.

Hodac also cited particulate filters that European automakers and suppliers have developed to reduce potentially harmful exhaust emissions from diesel engines.

"These technologies came from within the industry," said Hodac. *"It is time that we stood up and talked about our contributions to society and our achievements,"* he said.

The heads of Europe's auto companies recently organised their first high-level delegation to lobby politicians and lawmakers on regulatory issues.

Volkswagen CEO Bernd Pischetsrieder, who is current ACEA chairman, accompanied by Ford of Europe president Lewis Booth, PSA/Peugeot-Citroen CEO Jean-Martin Folz and other auto industry chiefs, personally lobbied EU Commission President Romani Prodi and German Chancellor Gerhard Schroeder in two separate meetings.

Europe's automakers claim that new regulations are pushing up showroom prices of new cars, hitting their competitiveness and putting thousands of jobs at risk.

They are demanding that independent impact assessments are carried out before any more new regulations are implemented.

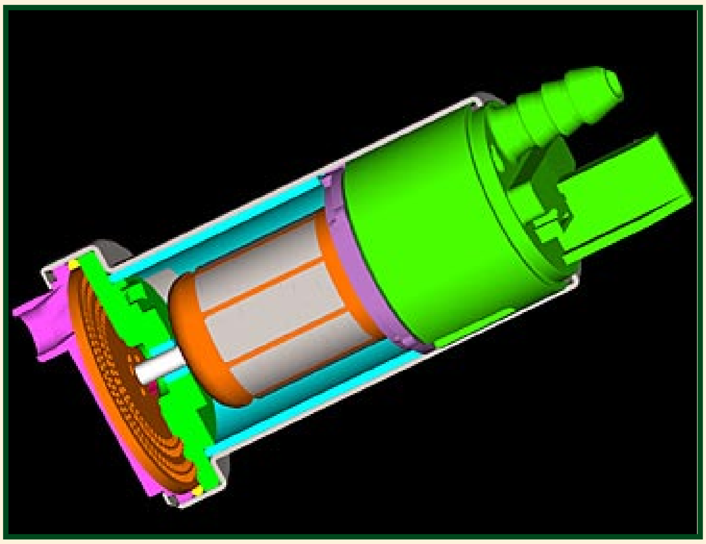
Source: just-auto.com

TI to introduce revolutionary fuel pump to meet the needs of modern GDi systems

Fuel delivery systems specialist TI Automotive has announced a revolutionary type of fuel pump especially to suit modern gasoline direct injection (GDi) engines. The latest GDi engines' need for increasingly higher fuel pressures (5-6 bar, up from today's 3-4 bar) and fuel flow rates poses quite a challenge for the pump, not least because the harder the fuel pump works, the shorter the life of the pump motor.

TI's new Dual Channel Single Stage (DCSS) pump overcomes this problem by increasing the flow rate in a unique way. Conventional turbine type pumps use an impeller to drive the fuel around a single channel – whereas the new DCSS design uses a patented impeller with sets of specially curved blades to drive the fuel around circular parallel channels. This greatly increases the pump's capacity (250-200 Litres/hr at 4-6 bar), with little or no corresponding increase in friction, so the pump can be run at lower speeds, thereby increasing motor life. *"Present pumps only give you a maximum pressure of about 5 bar and flow rates of 180 L/hr,"* explains Kuhlen.

The second major benefit is that the twin channels help to overcome hot fuel handling problems in high performance GDi engines. The higher engine temperatures (necessary for improved emissions) and higher fuel flow rates increase the tendency for the fuel to vapourise in the pump, especially on hot days. As Ernst Kuhlen, TI Director, Global Fuel Delivery Systems explains, *"if you have two parallel channels, one can be blocked, but the other is ok and the bubbles clear soon,"* – any fuel vapour bubbles that form remain in the inner channel, whilst centrifugal force drives the liquid fuel into the outer channel, thus ensuring that some fuel always gets through in a situation that in other pumps could result in complete vapour lock.



TI's all-new DCSS pump was developed by its R&D team in Caro, Michigan

The DCSS pump's 50mm-enlarged section houses a 44mm impeller with an outer and an inner pumping channel to improve pumping efficiency by 50% over a single-channel turbine pump

The DCSS technology also brings nearly 50% greater efficiency (up to 30% efficiency, whereas conventional pumps can only manage about 20%) to the fuel pump, resulting in greatly improved overall fuel efficiency and driveability, explains Manouchehr Kambakhsh, TI Vice President, Global Advanced Engineering. *"The DCSS pump will enable automakers to increase fuel efficiency, reduce emissions and improve the overall performance of petrol engines,"* he goes on to say.

TI manufactures around 9m pumps (7.5m gasoline, 1.5m diesel) a year and expects that the new DCSS pump will replace the majority of its current generation fuel pumps *"within six years… on a global basis."* Larger engines will be the first to benefit and production will begin at the end of 2004 at the company's facilities in Caro, Michigan and Neuss, Germany. First applications are expected to be in a German car from early 2005, followed by applications in existing vehicles in the US and others. The company is also working on a smaller, lower-capacity DCSS design to meet the needs of high-revving Japanese engines.

Current high performance gasoline and diesel engine fuelling needs will continue to be met by TI's novel E5L and E3L screw pump designs. These offer a very wide, flexible, range of fuel pressure and flow rates for high-end vehicles from Bentley, Rolls Royce, Maybach, AMG and DaimlerChrysler. Extremely high flow rates (270-390L/hr) and excellent hot fuel handling characteristics are features of these special pumps. The screw pump and DCSS pump designs supply high pressure fuel directly to the fuel injectors, eliminating the need for any other type of pump in the fuel delivery system.

Source: just-auto.com

Campro: A Worldwide project

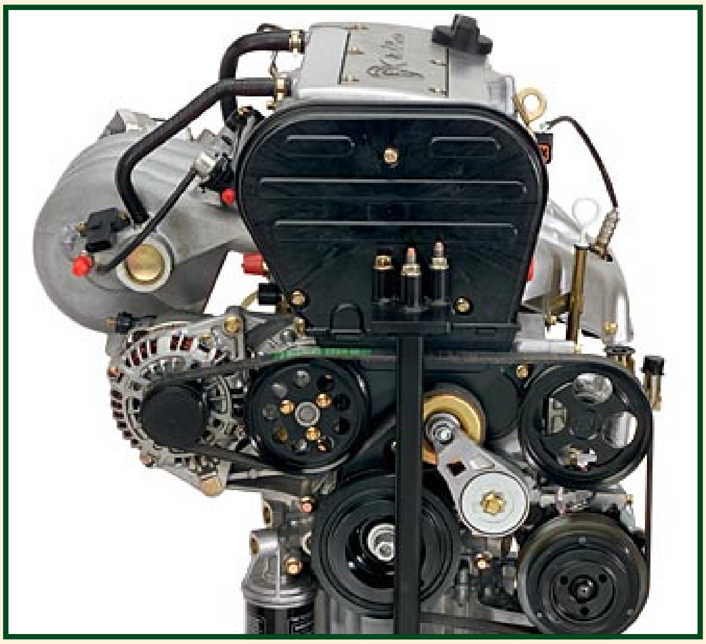
With a production launch in 2004 the CamPro project has successfully confirmed Proton as an independent engine manufacturer. The new 1.6 and 1.3 litre gasoline engines were engineered with Lotus and now power the new Proton Gen 2 vehicle, the first application of a Proton designed and manufactured engine.

The Campro project was initiated in late 1999 when Proton made clear their vision to complete their independence, by replacing engines currently being built under licence with their own designs. Proton also aimed to transform their understanding of the process of engine design and development to confirm a future as an independent engine manufacturer.

The brief was given to Lotus to design from a clean sheet of paper an engine of 1.3L and 1.6L capacity, with world class combinations of power and torque, future emissions protection and minimum component BOM cost. To maximise profitability the program was to utilise much of the existing Proton manufacturing facilities, even while they still produced some of the existing engines under licence, and have maximum commonisation of components between the two new engines to limit inventory.

Achievement of the stringent BOM targets required a flexible combination of local vendors and a global supply base.

The Lotus solution to these requirements constituted an engineering programme which spanned the globe, drawing on the engineering expertise of Proton, Lotus and a host of suppliers and technical partners. Co-ordination and delivery of this complex global project required not only engineering excellence but also the application of new technology to make it a reality.



The following describes the resources, methods and operational locations which were key in delivering the CamPro program.

The project was split into two distinct operating phases, Prototype and Production, to reflect the changing needs of the programme as it progressed to start of production.

Prototype Phases

For Mule, F1 and F2 prototype phases the majority of the work and ‘centre of gravity’ of the project was located in the UK to exploit Lotus strengths in powertrain development. Throughout this period the project, product engineering, CAE, development and quality function groups remained based at Lotus Engineering, Hethel.

The Lotus design team included Proton engine designers who made up a third of the total team size and were all based within one confidential office. The Proton design staff relocated to the UK for this activity for a period of 2 years, undertaking much of the technology transfer process. The work related to production supplier nomination was co-ordinated and ably supported by Proton SST staff, also on secondment, working with Lotus Purchasing staff and liaising with Proton Group Purchasing and Project Management groups in Malaysia.

The project team had daily communications with project staff in Malaysia, which was coordinated by an LEM project manager who relocated to Malaysia to support this essential liaison and interface with the client.

Typical for Lotus projects, a product engineering team was appointed to co-ordinate the engineering of new components and systems. Key to their activity was management of the functional engineers based at various sites including suppliers. These suppliers were predominantly based in Europe, the Far East (including Malaysia, Korea and Japan), and in Australia. The functional engineers provided specific technical skills necessary to develop the component and were drawn from the best available to Lotus including, where necessary, Simultaneous Engineering Partner (SEP) companies employed to provide specialist knowledge to the team.

Communication between the engineering team rapidly developed to dominate and dictate project activity and was managed using email, video conferencing and copious amounts of travelling. To support work with the UK design team Lotus implemented a PC based CAD viewing tool which allowed project staff to see the same CAD data as the designer during discussions and meetings despite the physical separation between sites.

To enable efficient world-wide communications a project database was set up from the start of the program by the Project and Product Engineering group, it being essential to manage and co-ordinate activity in real-time across multiple time-zones.

Utilising contemporary technology the database was developed by Lotus specifically to support Campro and implemented on the secure Lotus intranet, with direct access for all project staff and connectivity from all global engineering sites.

The (SINDUR) database ensured that engineering concerns and the engineering release of drawings and critical project data could be communicated and approved by program staff across several sites. The software also provided the basis for subsequent transfer of the project centre to Malaysia for the later production stages of the project.

All engineering drawing releases were controlled using the project engineering database. This allowed the requirements for designs to be instigated by the engineering team and communicated to the designers and engineering team regardless of location. Drawings and models were developed and then released through the SINDUR database with authorised digital sign off by all key staff including design, project, engineering, development, CAE and purchasing. Completed design data was then released and exported to Proton for input into the Proton data management system.

The core CAE team made up of Lotus and Proton engineers was based at Hethel with the analysis being led by experienced Lotus engineers. Further illustrating the Group vision, certain aspects of the CAE work were undertaken in Malaysia by Proton staff following their return from the UK.

Prototype engine build and development testing continued in the UK in dedicated facilities at Hethel. Engineering concerns generated from the test program were put into the engineering database for resolution, management, reporting and control. These concerns being accessible by all function groups for monitoring and approval.

Pre-Production

In the pre-production phases of the program the operating model changed to reflect the progressive ramp-up of manufacturing preparations for start of production (SOP) in Malaysia. To manage this activity the focus of the engineering staff moved to the Proton Powertrain satellite office in Shah Alam, Malaysia.

The product engineering leader relocated to Malaysia and led a team of European and Malaysian engineers from Lotus Engineering Malaysia. Their responsibilities remained the same as the prototype phase to deliver the engineering to provide a robust design.

A relocated design team was made up of an experienced design leader from Lotus Engineering (LE) Hethel and locally recruited Lotus Engineering Malaysia (LEM) staff. This team progressed the design through to production, releasing drawings and data to the Proton data management system (PDM).

To support the growing development activities for durability and validation the project now utilised facilities at both LE Hethel and Proton Shah Alam. The extensive vehicle calibration program for Campro was continued by Proton staff under the leadership of a senior experienced Lotus employee who also relocated to Malaysia to support the program. Calibration test work, with vehicles being shipped overseas where necessary, took place in Malaysia, the UK, Sweden and Australia.

Proton Group Purchasing had production purchasing responsibility and placed all purchase orders for the pre-production and production components and tooling. To support the supply base preparations, Supplier Quality Assurance (SQA) engineers travelled the world, visiting suppliers and assessing PPAP readiness.

Throughout this phase of the program the project database (SINDUR) was essential in co-ordinating the engineering data from the two primary engineering sites, engineers using the system to record /manage data and co-ordinate activity such as concern resolution.

Conclusions

The Campro program was a very complex project utilising the best engineering resource around the world. Effective use of this resource required the application of proven Lotus Powertrain best practice and development of dedicated project management tools.

The project activities spanned the world and demonstrate the global nature of modern engineering programs and the strengths required to deliver these.

The CamPro engine has now entered production in Malaysia with a first application in the Proton Gen 2 vehicle. It has received good press reviews that illustrate the success of the engineering approach adopted for the project.

Sources: Andrew Arden, Lotus Engineering

Taking the Elise to America

The Elise was first introduced to the European market in 1996 changing the rules in the design of new cars. The Elise proved that it wasn't necessary to build a large and heavy car to meet ever more stringent safety legislation and underlined the benefits to performance, fuel economy and emissions of a low mass approach. Now, Lotus has successfully launched the latest variant of the Elise into the ultra-competitive Federal market for the first time, with customer deliveries starting in July.

A major exercise was undertaken to understand exactly what would be required to meet both market expectations and the demands of Federal vehicle legislation. Ultimately, a large proportion of the vehicle's components were revised during the design and development process, including the powertrain, the fuel system and the interior.

Despite exceptional performance of the original Elise through its light weight, Lotus understood that for the Elise to be a commercial success in the USA the power output of the engine would have to be greater than that achieved by the Rover K-series engine. In addition, the Rover unit

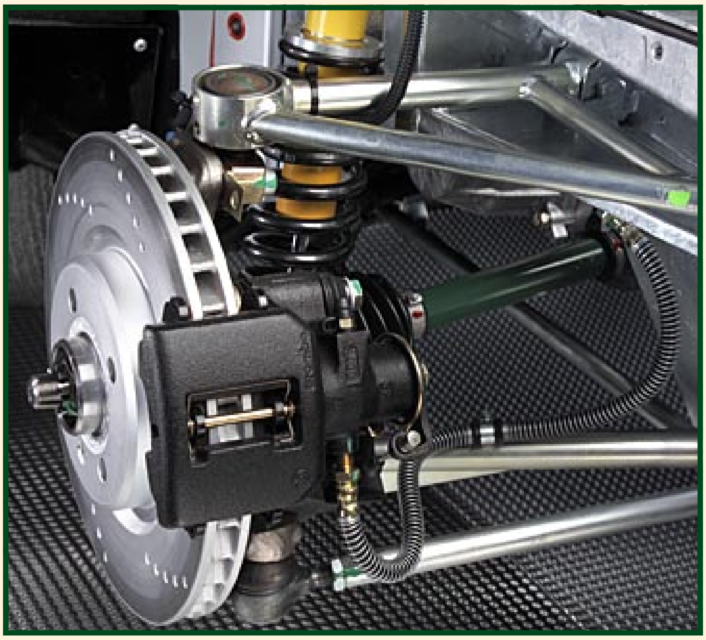
had not been homologated for the States and its more stringent Federal exhaust emissions regulations, and it would have proved a significant and costly exercise. These factors led Lotus to seek a new powertrain for the car, and after assessing a range of options, the decision was made to install the elegant 190bhp Toyota 2ZZGE engine from the Celica GTS.

Although the Toyota powerplant was already fully approved for Federal use, Lotus elected to use a bespoke Engine Management System, developed in-house, to ensure it was tailored to perform as desired in the Elise, a far lighter car than its donor. This decision effectively defined the critical path for the programme timing, with the very first prototype cars being built for calibration development work and the very last activities on the programme being the final approval of the vehicle by the US Environmental Protection Agency. This whole process ran to schedule and took just 16 months to complete.

Federal evaporative emissions legislation required a complete redesign of the vehicle fuel tank and associated systems, presenting a major challenge in terms of being able to accommodate the necessary systems within the available space. In addition, the opportunity was taken to increase the fuel tank capacity and revise the tank construction to use stainless steel.

The interior of the car was completely renewed, primarily to enable the inclusion of both driver and passenger airbags to meet Federal unbelted occupant requirements. Tests confirmed that the Elise offered a high level of occupant protection. This is attributed to its exceptionally stiff aluminium tub chassis, combined with the innovative composite crash structure, aluminium door bars and steel seat belt anchorage frame. In addition, a programme of NVH development within the vehicle structure has also achieved a greatly improved level of comfort within the cockpit.

The Elise required little more than the addition of front airbags to meet the Federal safety requirements as the existing structure provided excellent test results in side impact, rear impact and roof crush tests. The driver's airbag is neatly contained within the hub of an ergonomic Momo sports steering wheel, while the passenger airbag is unobtrusively positioned behind a tethered door in the facia trim. The increased manufacturing volume of the car justified the use of injection moulding to manufacture the



majority of the plastic trim parts rather than vacuum forming as has been used previously on the Elise, with a commensurate improvement in quality.

The Elise has always been quite rightly famed for its exceptional ride and handling capabilities; compromising this key characteristic was entirely out of the question. Brand new bespoke Yokohama Advan Neova AD07 tyres have been developed in parallel with unique spring and damper settings to not only maintain but improve on the high standards set previously by the European version of the car. A number of tyre submission tests were performed, each one reviewing a range of different construction and compounds and deciding the specifications to be assessed at the next test. In addition to the standard suspension there is also a Sports suspension option which is aimed squarely at the track day enthusiast or club level race competitor. This offers increased rate springs and revised damper settings plus a set of wonderful ultra-lightweight forged aluminium wheels and high performance Yokohama A048 sport tyres. The sports suspension option offers the ability to pull lateral "g" levels which would put many a race car to shame.

The new powertrain offers a power delivery characteristic which perfectly suits the sporting nature of the Elise, with unusually high peak power and torque speeds. A more conventional engine would normally achieve its peak torque at a lower rpm. This encourages the driver to utilise all of the engine's speed range and together with the precise shifting close ratio six speed gearbox produces a driving experience which is not only fast but feels fast too, bringing the fun back into driving at sensible speeds.

The total programme took just over 16 months from initial concept approval to start of production and involved 33 prototype vehicles for the Federal programme in parallel to the simultaneous programme which introduced a Toyota engined Elise to the existing non-Federal markets. The design and development team was organised on a cross-functional basis with a core team of 5 Release Engineers, a Development Manager and a Supply Chain Manager all reporting to the Chief Engineer, Malcolm Powell. Each of these function leaders controlled a team drawn from the resources within Lotus Engineering. At the peak of the programme the direct team totalled approximately 60 members.

The success of the programme is self evident, with Lotus currently having firm orders for more than the first year of production of the Federal Elise even before demonstrator cars had been delivered to dealers. The car was formally launched at the 2004 Los Angeles Auto Show where it won the unofficial accolade of *"most exciting car of the show"* and the Lotus stand was besieged with thousands of visitors every day.

The introduction of the car to the dealers and the press was held over a three-day period at Barber Motorsports Park near Birmingham, Alabama in March 2004. Press reports from the event rate the car as one of the most exciting road vehicles available at any price, and draw direct comparisons with other illustrious marques such as Ferrari and Porsche.

Having fully tested the Elise's supercar-challenging performance and understood the exceptional fuel economy and low environmental impact that its low mass makes possible, one major sports car magazine felt compelled to ask the question *"Is this the most significant new car to come to America this year?"*

Source: Nick Adams, Lotus Engineering

Global Engineering: Myth or reality?

Global engineering is discussed today in the same way that, in the 1990s, suppliers talked about *"think global, act local"* as they chased the vehicle manufacturers to the expanding and low-cost markets of the world.

But does engineering have to follow the same route? Does it make sense to have pools of engineering excellence dotted around the globe, or is it better to have centres of excellence in different disciplines able to support each other?

Recent evidence is that one size does not fit all – there are as many solutions to the potential problems caused by globalising engineering as there are companies who feel the urge to do it, either because their clients want their presence or the engineering consultancies feel they will win more business by expanding their global footprint.

Demetris Agrotis, director of Delphi's Mexico Technical Center in Cd. Juarez, which exports its technology around the world, believes the role of such technical centres is slowly changing.

"Five years ago we had groups of engineers with expertise training Mexican colleagues – knowledge was held in different pockets for different products." Now that knowledge is far less compartmentalised and the aim is to expand technology globally. "We have four Chinese engineers here now so that as we localise products around the world, the knowledge will go with them," said Demetris.

A part developed at MTC may be engineered in Tokyo, assembled in Spain for delivery to a car plant in the UK – and the sub-suppliers may be spread around other parts of the globe. This creates pressure of managing what is at times a fairly thin supply chain.

Jerry Haller, site manager Delphi Steering Systems at MTC, points out that development time for new products was once 18 months, the norm now is more likely to be four or five months. And while Delphi has technical centres all around the world, the engineering cycle of technologies or products has not yet reached a point where responsibility can be handed over to "the next shift" so, for example, when Japan and the Eastern hemisphere closes for the day, the Western hemisphere opens to give 24-hour development.

"This is something that may come one day," said Haller. "Right now the areas of responsibility are still quite narrow."

Despite this, research and development centres like MTC have a global role. *"Technology allows us to work globally,"* said Haller, *"even if we have to come in at 5 a.m. for a meeting with China or stay until 8 p.m. for a meeting elsewhere."*

The Far East is quite a well-trodden path for European engineering houses, many of which have been serving the South Korean auto industry for years.

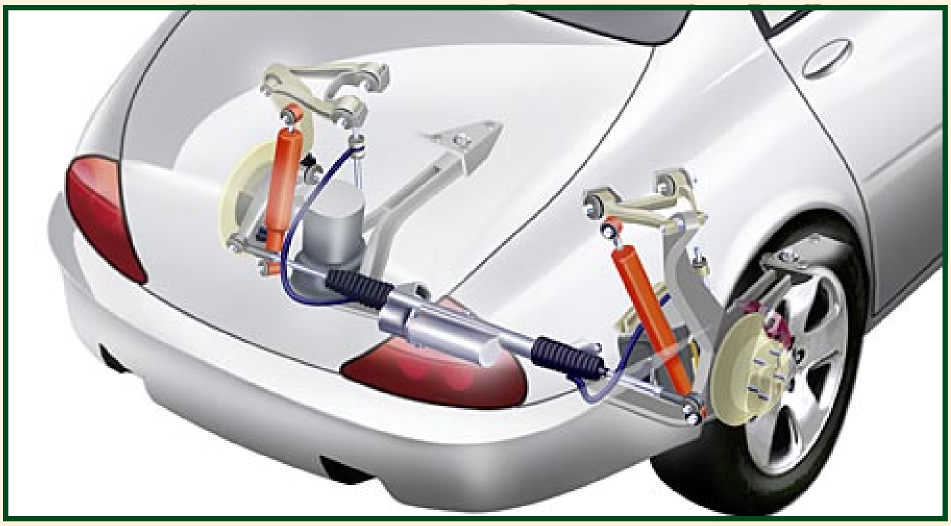
While China is the obvious location at the moment, it's not the only one.

India is fast developing a reputation as a good place to do business, with considerable advantages over China for Western-based companies. India, thanks to its imperial history, has a more familiar legal framework. It has better management resources than China and a large pool of well-trained engineers and technical graduates, evidenced in the country's globally competitive software and IT sector.

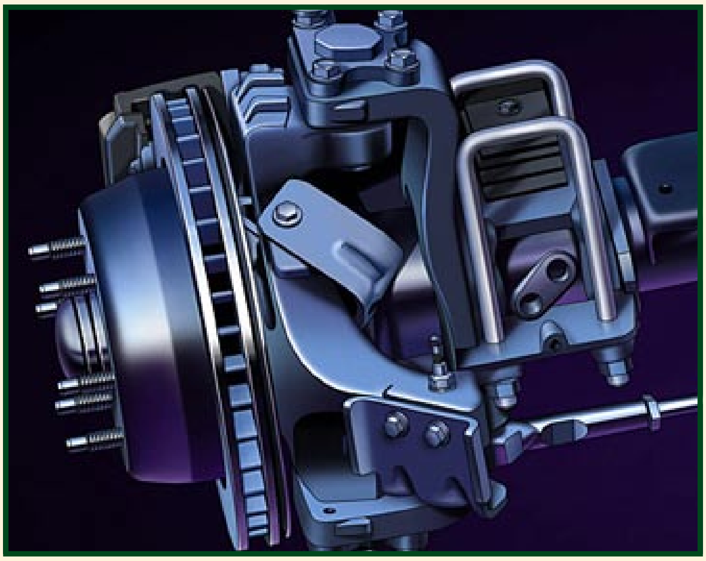
India also doesn't have the language barriers that exist in China, especially when dealing with suppliers based outside China's major cities.

There is also a worry that costs in China could get out of hand unless they are carefully controlled.

"When you first look at China, you think it's going to be a low cost base. As we look at it more, it is not that cheap," according to the European manager of one engineering consultancy which has just opened ship in China. *"The salaries of experienced and*



Delphi's Quadrasteer system
Source: just-auto.com



competent Chinese engineers will increase rapidly as the demand for them increases rapidly."

Skilled Chinese engineers are in short supply already with the huge boom in the country, and the worry is that they will only get more expensive if the phenomenal growth seen in the last two years continues.

Confidence in India remains high. One indicator is a recent forecast that exports of automotive components from India could rise to around $10bn by 2010, up from around $1bn.

While car makers and suppliers are moving into new territories, they stress that it is important not to forget the developed markets – after all that is where the money is right now.

Latest to spread their wings to the United States and Europe in terms of technical capability are the South Koreans – largely to support new factories but also to study the markets in those regions more closely and to engineer their cars accordingly.

Hyundai opened its new technical centre in Frankfurt, Germany, last year to help capture some European influences.

Hyundai Motor Group is developing an all-new model specifically for the European market which will go into production at the company's new 300,000-unit assembly plant to be built in Slovakia.

The Ford Focus-size model, somewhere between Hyundai's Accent and Elantra models was also seen as the E3 concept at the Geneva Auto show.

The car is being developed in response to European distributors and dealers who say they could boost sales with one model rather than the current two in the mid-size segment. Sales of Elantra struggle in many European markets.

The new car will also form the platform for the company's re-entry into the World Rally Championship.

The South Korean automaker plans its return to the WRC in 2005 running its own team out of Frankfurt through the newly formed Hyundai Motorsport.

The E3 concept could also form the basis for the new model to be built at the new Kia plant at Zilina, Slovakia, due to start producing cars from 2006.

Toyota's European Design Centre is close to Nice in the South of France. It has had considerable input into the new Yaris, built at Valenciennes in the northern part of he country.

Yaris has built up a strong reputation in Europe and Toyota said it is keen to maintain this by keeping strong influences from the region in terms of design as well as performance.

The key now is how to manage this technical capability around the world. It would seem to be a case of horses for courses. Different time zones mean that engineers around the world can work on project for 24 hours a day – as one centre closes another opens.

Whether this is practical or not remains to be seen. In some quarters it is believed that engineers should be focused on a specific project which means technical facilities would be more likely to become 'Centres of Excellence' for projects which ultimately have a global reach.

By Anthony Lewis and Chris Wright

Sources: just-auto.com / Lotus Engineering

Logan: Renault's 'world car'

Renault has unveiled its long-awaited '€5,000 car', and has revealed ambitious plans to build close to a million of the cars a year worldwide by the end of the decade. Mark Bursa takes a detailed look at the project.

The car, previously codenamed X90, is a four-door sedan based on the new Renault-Nissan B platform. It has been named Logan, and will be built initially at Renault subsidiary Dacia in Romania. It will be sold under both Dacia and Renault brands, depending on the market. Dacia will be used in Central and Eastern European markets as well as Turkey and North Africa, where the brand has traditionally been sold; in Russia, South America and the Middle East it would carry Renault badges. The car is homologated for Western Europe but there are no initial plans to sell it there.

On the face of it, the plan looks similar to Fiat's 'Project 178' world car of the mid-1990s, which spawned a variety of vehicles including the Palio hatch, Siena sedan and Strada pick-up. But Renault executives claim there are key differences between the two. Firstly, the Logan is based on Renault's latest technology - Palio used some componentry from the Uno. And secondly Logan will be cheaper - whereas Siena is seen as a premium Fiat in Central Europe, Logan will be the entry point for Dacia as soon as production of all old Dacia models ceases next year.

Renault Logan and Fiat Palio projects are similar

But really the two projects are similar. The biggest difference is timing - Renault has also got the timing right. Palio sales suffered because of the collapse of some of its key markets, especially in South America, in the late 1990s. Logan is being focused more heavily on Central and Eastern Europe, and with EU enlargement these markets are ripe for growth. And China in the 1990s was a largely stagnant market, not the rapidly growing powerhouse it has become over the past couple of years.

From the start, the X90 project was referred to as a *"€5,000 car"*. However, the promised €5,000 retail price will not be available when the car goes on sale in September - Renault is holding back the budget-priced base model until next year in order to avoid conflict with the current Dacia Solenza model, which will cease production in 2005. Initial Dacia Logans will be higher-specified models - the top priced model will cost around €8,000. And the €5,000 price tag will not be available outside Romania - import duties in neighbouring states have put paid to that.

Nevertheless, Logan extends the reach of Renault's product offering into the all-important lowest segment. In Poland, for example, Renault does not at present have a car that competes in lowest price bands that account for 30% of the local market.

Apart from Romania, Renault is eyeing five assembly sites for Logan. It plans to build the car from CKD kits in Russia, Morocco and Colombia, and is exploiting traditional strong French business relationships in the Middle East by planing a massive 300,000-unit joint-venture facility in Iran. And an agreement to build the car in China under a 50:50 JV with partner Dongfeng Motor is due to be signed in the next few weeks.

The car is part of a grand plan by Renault to increase worldwide sales to 4 million units a year by 2010 - a goal that could only be achieved through "vigorous expansion into new markets outside Western Europe", according to Renault chairman Louis Schweitzer. His target is to sell 25% of Renault's global annual production outside Western Europe.

Engineering challenge

The challenge for engineers at Renault's Technocentre south of Paris, where the car was developed, was to build a car that was price-competitive against the kind of cars customarily on offer in emerging markets - Russian Ladas, Iranian Paykans - and Dacia's own old Renault 12-derived models.

Logan uses as many existing components sub-sets as possible, while simplifying elements of design and minimising the numbers of parts. The dashboard, for example, is a one-piece moulding; the front suspension from Clio and the rear suspension is from the Modus. Many trim and interior parts are carried over from Solenza, a Dacia-designed car dating from the early 1990s but heavily re-engineered by Renault since it took over Dacia in 1999. Instrument panel, door handles, steering wheel and column switches come direct from Clio. Some parts, such as

the air vents and gear lever knob, are from the Espace. Original Logan parts have been designed for simplicity - even the plastic rubbing strips on the outside of the doors are reversible, so the same part can be used on near and offside.

Third car for 'B' platform

Logan is the third car to be built on the Renault-Nissan Alliance's B platform, following the Nissan Micra and just-launched Renault Modus. The Logan will be launched with a choice of K7 series eight-valve petrol engines: the 75hp 1.4 litre and 90hp 1.6 litre. Both engines are combined with the five-speed manual gearbox also used in the Laguna and Mégane.

The engines have been well proven in several Renault vehicles, and are still used in the Clio saloon and Kangoo van. A 65hp 1.5 dCi diesel option will be available in 2005, as well as a 107hp 1.6 litre 16-valve petrol unit. Part of the logic for using slightly older engines was their ability to run on fuel of widely differing quality. They have also been approved for use with 87-octane and 91-octane gasoline as well as 95-octane fuel. The engines comply with EU Euro 4 emissions standards and the body meets European standards for front and side impacts.

The B platform has been stretched dimensionally to the limit - the Logan is close to C-segment in terms of length (4,250mm), width (1,735mm) and height (1,525mm). The boot volume of 510 litres is claimed to be the best in the class. A right-hand drive version is planned as Renault wants to assemble Logan in South Africa, where Nissan has a plant.

From early 2007 other body styles will be launched on the same platform, including an estate, a small van and a pick-up. But there will be no hatchback version - with Clio, Modus and the forthcoming new Twingo, Renault believes another hatchback is not necessary. The Clio Symbol four-door sedan will continue to be built, however, and will be pitched as a more upscale vehicle than Logan.

Maintenance costs, a key criterion for car buyers in emerging markets, have been kept low. Service intervals have been made as long as possible - in some markets the oil, spark plugs and air filter are changed only every 30,000km. There was also a focus on simple, practical techniques for easy servicing. The headlamp bulbs can be easily reached from the engine compartment, so customers can change them themselves.

The heating system is the same one that will be used in other Renault B-segment vehicles, such as Modus. The single-part design approach, using simple pipework and short circuitry, ensures high mechanical reliability and helps to make savings on design costs without sacrificing thermal performance, which is among the best in the segment.

Electronic functions are grouped together in a central cabin unit based on the one used in Clio and Twingo. Logan has the same engine compartment as Clio, designed using the same interfaces so proven assembly procedures can be used.

The final development budget for the Logan was €360 million, a relatively low figure achieved through use of the *"design to cost"* method; use of carry-over parts to optimise reliability and manufacturing costs and the application of digital design. *"The 'design to cost' method was introduced at Renault in 1992 with the Twingo project, and underwent a decisive development with the launch of the X90 project in 2000,"* said engineering project manager Odile Panciatici.

Logan was a pilot project for using digital simulation in designing vehicles and production tooling, as well as for adjusting manufacturing processes. Calculating vibrations and testing acoustics on digital models helped designers predict noise levels in the vehicle without using a physical model. The advantage of using digital techniques, especially in defining and developing the body structure, is that costly prototypes of vehicles and tooling did not have to be built, so many physical stages in the design process were eliminated. The total cost saving is estimated at about €20m.

Industrial investment

As well as the cost of developing the car itself, the Logan is part of a major industrial investment in Renault's global manufacturing capacity. The company may have spent €360m on the car, but is spending far more on production facilities - €205m in Romania; €230m in Russia; €22m in Morocco; €16m in Colombia, and a massive €300m in Iran. The China plan is likely to become part of the $2bn JV between Dongfeng and Nissan.

Schweitzer said Dacia's Pitesti plant had been completely renovated - *"only the exterior walls are the same"*. Certainly the plant had suffered from neglect since the fall of the Ceaucescu regime - a visit in 2001 revealed a sprawling, gloomy, low-tech complex, with thick layers of grease and grime on the factory floor and dark industrial deposits on the roof cutting out natural light to the shop floor.

However, the renovation had started, and the cleaned-up parts of the plant, such as the engine line, showed the potential of the plant, built originally in the mid-60s to make the Renault 8. Many powertrain parts are now machined at the site, such as the cylinder head cover, mounting brackets, engine mountings and oil sump.

Suppliers have been heavily involved in the programme: altogether the Logan project uses 143 first-tier suppliers, 43 of which are located in Romania, nine in Turkey, five in Eastern and Central Europe and 10 in Western Europe. Eight Tier 1 suppliers have located facilities at Pitesti in existing former Dacia buildings. These are: Valeo, Johnson Controls, Faurecia, Euro APS (a joint venture between ADPlastic and Simolder), ACI, Piroux, Iri, MCI Ingénierie and Metal Impex. In order to improve the capacity of Dacia's partners, the number of suppliers has been cut from 200 for the Dacia Berlina (Renault 12), which will be phased out towards the end of 2004, to 143 for Logan.

Schweitzer said he expected the business to turn in a profit next year. It will build 200,000 complete Logans and 150,000 CKD kits. The Pitesti site covers about 2.9m square metres, including over 623,000sq m of buildings. Most of the investment was allocated to updating production facilities at the Pitesti site.

Six stamping lines have been upgraded, with 30 presses (five per line) replaced or renovated. Some of the *"new"* stamping lines use reconditioned machinery from Renault's Sandouville plant, itself upgraded three years ago for the new Laguna, Vel Satis and Espace. The body-in-white assembly shop has been totally restructured and flows rationalised, taking account of very competitive labour costs which put the emphasis on manual operations - the workshop has only one robot.

In the powertrain department, the aluminium foundry and machining shop for powertrain components have been completely modernised. This has made it possible to transfer assembly of the 1.9-litre diesel engine from the Cléon plant, where it was built until the end of 2003, to Pitesti.

New facilities for surface treatment and cataphoresis have been installed in the paint shop. Ovens have been built to the same standards as those at Renault's most modern plants. Added together, the improvements brought the plant's capacity up to 32 vehicles an hour by 2004. An increase in the number of shifts from two to three will take place in 2005, depending on demand for Logan.

Satellite assembly plants will be designed to have highly competitive costs. Renault has decided to take a labour-intensive approach for assembly, with low automation levels. Because of the mainly manual assembly process, the engineers have tried to optimize the use of materials and have not developed any large body panels. They have also managed to avoid using laser butt welding technology for sheet metal assembly.

The plants that will produce Logan will use the Renault Production System (SPR) - itself based on Nissan's approach to production. This system, introduced in 1998, brings together everyone involved in the production process - purchasers/ suppliers, logistics experts, engineers and manufacturers - to focus on common targets and procedures. One aspect has been the setting up of *"dexterity training"* or *"patterning"*, which helps operators to perform movements more easily and effectively.

SPR makes the workstation the focal point of industrial organisation and standardises the movements made at each workstation in great detail. This approach optimises plant productivity, product quality and workstation ergonomics.

Renault is investing €230m to make Logan in Russia from mid-2005. The production unit, to be installed in the Moscow plant of Avtoframos, a subsidiary jointly owned by Renault and Moscow City Authorities, will have capacity of 60,000 vehicles per year.

The investment involves setting up production lines and developing the dealer network and support functions. With body-in-white, paint and assembly workshops,

the Moscow production site will employ up to 2,000 people when operating at full capacity. It will gradually bring in local subcontractors. The plant is currently handling final assembly of Clio Symbol saloon at the rate of eight vehicles per day, and this will continue until Logan goes into production.

An even larger investment of €300m is being made in Iran, a new market for Renault but one where French-band cars are commonplace, with Peugeot assembling 405 and 205 models there. Renault and IDRO (Industrial Development & Renovation Organization - the Iranian public body responsible for the automobile industry) set up a joint company, Renault Pars, in May 2004.

Iran's two leading automakers, Iran Khodro and Saipa, will produce and market Logan from 2006, with initial capacity of 300,000 units. Some of this production is scheduled for export. The vehicles will be assembled from sets of imported parts and components supplied locally by Renault Pars. The company will be responsible for all the operational functions of an automaker, including engineering, quality, purchasing and logistics, as well as coordinating sales policy, marketing and aftersales.

Logan will be distributed under the Renault brand by Iran Khodro and Saipa's dealer networks. Iran, with a population of 68 million, has seen its car market put on a spurt of growth in the past three years. In 2003 it totaled 700,000 passenger cars plus LCVs.

Other investments include €22m to make Logan at the Somaca plant in Morocco from the second half of 2005. Production of 30,000 vehicles a year is envisaged, with some going for export; and €16m in Sofasa of Colombia, which assembles LCVs for Toyota and Renault Twingo, Clio and Mégane passenger cars). Sofasa also exports vehicles to other Andean Pact countries, and to a few Central American countries for Renault.

Perhaps most important for Renault, an announcement for Logan production in China is expected later this year. This will be a joint venture with Dongfeng Motor Corp, which set up a wide-ranging $2bn JV with Nissan last year.

According to sources in China, the Dongfeng-Renault JV will be set up in Shenzhen, in the Guangdong province of southern China, rather than close to Dongfeng's base in the central Hubei Province. "Both parties will have a 50% stake in the joint venture with a planned annual capacity of 300,000 Renault cars," reported China Daily. No official details have been revealed, and it is unclear whether the 300,000 units would all be Logan-derived cars or include other models.

After a false start a decade ago, the move is further evidence that Renault is getting its act together in China, both independently and via Nissan, in which it has a 44% stake. In January, Dongfeng and Renault agreed to create a JV based on the former's affiliate in southern China's Guangxi Zhuang Autonomous Region to make Renault trucks. Dongfeng also has diesel engine JVs with both Renault and Nissan in China.

Renault set up a JV in 1994 in Hubei with another Chinese partner to assemble its Trafic minibus. But the partnership has almost come to a standstill as a result of sluggish sales over the past years. Renault and De'long, an industrial and investment firm registered in Shanghai, were in talks last year about attempting to revive the venture by introducing Renault's Kangoo light van and MPV models. De'long was also pitching for the Logan project, but Dongfeng is a much more powerful automotive force - one of the 'Big Three' Chinese auto makers that are set to dominate the rapidly expanding Chinese market.

Source: just-auto.com

Regional perspectives

In response to the demand for Lotus automotive capability, Lotus Engineering now has dedicated operations in China and in Michigan, US.

Currently, China is the world's fastest growing automotive market, with forecasts suggesting the market will grow to 15.6 million units per annum by 2020(1). Mark Schulz, Ford Motor Co's executive vice president for Asia Pacific comments that *"China is now the epicentre of growth in the auto industry."*(2) According to recent reports, VW sold more cars in 2003 than in Germany *"we also made more money in China than in Germany"* says Barthel Schroder, VW executive vice president and management board member in charge of technology. *"By 2008, we expect China will be the most important market for the total VW group"* (3)

Reporting back from the field Ben Boycott, General Manager Lotus Engineering China (LEC) realises that its not all plain sailing for car manufacturers - either those with a Chinese heritage or those looking to set up operations and take a foothold in China.

"Manufacturer's are caught in a catch twenty two situation. Although wanting to transfer work to the local region and capitalise on both the investment in local facilities and what they believe as the 'low cost of labour', in actual fact the lack of experience in the local market is making this extremely difficult. There is an urgent need for rapid technology as well as knowledge transfer in order to meet global quality standards. Everyone knows that expatriate placement is hugely expensive. This can cause problems."

Predictably, such issues have lead to significant competition for human resource. *"Expansion is increasingly fuelled by new graduates being lead by 'old hands' – those with 3-4 years experience…."* says Boyott. LEC has adopted an open house approach, operating combined project teams with Lotus technical specialists permanently residing in China to help overcome such issues. With so many of the OEMs' decisions continuing to be made by an international head office, it's imperative that global quality standards are achieved in all aspects of the project from concept through to production. The right partner is vital and knowledge of the local environment cannot be understated in the selection process. With China rapidly becoming a preferred manufacturing centre for many companies, the problems that are becoming evident lie in the fact that the infrastructure is not readily available to support the growth of the industry in the region.

Go west and it's not industry growth causing market issues, quite the opposite. There is a common agreement between Industry analysts that although the US market is fairly stable it is still undoubtedly tough. Volvo's recent announcement that it will not be manufacturing in the US has been met with disappointment. Curt Germundsson, Volvo Senior Vice president for Manufacturing

Ben Boycott
Lotus Engineering
China

Simon Cobb
Lotus Engineering
USA

explains *"Volvo is striving for a high degree of commonality. We find that in Europe more than in the US"* (4).

OEMs' are fighting hard to maintain market share and volume. Incentives, no matter how enticing, are not having the desired effect. The industry conclusion is that new and exciting products are the key to boosting sales. John Lawson, auto industry analyst for Smith Barney in London, says vehicles must be distinctive and alluring if carmakers are to sell into their markets. Hence strategies such as the Cadillac rebirth; the Pontiac Solstice; Chrysler 300 and Ford GT40 have enabled the US market to keep unit numbers buoyant at around 16-17million. Nevertheless the tangible pain is that the margins have been heavily eroded and engineering programmes reduced. Simon Cobb, chief engineer for Lotus Engineering Inc (LEI) in Detroit, has broadened the engineering solution offering using Lotus' global resource to include such things as functional show cars, engine programme capability as well as chassis compliance and kinematics testing with Lotus' own analysis software. Lotus' flexibility coupled with its understanding of the automotive business has meant that LEI's business is growing. With the on-going development of diesel technology and its associated emissions, engineers are kept busy. With gasoline prices at more than $2 per gallon, VW is also positive about the American market, recently predicting a 37 percent boost in diesel vehicle sales this year. A study by ABI Reset claims *"the engineering goal in the American market is to maintain or improve performance while simultaneously improving economy and emissions"*. That aside, the industry is looking ahead, sales growth may be sluggish but with the development of new technology in energy storage, hybrids and fuel cells the US is planning to have a say in its automotive future.

Sources: (1) - just-auto.com
(2, 3, 4) - Automotive News Europe

Group Lotus plc

Head office:
Lotus Cars Ltd
Hethel
Norwich
Norfolk
NR14 8EZ
United Kingdom

Editor: Ann-Marie Jones
E: proactive@lotuscars.co.uk

just-auto.com

Head office:
C/o Aroq Ltd
Seneca House
Buntsford Park Road
Bromsgrove
B60 3DX
United Kingdom

Contact: Mike Gove
E: mike.gove@aroq.com