



**LOTUS**  
ENGINEERING

**proActive**  
The official e-magazine of Lotus Engineering



**Series hybrids and the Lotus Range Extender**

**Technology integration for low carbon – A review of the Lotus/IMEchE seminar**

**Lotus Evora Type 124 endurance racecar**

**Q&A with Oskar Goitia – MD at Mondragon Automocion**

Sep/Oct 2009

ISSUE  
34



## Contents

### Industry News

3-6 ▶

**FRANCE:** PSA wants 20% 'green' material in vehicle plastics by 2011

**UK:** Road pricing 'to curb emissions'

**JAPAN:** Honda on fuel cell learning curve with Clarity

### Lotus News

7-13 ▶

Lotus Elise Club Racer – the perfect combination of performance, efficiency and style

Lotus triumphs at engineering awards

First Evora is delivered to customer

Lotus appoints new CEO

Lotus Evora Type 124 endurance racecar

Malaysian King and Queen visit Lotus UK

Evora wins *Car Magazine's* coveted Performance Car of the Year

### Series hybrids and the Lotus Range Extender

14-17 ▶

### Technology integration for low carbon – A review of the Lotus/ IMechE seminar

18-20 ▶

### Q&A with Oskar Goitia – MD at Mondragon Automocion

21-26 ▶



**It has been non-stop at Lotus for the last few weeks. We have welcomed our new CEO, Dany Bahar, we have been honoured by the visit of the King and Queen of Malaysia to Hethel and the Frankfurt motorshow saw the return of Lotus after ten years absence.**

It was in Frankfurt where we unveiled the fantastic Lotus Evora Type 124 Endurance racecar that will see Lotus return to Motorsport at the Nurburgring, Sepang, Silverstone and Dubai endurance races next year.

Frankfurt also saw Lotus Engineering present the Lotus Range Extender engine, designed specifically for series hybrid vehicles so that the benefits of electrification of the drivetrain can be realised, with less compromise on range, recharging and cost.

Publicly, at least, from what was seen at Frankfurt, the whole industry's position on reducing carbon is primarily to move towards electrification. What was interesting, however, was the number of volume vehicle manufacturers that were showing pure plug-in electric versions of their mainstream

vehicle lines. Whilst plastering 0g/km CO<sub>2</sub> on the side of a car makes a powerful statement, there seemed to be little explanation as to how the issues of range and recharging would be addressed. Consumer acceptance after all is key, and car buyers will resist change that makes motoring less practical. It was put to me recently that future EV motoring use will evolve like mobile phone use, a widespread availability of charge points being analogous to roaming. But is that a disingenuous comparison? By choosing an EV, despite the environmental imperatives, surely motorists are being asked to go from the mobile phone to the phone box, unless range and charging times are drastically improved? Electric-only vehicles have a place in certain sectors – small city cars and performance for instance – but beyond this range extenders in some form must come into play.

Enjoy the read

Peter Morgan

Marketing Manager – Lotus Engineering



Peugeot has a reforestation project in the Amazon Rainforest

**FRANCE:** PSA wants 20% 'green' material in vehicle plastics by 2011

**PSA Peugeot Citroën has presented the latest developments in its green materials plan, set up to limit the eco-footprint of its vehicles during their service life.**

The group has set an ambitious target in eco-design: to include 20% of green materials in the polymers used to build its cars by 2011.

A car is made up of 70% metal, already largely recycled, 5% miscellaneous materials (glass, etc) and 5% fluids. The rest is plastics (polymers).

The term 'green materials' covers natural fibres such as linen and hemp, non-metallic recycled materials and biomaterials, which are produced using renewable resources rather than petrochemicals. The aim is to use fewer fossil fuel plastics and to increase the use of raw materials from renewable sources to make parts lighter, in some cases, to cut CO<sub>2</sub> emissions from plastics production and to promote plastics recycling.

The company says end-of-life processing is factored in from the design stage. The aim is to boost recyclability and thus reduce the potential impact of end-of-life vehicles. As a minimum, 85% of a vehicle's weight can be reused or

recycled, and a further 10% can be used for energy recovery.

The key feature of the action plan set up by PSA Peugeot Citroën in 2008 is that it concerns all group vehicles and the three families of green materials. The green material content of each vehicle project must be increased. This approach also involves existing vehicles, with green materials being integrated during their production life, PSA says.

Its engineering teams are working in close cooperation with suppliers in order to utilise these new materials.

This effort also gives new impetus to the recycled materials industry, PSA maintains.

The subject of biomaterials is still at the research stage in the automotive industry. To address the issue, scientific partnerships have been set up as part of research groups bringing together public laboratories, chemical firms and parts suppliers. PSA says that the aim of these partnerships is to accelerate the application of these materials in the automotive industry.

**Source:** just-auto.com editorial team

A car is made up of 70% metal, already largely recycled, 5% miscellaneous materials (glass, etc.) and 5% fluids. The rest is plastics (polymers).



## UK: Road pricing ‘to curb emissions’

**A report by the UK government’s Committee on Climate Change is advocating road pricing and strict 70mph (110km/h) speed limits on motorways as well as ‘eco-driving’ lessons to help the country meet legally-binding carbon emissions targets.**

The committee, in its first annual report, said the Government was unlikely to be able to meet the target to cut greenhouse gas emissions by at least 34% by 2020 unless there were radical changes in power generation, transport and homes.

Committee chief executive David Kennedy said reductions in carbon emissions would have to triple to 3% per annum by next year.

He said Government policy needed to start introducing policy to change lifestyles, including road pricing, in order to encourage lifestyle change.

“We are not calling for government to rush ahead and introduce road pricing but it’s something that should not go off the agenda in years to come,” he said.

The main transport recommendations are:

- subsidies for the car industry to encourage 1.7m electric cars onto the roads by 2020;
- driving at no more than 70mph on motorways to conserve fuel;
- teaching people to drive in higher gears and rev the engine less through ‘eco-driving’ lessons;
- more use of public transport or car sharing by making driving more expensive by introducing road pricing .

**Source:** just-auto.com editorial team

## JAPAN: Honda on fuel cell learning curve with Clarity

**A radical move to bring the fuel cell car into mass-production is already yielding valuable fresh knowledge and expertise in specialist manufacturing techniques at Honda, writes Maurice Glover.**

But the Japanese maker still has a long way to go before it is able to close the yawning cost gap that separates the transport of today and tomorrow.

No-one is more aware of that than Sachito Fujimoto, Honda’s ‘Mr Fuel Cell’ and the engineer behind FCX Clarity, the pacesetting model that has just

embarked on a major European tour in support of the motor industry’s call for a viable hydrogen supply infrastructure to be in place by 2015.

As two pristine examples of the flagship sedan set out on an intensive programme of demonstrations to politicians, fuel supply executives, journalists and other public opinion formers, Fujimoto acknowledged the present huge difference in cost between the fuel cell and petrol or diesel power.

“This presents us with a considerable challenge – but we see it as our duty to do all we can to bridge





the difference and bring down the cost of the cell. We just have to do it because what we're talking about here is of great importance...it represents the next era in transportation," he said.

Despite being launched as a series production model last summer, the role of the Clarity is to steer Honda through a dramatic learning curve in manufacturing as well as providing real-world feedback from selected users in leasing programmes in the US and Japan.

Volumes are low - fewer than 30 examples have been built so far and Fujimoto, the company's research and development senior chief engineer, revealed that no more than 200 units are due to be produced over the three-year exercise.

"The numbers are low, but the fact is that the line is running for a proper mass-production vehicle and we are learning so many things every day - things that I obviously don't wish to make public.

"Of course, in time we will be involved in the production of thousands of units. I can't say when that will happen, but obviously, it is taking us a long time to assemble each car. When I compare our production rate with the volume achieved in our factory at Swindon, where a vehicle comes from the line every two minutes, it is clear we have to accelerate our processes by a factor of hundreds.

"Building a fuel cell stack is a very complex series of operations that take time. The simplest way to increase volume would be to duplicate the stack production units by a large amount, but that is neither practical nor feasible from an economic viewpoint.

"That means we must continue to work to effect cost reductions as well as further increase efficiency - our target has to be to bring the Clarity to a level where it could be offered as a viable option to conventionally-powered vehicles of similar size and specification," he said.

Fujimoto was speaking in Germany as Honda Motor Europe put two examples of its fuel cell car, the FCX Clarity, on the road to back a campaign launched by car manufacturers for support from politicians, fuel supply industry executives and public influencers for a hydrogen supply infrastructure to be in place by 2015.

Both he and company European engineering research spokesman Thomas Brachmann describe the demonstration drive programme as a vital part of the campaign.

Said Brachmann: "This is the classic 'chicken and egg' problem that always exists for a new type of powertrain. It was true for diesel in the past and is true for electricity, natural gas and hydrogen. But the good thing is that hydrogen does not differ so much from natural gas in terms of infrastructure - safety measures are something else, but a lot of the gas supply technologies can be applied.

"The supply industry usually hesitates to start something fresh when they have no sign of business, so we have to generate the business case for hydrogen. And we have - major manufacturers have signed a letter of intent to introduce 100,000 fuel cell cars to the market by 2015. In reality, this figure is likely to be much higher, so we hope this will give the industry sufficient confidence to start building the infrastructure."



According to Brachmann, Honda is confident about fuel cell mobility, regardless of the present infrastructure, and remains unconvinced of the effectiveness of the plug-in electric cars favoured by rivals.

“This is a solution involving the use of a different type of fuel. It requires energy storage - the battery - and while power density is fine, energy density is not so good. The plug-in is not undermining our confidence because it has a restricted range.

“Our development of the fuel cell car was the result of the poor experience we witnessed with batteries between 1995 and 1999, when lots of electric cars ended up parked in the desert in California because they were not used anymore. The energy density of batteries needs to be improved,” he said.

Asked how long it is likely to be before Honda is able to make the cost of its fuel cell cars more comparable to those with conventional motors, he

said: “Our hope is to reach price comparability in 10 to 15 years’ time.

“We expect to enter serious production from 2015 but not with the Clarity. This car has good performance, all the features people want and an acceptable range of operation. But it has a dedicated platform that is expensive because the tooling is for this car only.

“Production of the fuel cell stacks is largely automated and continual refinements mean we’re always having to change the tooling and production methods, but that’s how we are gaining our experience.

“We’re on a massive learning curve. The fuel cell involves electro-chemistry and not mechanical engineering, but it will present us with lots of new opportunities.”

**Source:** just-auto.com editorial team





## Lotus Elise Club Racer – the perfect combination of performance, efficiency and style

**Making its debut at the I.A.A. in Frankfurt 2009, the Special Edition Lotus Elise Club Racer introduces new and exclusive colour schemes, bespoke interior and lightweight components all in a world class, high performance and low emission sportscar:**

- 179g/km CO<sub>2</sub>
- 0-60mph in 5.7 seconds
- 0-100km/h in 6.1 seconds
- combined cycle fuel consumption: 37.2mpg or 7.6l/100km

Lotus has taken four of the classic colour schemes used by Lotus in the 1960s (Elite Yellow, Carbon Grey, Sky Blue and Old English White) and combined them with exclusive Club Racer interior design features to give a stunning sportscar that beautifully morphs function and form.

The firm and supportive Elise seats are clad with lightweight microfibre comfort pads, perfectly positioned to give the right amount of support with the minimal amount of weight, but still keeping the body-coloured seat shell partly exposed.



The exterior body colour theme is carried over to the transmission tunnel and combined with silver and black paint highlights, bisecting the cockpit and tying together the whole sporty theme that is unique to the Club Racer.

Other exclusive interior design features of the Club Racer are the anthracite-anodised gear knob and handbrake sleeve, the Club Racer (CR) logo hand embroidered on the seat headrest and the unique anodised aluminium flooring in the driver's and passenger's footwell. The small 320mm diameter leather rimmed steering wheel has an on-centre marker, enabling the more spirited driver to quickly and safely identify the straight-ahead position of the front wheels.

The lightweight six-spoke alloy wheels, shod in bespoke Yokohama AD07 LTS tyres, are also anthracite-anodised, complementing the key interior components.

**Source:** Lotus Cars



**Mark James, Head of UK Operations at Lotus Engineering, collecting the Judges' Special Award**

## Lotus triumphs at engineering awards

Lotus Engineering has been victorious in the recent British Engineering Excellence Awards, winning the Judges' Special Award, while also being Highly Commended in the Consultancy of the Year category.

The British Engineering Excellence Awards recognise the design engineering excellence of industry and show the world the depth of variety of engineering design innovation throughout the UK. The Judges' Special Award was presented to acknowledge a company that epitomised the aim of the British Engineering Excellence Awards by being recognised globally as a world leader in its chosen field of engineering.

The judges looked at recent projects that had been undertaken and assessed how

Lotus Engineering has been able to diversify its knowledge base and deliver world class engineering solutions. They were impressed that the company had continued to thrive despite the economic problems experienced by the sector in the last 18 months.

In summing up Lotus Engineering's achievements, the panel of judges said: "Most of its business is derived from engineering services and it is even more impressive when you think about the size of some of the companies that have gone to Lotus for its help. Lotus is a truly excellent organisation and an obvious flag bearer for all that is good in UK engineering."

**Source:** Lotus Engineering



**Luke Bennett, Director of Lotus Cars (left) hands over the keys of the first customer Lotus Evora to Matthew Melling at the Lotus Headquarters in Norfolk, UK.**

## First Evora is delivered to customer

Matthew Melling of Twickenham, UK received the keys of a Storm Titanium Lotus Evora from Luke Bennett, Director of Lotus Cars at the Lotus Headquarters where the new mid-engined 2+2 sports car is hand built.

Many Lotus dealers around the world have already received their demonstrators and Lotus has, so far, received orders for the next five months of production. Demand for Lotus' award-winning Evora has meant that 150 extra new manufacturing staff have been recruited to support assembly operations in Norfolk, UK, a very positive sign at a time when the global

motor industry faces huge challenges. Full production is expected to reach the maximum rate by the end of November 2009.

Matthew, a customer of Stratton Motor Company, in Norfolk said: "I was determined to be the first in the world to get my hands on an Evora so with Stratton Motor Company's help, I laid down my deposit within seconds of the order books being opened last year. I have read all the press reviews of the Evora and am so excited about getting behind the wheel – what a great start to September!"

**Source:** Lotus Cars



## Lotus appoints new CEO

**Dany T. Bahar has been appointed as the new CEO of Group Lotus, effective 1 October 2009, replacing Michael J. Kimberley, who retired in July.**

Prior to this appointment, Bahar was Senior Vice President, Commercial & Brand for Ferrari SpA where he was responsible for worldwide road car sales and after sales business, overall road car and F1 marketing activities, licensing, and merchandising business.

Before joining Ferrari SpA, Bahar was the Head of Corporate Projects Business in Red Bull GmbH. He was responsible for the overall corporate project business development, with emphasis on diversifying the business such as setting up its F1 strategy with Red Bull Racing and Scuderia Toro Rosso and the US-based Nascar Team operations, acquiring football clubs in Salzburg, New York and Ghana for commercial purposes.

On his appointment, Bahar said, "I am looking forward to taking on the challenges as CEO of this legendary and iconic company with a peerless motorsport history. Lotus has a worldwide reputation for innovative engineering and superb sportscars that lead the world in efficiency, design and dynamics. With the recent launch of the award-winning Evora, there is proof that Lotus is better placed than many

to capitalise on the rapidly changing automotive market. I can't wait to get my plans underway in October."

In welcoming Bahar, Dato' Mohd Nadzmi Mohd Salleh, the Chairman of Lotus Group, stated "With Dany's track record in motorsports and Ferrari, we strongly believe that we have found the right CEO to enhance the Lotus image, brand and reputation as a world class sportscar and engineering company. With a strong management team already in place, we are confident this objective can be attained."

Bahar, a Swiss national, holds an MBA and is married with two children.

**Source:** Group Lotus





## Lotus Evora Type 124 endurance racecar

**The Lotus Evora Type 124 endurance racecar has been developed from the award-winning Evora road car and is built to FIA regulations and safety standards.**

The Type 124 (pronounced One Twenty Four) endurance racecar is the next step in the evolution of the Evora. The car will make its 24-hour racing debut at the ADAC Nürburgring 24 Hours, which provides a great test for the Evora's performance, efficiency and durability under tough and demanding endurance race conditions.

At the heart of the Lotus Evora are fundamental racecar elements: mid-engine layout, high-tech and super-stiff extruded and bonded aluminium chassis and very strong lightweight forged aluminium wishbones. All these elements mean that it is a natural evolution from the road-going Lotus Evora to a competitive endurance racecar.

From the outset, the design team had intentions to take the Evora racing and the chassis was designed with this in mind. Endurance races are the perfect events to showcase the efficiency, handling and durability characteristics that have been fundamental to the concept of the Evora.

The Lotus Evora Type 124 endurance racecar has a race-tuned version of the mid-mounted Toyota V6 engine, with power increased to over 400ps (depending on race regulations). Vehicle mass is expected to be reduced by up to 200kg, bringing the weight of the racecar to less than

1200kg (depending on race regulations).

Further changes for the Lotus Evora Type 124 Endurance Racecar include a six-speed sequential paddle shift racing gearbox, full FIA specification roll cage, FIA-compliant 120-litre ATL fuel system, FIA fire extinguisher system, competition carbon fibre rear wing, diffuser and front splitter.

The racecar is fitted with AP Racing 6-piston-callipers front and rear, with a race-tuned Bosch ABS system, four-way adjustable dampers and adjustable anti-roll bars. The racecar runs on 18inch rims shod with Pirelli racing slicks and the wheels widths have been increased over the roadcar to 9 ½ J on the front and 11 J on the rear.

The aerodynamically efficient Lotus Evora Type 124 Endurance Racecar body design, made from lightweight composite and carbon fibre panels, remains predominantly unchanged from the road car, with the only modifications being to the lower sections of the front and rear clamshells and the side sills.

Every Lotus car is designed to be at home on the race track as well as the road, and the Evora is no different. Designed primarily as an everyday road car, the Evora's lightweight and stiff structure, its aerodynamics and performance means that it is perfectly suited to taming race tracks around the world.



The racecar is expected to compete in a number of endurance races in 2010/2011 forming part of a factory-supported race programme. The races that are targeted are: the 2010 ADAC Nürburgring 24 Hours (Nürburgring Nordschleife, Germany) in May 2010, Merdeka

Millennium 12 Hours (Sepang, Malaysia) in August 2010, BritCar 24 Hours (Silverstone, UK) in October 2010 and the Dubai 24 Hours (Dubai Autodrome, UAE) January 2011.

**Source:** Group Lotus





## Malaysian King and Queen visit Lotus UK

**Group Lotus Plc, a subsidiary of Proton Holdings Berhad, received an honorary visit by the King and Queen of Malaysia, His Majesty Seri Paduka Baginda The Yang di-Pertuan Agong Al-Wathiqu Billah Tuanku Mizan Zainal Abidin Ibni Al-Marhum Sultan Mahmud Al-Muktafi Billah Shah and Her Majesty Seri Paduka Baginda The Raja Permaisuri Agong Tuanku Nur Zahirah to its headquarters.**

“It is an honour for us to have His and Her Majesty’s presence here at our Lotus facility and this indeed is a meaningful occasion for all of us, both in Lotus and Proton. I am certain that it will definitely inspire us to further strive and work harder in bringing Lotus to greater global prominence and in realising Proton’s vision to become Asia’s premier automotive company,” said Dato’ Mohd. Nadzmi.

“Lotus has contributed immeasurably to the technological development and engineering capabilities of Proton. An unmistakable legend in the world of automotive industry, Lotus thrives on its strong foundation built by its founder Colin Chapman in 1948, and now after 61 glorious years, Lotus still holds reign as one of the few esteemed sportscar makers, distinguished especially for its lightweight engineering prowess and performance superiority,” said Dato’ Syed Zainal Abidin.

During the visit, Proton and Lotus were honoured to have the King and Queen of Malaysia unveil the new Proton Higher Performance Engine, a new high-torque pressure-charged engine to support future product introductions. The engine, developed in collaboration between Proton and Lotus Engineering with active involvement of Malaysian engineers and vendors, boasts an improved rate of emission and performance quality. The engine, produced within 18 months from approval of engineering proof of concept, promises a high torque for enhanced driveability with improved economy, performance and emissions.

The King and Queen of Malaysia spent the morning taking in various exhibits from Lotus Cars including a brief on classic Lotus cars by Clive Chapman, the son of Lotus founder, Colin Chapman. The King and Queen were also escorted on a guided tour of the Lotus Cars assembly line, and were briefed about the latest Lotus Design projects. The King also took time to test-drive the award winning Lotus Evora as well as the Tesla and Exige models.

**Source:** Group Lotus





## Evora wins *Car Magazine's* Coveted Performance Car of the Year

**The Lotus Evora beat strong competition from 29 other cars to win the title of Performance Car of the Year 2009.**

The prominent competition included cars from some of the greatest Marques in the world such as Lamborghini, Ferrari, Porsche and Aston Martin.

The 2009 Performance Car of the Year comprised 30 cars, and included exhaustive subjective and objective testing. The feature incorporated testing on some of the greatest driving roads in Britain, with objective testing at the Rockingham Motor Speedway, where Darren Turner, a Le Mans winning racer, put the cars through their paces.

Chris Chilton, Assistant Editor at Car Magazine was so taken with the Lotus Evora during the first drive activity in Scotland that he said he would eat his Apple Mac if the Evora didn't win this year's Performance Car of the Year.

In saving his Apple Mac, Chris commented, "There are executive saloons that don't ride this well, supercars that don't turn in so crisply, and surely no car on the planet steers like this". To further safeguard his constitution, Chris added, "Lotus has managed to transfer everything that we love about the Elise to a bigger, more refined, more grown up platform...It couldn't

really be much better to drive -the Evora is nigh-on perfect. A winner on every conceivable level".

Roger Becker, Vehicle Engineering Director said that "It is very rewarding to win the well established Car Magazine, Performance Car of the Year award against such tough competition. I am personally very pleased that Chris Chilton so accurately informs on the character and performance that we set out to achieve in the Evora: They are all you would expect from a modern everyday Lotus. The Evora is a great ownership proposition, offering the great Lotus driving experience in a very comfortable, practical, refined and efficient package."

He added "It is a great validation of the expertise at Lotus to win this title against incredible competition from such a highly regarded publication and very pleasing to continue Lotus' outstanding record in this competition".

- **Lotus Evora:** 205 g/km CO2
- **Combined Cycle:** 32.5 mpg (8.7 litres/100 km)
- **Urban Cycle:** 22.8 mpg (12.4 litres/100 km)
- **Extra Urban Cycle:** 43.5 mpg (6.5 litres/100 km)

**Source:** Group Lotus

# Series hybrids and the Lotus Range Extender



**With the global requirement to reduce CO<sub>2</sub> emissions driving a move to the increased electrification of the vehicle, the realities of economics provide a serious challenge for electrical cars. Whereas stationary energy consumers do not require a significant energy storage capability, vehicles do and current battery technology is both heavy and expensive.**

Although America and Japan are currently the largest markets for hybrids and electric vehicles, these countries prefer gasoline as the liquid fuel of choice for passenger car vehicles. Despite this, there are a significant number of hybrid vehicle options, particularly in the US, with an increasing number of electric vehicle options being developed.

Some observers believe Europe is behind the US and Japan in terms of the number of hybrid or electric vehicles. This is due in part to Europe's much greater use of diesel in passenger car vehicles and the fuel consumption benefits of diesel engines compared to gasoline engines. As emissions legislation tightens and diesel exhaust after-treatment becomes increasingly expensive, the European manufacturers are looking to hybrid and electric vehicles, with a focus on gasoline engines for lower cost vehicles, as a means of offsetting the overall cost of the hybrid systems.

Elsewhere, China is increasingly looking to hybrids and electric vehicles. It is a net oil importer and the Government is pushing local vehicle manufacturers towards hybrid and electric solutions as a means of reducing the countries dependence on imported oil, increasing the usage of China's natural resources, such as coal and gas to generate electricity and lithium

to produce batteries. China's passenger car vehicle market is also primarily gasoline.

## Why not move straight to electric vehicles?

Electric vehicles have four primary disadvantages when compared to a conventional liquid fuel powertrain: range, charge time, mass and cost. Primarily these are all attributable to the battery.

Across the industry there is widespread research into new battery technologies with the aim of developing solutions for electric vehicles that will be comparable or better than current conventional internal combustion engine powered vehicles in cost of use and usability terms. However, these may still be many years away from volume production readiness.

In the meantime, to reduce the effect of the primary disadvantages of electric vehicle technologies, while still reaping most of the benefits of full electrification, the range extended plug-in hybrid electric vehicle (RE-PHEV) is a 'stepping stone' to a viable electric solution.

## What is a range extender?

In its simplest form, a range extender (RE) is a device used to charge an energy storage unit i.e. a battery or hydraulic cylinder in a series hybrid vehicle.

The range extender charging device is typically an internal combustion engine mated to a generator and some manufacturers developing a RE-PHEV have selected to use a small conventional internal combustion engine mated to the generator. However this is inevitably a compromise and there are advantages of considering a dedicated range extender engine. A number of engine configurations have been



proposed by various manufacturers, such as rotary engines and conventional piston engines, with a variety of numbers of cylinders, capacities and outputs. Alternative engine configurations have also been proposed, although these are often more leftfield and could require a level of blue sky thinking and usually deep pockets to prove-out the claims.

The performance requirements of a range extender engine differ greatly, from as little as 15kW, to engines in excess of 150kW. The reason for such a varied performance range is down to the strategy of a particular vehicle. Determining the vehicle requirements with respect to economy, performance, and the specification of the vehicle, such as mass and energy required to maintain a given speed, battery size, all have an influence when specifying a suitable range extender performance requirements.

Fuel cells are also effectively range extenders, being developed as they are for the same purpose of

# Series hybrids and the Lotus Range Extender



maintaining the charge level of the vehicle's battery, although the technology costs of fuel cells may prevent them from being commercially viable in the short to medium term.

## How does the Lotus Range Extender work within a series hybrid?

A series hybrid provides drive to the wheels through an electric motor. There is no mechanical connection between the engine and the wheels. The purpose of the range extender is to charge the battery. The engine starts only when the state of charge of the battery drops below a certain point and continues to charge the battery until the state of charge is above a certain point.

There are a number of permutations of operation that are possible, depending on the operation strategy being used, such as charge-sustaining or

charge-depleting. The battery size and type have a significant effect on the strategy of engine operation and performance requirement of the range extender.

## So how has Lotus tackled the range extender?

In assessing the requirements for series hybrid vehicles, Lotus concluded that the use of existing conventional engines as range extenders is both too costly and too compromised to be viable. A specifically designed range extender is not just desirable but a necessity for an optimised series hybrid drivetrain. This had led to the Lotus Range Extender engine, unveiled in September at the Frankfurt motorshow, to great interest from the media and industry alike. Now fully designed and in the build phase, the approach Lotus has taken with its range extender has many advantages.

As a component of a drivetrain configured for reduced environmental impact, clearly key to a range extender specification is a high thermal efficiency for low fuel consumption which can be achieved for an engine designed specifically for this purpose. Series hybrid drivetrain currently face the challenge of higher costs than conventional powertrain and as such, the range extender fundamentally needs to be a low-cost engine. However, the narrower operating range for optimised thermal efficiency can be achieved with a simple, low technology engine if carefully designed, which also can lead to the elimination of expensive exhaust aftertreatment. A simple engine architecture and technology specification has the additional



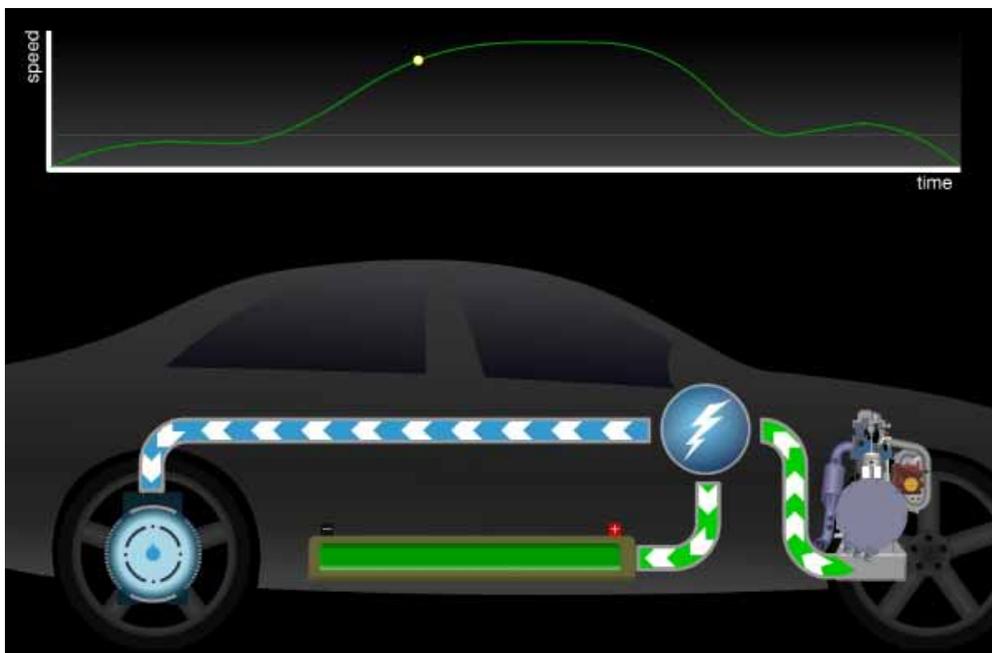
benefit of reducing engineering risk, cost and time to market.

Another issue facing series hybrid vehicles which a specifically designed range extender can in part address is vehicle weight and packaging. A low-mass, small package range extender is important as this not only improves the vehicle performance and efficiency, it also allows reduction of the battery pack to deliver the same vehicle performance, a real benefit both for vehicle weight and cost. Also, it is necessary to keep the mass of the engine low since, depending on the vehicle's all electric range and the user's drive cycle, the engine may only be required infrequently, meaning that the vehicle is carrying around what is, in effect, excess mass.

So while the requirements for high efficiency, low mass and cost and a minimum package space

# RANGE EXTENDER

# Series hybrids and the Lotus Range Extender



<b>General</b>	1.2 litre 3-cylinder with 2 valves per cylinder, SOHC Belt driven
<b>Construction</b>	Monoblock with Integrated Exhaust Manifold all aluminium Balance shaft (optional) Direct-coupled generator
<b>Bore and Stroke</b>	75.0mm x 90.0mm
<b>Compression ratio</b>	10:1
<b>Maximum power</b>	35kW (47bhp) at 3500rpm via integrated electrical generator
<b>Peak torque</b>	107Nm at 2500rpm
<b>Maximum BMEP</b>	11.2bar
<b>Maximum Engine Speed</b>	3500rpm
<b>Fuel System</b>	Port fuel injection, Lotus EMS
<b>Fuel</b>	95 RON ULG / ethanol / methanol
<b>Dry weight</b>	56kg

are arguably fundamental for any range extender design, Lotus has paid particular consideration to the performance and engine architecture of its range extender.

Looking firstly at performance, Lotus conducted detailed simulations on various vehicle types from MPVs and sedans to sports cars. The results of these simulations have shown that a 35kW power rating will suit the drive cycle requirements of most C/D class vehicles, the class of vehicles that Lotus believes will be most popular for series hybrid applications. A typical four-stroke gasoline engine is at its most efficient around the 2,500 - 3,500rpm mark, so the Lotus Range Extender has been optimised to produce the required 35kW at 3,500rpm. Different operating modes, such as a

power 'overboost' for times that may require additional power or low speed operation to provide a 'quiet in-town' running mode have also been investigated and a full programme of development of these strategies will form part of the in-vehicle engineering phase of the programme.

The engine architecture of the Lotus Range Extender has been carefully designed for low mass, cost and a compact package. It is a spark ignition (SI) gasoline engine, with ethanol flex-fuel capability and easily adaptable for CNG/LPG options. A spark ignition architecture was selected to avoid the significant aftertreatment costs associated with a diesel engine and ensure suitability to all the major markets for initial plug-in hybrid uptake, where diesel may be less

popular. After all, optimising operation of the engine to run at its most thermally efficient point, should help bring the engine closer to the thermal efficiency of a diesel engine.

The 1.2-litre engine capacity chosen may initially appear large, particularly compared to some engines being promoted as range extenders. However analysis has demonstrated that this displacement is optimum for the performance requirement when friction and pumping losses are considered. For example, a smaller capacity engine could produce the required power, but would need a higher engine speed, increasing friction, pumping losses and noise which would negate the benefit. Alternatively, introducing additional engine technology such as forced induction could allow

# Series hybrids and the Lotus Range Extender

a smaller displacement but would incur greater unnecessary cost and complexity.

A key feature of the Lotus Range Extender engine architecture is the introduction of the monoblock design with an integrated exhaust manifold, with a number of benefits. The monoblock effectively combines the cylinder head and cylinder block of a conventional engine, reducing component count, complexity in assembly and it improves durability, eliminating what is a critical joint. The integrated exhaust manifold, that Lotus has successfully employed on several other recent engine designs, also improves efficiency, with reduced engine warm-up time for an emissions benefit.

The crankcase is designed to allow simple modification of the casting to accommodate a variety of generator packages. The engine transfers power to the generator via a 'dual damped' coupling, to reduce NVH on engine start up as well as power generation.

The low engine speed also means that only two valves/cylinder are required, simplifying engine manufacture and reducing costs. The combustion chamber is designed with an offset slant squish to improve engine efficiency. The low engine speed again brings benefits by being able to optimise the engine internals to minimise mass, with the bearings being designed for minimal friction. Conventional port fuel injection (PFI) is utilised, rather than the significantly more expensive direct injection (DI) option. As the engine operates on fixed speed cycles, the benefits of DI are reduced to a point where an optimised PFI system can provide similar efficiencies.

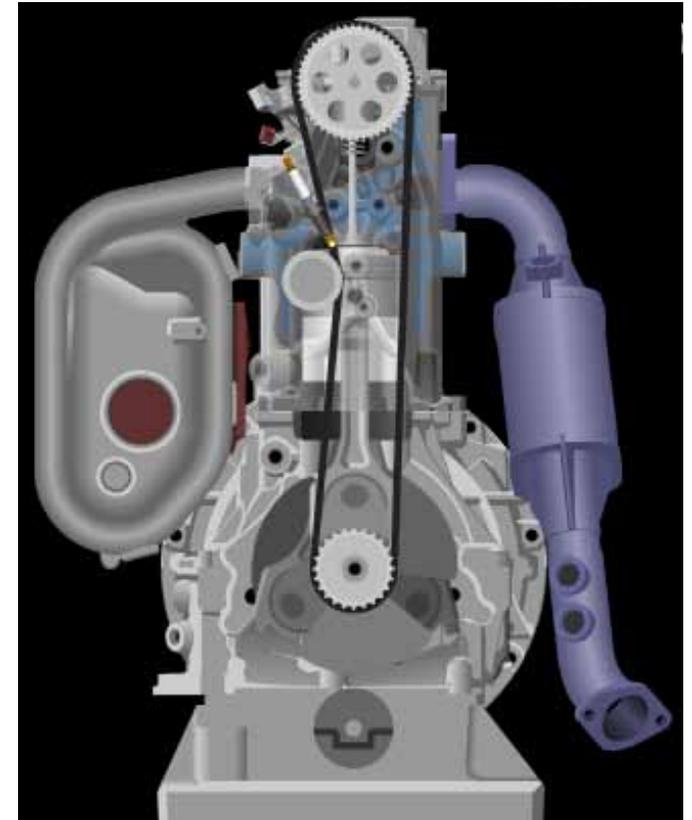
A significant amount of investigative work was conducted on the number of cylinders required. Studies showed there was little difference between using two or three cylinders, each with inherent advantages and disadvantages. Ultimately three cylinders were chosen as there were minimal internal friction differences between the two options and the NVH of a two cylinder engine was seen as a significant downside, where a balance shaft would be a likely requirement for all applications, rather than an option as it is on the Lotus Range Extender.

While a typical three cylinder conventional gasoline engine might have a mass of 80-90kg, as a result of its novel architecture and design features, the Lotus Range Extender is incredibly light, with a mass of only 56kg. Production optimisation should see this figure reduce further.

## Where can I see the engine?

Clearly this Lotus Range Extender, designed specifically as it is for series hybrids offers numerous advantages for vehicles of this type. The test and development phase for prototype engines will prove out this novel design which will first feature in a vehicle as part of the Limo-Green project. This Technology Strategy Board-supported project, in collaboration with Jaguar Cars, MIRA and Caparo, will see the Lotus Range Extender installed within a new Jaguar XJ to demonstrate that a luxury vehicle can produce CO<sub>2</sub> figures below 120g/km without affecting the desirable elements of a luxury vehicle.

And while the LimoGreen project will be the first to test the range extender in a vehicle, production versions could be much nearer that you think. Lotus is already



talking to several vehicle and engine manufacturers and Tier 1 suppliers that recognise the benefits the Lotus Range Extender offers. With engines like this, widespread uptake of series hybrids could be a very real possibility soon.

**Source:** Lee Jeffcoat, Lotus Engineering

# Technology integration for low carbon –

## A review of the Lotus/IMechE Seminar



**The Institution of Mechanical Engineers (IMechE) recently held its latest seminar in a busy calendar of events for the mechanical engineering community. Titled *Integrating Technology for Low Carbon*, it was the fourth in the series organised by the IMechE in conjunction with Lotus and the Hethel Engineering Centre and examined how technologies can be integrated to achieve significant gains in reducing CO<sub>2</sub> and looked at how various technologies are being implemented to meet the challenges that need to be overcome in pursuing low-carbon goals.**

The event attracted a wide range of engineers, consultants, students and academics. Presentations covered the integration of technologies related to advanced internal combustion engines, transmissions, hybridisation and electrification that enable the delivery of the low-carbon benefits without compromising vehicle drivability and driver perception.

The UK's transport sector currently accounts for almost 24% of the nation's CO<sub>2</sub> emissions. Of this total, road vehicles account for nearly 80%. It is apparent that no single technology alone can meet the legislative challenges of the UK government's target of an 80% reduction in CO<sub>2</sub> emissions by 2050. Combined, however, real advances can be made, but necessitate strategies for integration.

Robert Evans, Chief Executive Officer of Cenex, started proceedings with a keynote address. Cenex is a delivery agency established with support from the Department for Business, Innovation, and Skills to promote UK market development and competitiveness in low carbon and fuel cell technologies for transport applications.

Evans, although acknowledging that the automotive industry, economically, is in difficult times, was quick to focus on the doors this situation has opened with the increased hunger for new technology and new product development, with a higher number of innovative collaborative projects aided by public funding. This, Evans stated, proves that the UK low carbon vehicle community is very much alive and kicking and is well placed to establish a competitive position.

In summing up, Evans accredited the industry with the high level of technological innovation dictating that the sector has a number of alternative energy options and is determined to continue to ensure that the policy support for the automotive industry low carbon investments in the UK is the best it has ever been.

Paul Stewart, Professor of Aeronautical and Automotive Engineering at the University of Salford, was next to present on the subject of Novel Hybrid Electric Vehicle Research and Development. Stewart focused

on the latest advances on free piston engines and the advanced control techniques for high efficiency, low emission hybrid electric drivetrains. Two free piston engines were discussed, the Lotus Engineering four-stroke experimental free piston engine and the Volvo FPEC free piston engine. The Volvo engine, Stewart explained, has the piston movement controlled by tubular permanent magnet electrical machine and the piston motion profile controlled to create variable compression ratio, which facilitates HCCI, leading to improved fuel economy, and reduced NO<sub>x</sub> and CO<sub>2</sub> emissions. In summing up, Stewart outlined the benefits of the four-stroke free piston engine – variable swept volume, variable top and bottom dead centres, differential expansion and a high compression ratio.

Plug-In Hybridisation Studies for Premium Luxury Applications was the next topic, covered by Paul Bostock, HEV Systems Design at Jaguar/Land Rover. Bostock focused on decision making in target generation, setting and balancing key component specification and the opportunities for re-use. The



# Technology integration for low carbon –

## A review of the Lotus/IMEchE Seminar

Jaguar/Land Rover-developed Range\_e project, part funded by the TSB, was discussed. This uses a plug-in parallel diesel hybrid system in the 10MY Range Rover Sport to offer a premium SUV that can run as a pure EV in charge depleting mode, using energy from mains electricity, and can also operate as a conventional hybrid in charge sustaining mode. Bostock concluded that hybrid technologies affect premium luxury attributes in two areas: with respect to existing generic attributes and generating new hybrid attributes that may interact with generic attributes. Bostock continued that vehicle electrification introduces further elements and their interactions may go outside the industry and he also reinforced Robert Evans' earlier sentiments that Government part-funded projects provide a platform to investigate these areas more thoroughly and provide a basis for early attribute trading that will set the agenda for the exploitation of low carbon technologies.

Ivan Loncarevic, Business Development from Lithium Balance was next to the stage to confer on the Genuine Hybrid System – Marriage of Lithium and Fuel-Cell Technology. Loncarevic analysed power packs for electric vehicles that enable ranges of 300–400 miles per charge, power packs that enable refueling in minutes, power packs that more than double energy effectiveness of transportation and totally eliminate particle emissions and power packs that have 5,000–8,000 working hours' longevity. Lithium Balance, which makes Battery Management Systems for large Lithium-ion batteries, first piloted the technology in October 2007 with a 72V battery management system integrated with a 1kW PEM fuel-



cell, a 14.4kW Li-on battery on a city car which offered a 230km range. Loncarevic presented the latest development, a methanol based range extender for electric vehicles, a fully integrated system in one box which will have the capacity to enable electric cars to have a range of up to 600 miles.

The Application Selection of Cell Technologies for Battery Systems was presented by Simon Sheldon, Managing Director of Amberjac Projects Ltd, who covered the sometimes bewildering array of battery chemistries and cell construction and suitability for automotive applications. Sheldon firstly outlined the application requirements for hybrid electric vehicles, plug-in hybrid electric vehicles and pure electric vehicles before moving onto the capacity delivery and chemistries available, while also focusing on cell construction. He highlighted one misconception that is generally misunderstood, that cell chemistry is not related to construction type because virtually all chemistries are available in all construction types. Sheldon finished by stressing that choosing the correct cell chemistry is vital, choosing the correct cell construction is vital and choosing the correct cell performance characteristics is vital, but those three points are just the starting point in building a successful battery system. Physical, mechanical and electric design, battery management, thermal management and vehicle interface and integration are also vital areas of the decision matrix.

Dr Leon Rosario, Principle Engineer, Hybrid and Electric Vehicle Technologies at Lotus Engineering, then gave an Insight into Electric Vehicle Power and Energy Management, concentrating on the power and energy management of hybrid and electric vehicle systems and the introduction of a modular power and energy management framework. Rosario started with the EV technology enablers and key events, acknowledging the invention of the capacitor in 1745, and then progressed onto the concept of EV

# Technology integration for low carbon –

## A review of the Lotus/IMEchE Seminar



power and energy management, with particular focus on the hybridisation of energy systems. This in itself highlighted the problem a unified power and energy management system has of handling several tasks including energy resource planning, power delivery in real time and power processing architecture. The next topic was the implementation of a modular power and energy management framework with regard to power management shell, energy management shell and power processing shell and Rosario finished with a holistic description of power and energy management.

The seminar then covered the Technology Combinations for the Reduction of CO<sub>2</sub> Emissions with Hans Nuglisch, senior manager, Advanced Development Engine Systems from Continental Automotive presenting. Nuglisch started by highlighting the actual and proposed CO<sub>2</sub> emission regulations worldwide and then proceeded to outline the energy needed to move the car through the New European Drive Cycle. He covered the various options to improve

Powertrain design and focused on a collaboration between Continental and Lotus Engineering, offering an affordable downsized unit with a 1.5-litre three-cylinder engine with a single stage, fixed geometry turbocharger, which delivered performance equal to a 2.2-litre four-cylinder engine. After emphasising the importance of engine downsizing, Nuglisch finished with an emissions trend roadmap, stating what he believes to be the future of Powertrain technologies, provoking an interesting debate among attendees.

Tony Martindale, Chief Executive Officer of Connaught Engineering, gave the attendees an insight into Connaught Engineering, delving into the history of the company and also where it sees itself heading in the future. Martindale, who co-founded Connaught Motor Company in 2002 and became CEO of Connaught Engineering when the company demerged in 2007, was a successful competitive racing driver in Historic Formula Junior. During his presentation, Martindale gave his views on delivering carbon-neutral transport by taking proven technologies and applying them in innovative ways, while also presenting the products developed by Connaught Engineering.

Moving onto something which the FIA have given particular prominence to, Ian Foley, Managing Director of Williams Hybrid Power Ltd, presented on Flywheel, Energy Storage and Enabling Cost Effective Hybridisation. Foley, who has a prominent Formula 1 history while working for Team Lotus, focused on whole of life costs – flywheel vs existing technologies, challenges for production use, technology readiness and limitations of the technology. He outlined the different applications for the technology: light rail, renewable energy and then proceeded to focus on the automotive application, while taking the attendees

through the latest flywheel developments, targets and timescales for production readiness.

Lloyd Taylor, Sales Engineer of Poclairn Hydraulics, was the final presenter of the day giving an Introduction to Hydraulic Hybrid Transmission. Taylor discussed why hydrostatic transmissions are widely used in industrial machines but are largely unknown in the automotive industry and why combining the best available hydraulic technology in hydraulic hybrid transmissions offers huge improvements in fuel consumption and CO<sub>2</sub> emissions compared to conventional or electric hybrid transmissions. Taylor closed on how battery powered vehicles can also benefit from the reduced losses and improved energy usage to increase vehicle range, and he went through the various development challenges for hydraulic hybrids including noise control, system integration and the need for cost reduction, while also re-emphasising the extensive benefits of familiar materials and the reduced CO<sub>2</sub> emissions. The day concluded with a unique opportunity to see the vehicle assembly process at the world renowned Lotus factory, from receipt of the chassis to engine integration, right through to bonding of exterior body panels for the iconic sports cars.

The Integrating Technologies for Low Carbon seminar proved a great success with the high number of presenters giving the attendees the opportunity to learn from the leading industry speakers. It was an opportunity to reflect on the demands of future legislation and how this impacts on automotive engineers, not only provoking debate, but also generating ideas to ensure the automotive industry continues at the forefront of technological innovation.

**Source:** Matthew Reed, Lotus Engineering

# Q&A with Oskar Goitia – MD at Mondragon Automocion



**Mondragon Group, the world's largest workers' cooperative, has grown out of its historical Basque roots to comprise an organisation with global presence.**

It is also a significant player in the automotive industry components sector with cooperative firms manufacturing components, modules, machinery and tools. Oskar Goitia, MD of Mondragon's automotive division, tells *just-auto* editor Dave Leggett how the business is developing and staying true to its founding principles.

## **DL: How is business this year?**

**OG:** To put it in perspective, Mondragon Automocion represents around 10% of the Mondragon Group business. During 2009 turnover in the automotive sector has been around 25% lower than in 2008. We feel that compared to some of our competitors, the reduction we have faced has been less dramatic because of the wide range of products in our automotive portfolio.

The scrappage programs in Europe have also helped to increase production activity during recent months – and they also give us a fairly optimistic short-term scenario. The main worries, of course, are beyond the end of this year when support from national incentive programmes becomes much more uncertain as some schemes come to an end. A progressive reduction of such support may help our companies to adapt to the new situation. If the schemes were to immediately end that would reduce our volumes by at least 10%.

Elsewhere, our operations in Brazil and China have been growing this year.



Overall, our companies have been *focussing* on costs in order to face the new business era while always maintaining our cooperative principles. Keeping our cooperative DNA has meant relocating some of our labour force to areas of activity faring relatively well during the economic crisis and downturn.

We have also been able with our members to adjust our salary levels to the new demands in the market.

Investments programs, too, have been adapted to future needs.

We also have a priority to research new products and services required in the new electro-mobility model for the future, with new components for the electric vehicles as well as adapting the existing modules and components to the new lightweight and downsizing requirement to fulfil the lower CO<sub>2</sub> emissions regulations.

## **DL: Can you explain how the Mondragon Cooperative works and say a little about the automotive element?**

**OG:** Mondragon Automocion is part of Mondragon Cooperative Corporation, the largest business group

## **Mondragon – the first steps**

Many at the Mondragon Cooperative take inspiration from the arrival in Mondragon of a young priest named José María Arizmendiarieta in 1941. He is revered as the 'spark' which created the cooperative and its ideals.



It is said that his primary concern upon arrival was not the development of business activity but the welfare of his parishioners and a desire to provide opportunities for all as wells as to 'correct the acute social deficiencies' of a population still suffering from the consequences of civil war. Father José María is said to have worked tirelessly with the young people of the parish, organising sporting, cultural and educational activities.

Two years after his arrival in Mondragon, Father José María founded the Professional School, the seed which would later become Mondragon Unibertsitatea - the University of Mondragon. This institution has played a vital role over the decades, training many of those who later became key figures in the development of the cooperative project.

in the Basque region and the seventh-largest business group in Spain. Mondragon is a cooperative initiative celebrated on the global stage for its commitment to the cooperative principles laid down by both the founders and Father José María Arizmendiarieta - the inspiration behind the Mondragon movement.

# Q&A with Oskar Goitia – MD at Mondragon Automocion

## Products

Mondragon Automotive, with Fagor and Maier as its leading trademarks, manufactures and supplies components and systems made from the following materials and processes: cast iron, aluminium low pressure and gravity casting, aluminium diecasting, hot stamping, machining, plastic injection and finishing, rubber moulding and extrusion, composites, etc, collaborating in the design, development and manufacture of the final product.

Companies making components and modules: Fagor Ederlan Taldea, Fagor Ederlan Tafalla, Mapsa, Ecenarro, Maier, Cikautxo, FPK and Batz Sistemas.

Companies producing machinery and tools: Loramendi, Aurrenak, Matrici, MB Sistemas, Batz Troquelaria and Fagor Arrasate.

Mondragon's mission blends those basic objectives of a business organisation that competes on international markets with the use of democratic methods in its corporate organisation. Important principles include the creation of employment as well as the personal and professional development of the workers and a pledge to develop the local community. Its business approach is contained in its corporate values, which include:

- Cooperation - 'owners and protagonists'
- Participation - 'management commitment'
- Social Responsibility - 'fair distribution of wealth and involvement in the environment'
- Innovation - 'continual renewal'.

Mondragon has seen a steady increase in turnover in recent years with a 12.4% increase in 2007 and a 6% increase in 2008 bringing the total turnover to EUR16.78bn of which EUR6.5bn was specifically attributed to the industrial component of Mondragon.

Mondragon as a whole employed 92,773 people in 2008, which represented a net increase of 1,700 jobs from 2007 despite challenging market conditions in most business areas.

In 2007 the workforce was 42.2% female, the resources allocated to community schemes increased by 14.7% to EUR39m and the resources allocated to research and development over value-added decreased slightly to 4.6%.

Mondragon Automocion (MA) is a group of companies supplying some of the world's main automotive manufacturers and Tier 1 companies. It collaborates with clients at the design and development stages, producing and supplying a full range of components, modules, machinery and tools.

MA currently employs around 9,500 employees. In automotive components, in 2007, turnover rose by 13.5%, a figure that vastly outperformed the sector average, with a significant increase in domestic Spanish business for vehicles produced mainly for export.

International sales accounted for 64% of the total, with a growing contribution by the seven foreign plants, whose output rose 20% and has been joined in 2008 by the three facilities Batz Sistemas built in China, Mexico and the Czech Republic.

Fagor Ederlan Taldea has also completed the commissioning of the new Markulete foundry, the most



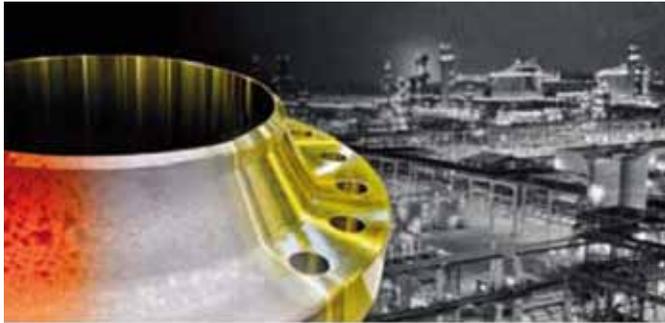
modern in Europe, characterised by its automation and flexibility, its safety and environmentally friendly approach.

MA is considered to be constituted of both Tier 1 and Tier 2 companies which supply the main global automotive OEMs and many of the Tier 1 suppliers. Some 85% of MA products and functions are supplied to the European automotive sector and 95% of products and functions are supplied to the global

# Q&A with Oskar Goitia – MD at Mondragon Automocion



automotive sector. Other industries supplied by MA companies include household appliances, railway, aeronautics and solar energy.



Recent highlights for MA have been the prize awarded to Fagor Ederlan as the 'Best Honda Supplier' and the good performance of its subsidiaries in Brazil and Slovakia. Maier, Cikautxo and FPK has a outstanding performance in the European market leading with some of their products in the European market.

Batz Sistemas strengthened its international projection through the building of three plants in Mexico, the Czech Republic and China, initiated production in 2008 and will cater for the delivery of pedal sets and handbrake levers for several models at General Motors throughout the world.

The Basque cooperatives Matrici and Batz, part of the Mondragon Corporation, have signed a major contract with Renault Trucks, within the framework of the development of future ranges.

Loramendi and Aurrenak are currently leading the foundry equipment and tooling deliveries and have been the biggest player in the world in fully automated systems to produce cylinder blocks and cylinder heads in iron and aluminium.

In addition to the benefits of having the Mondragon University, companies in MA benefit from the cooperative bank which will stick with a new co-op until they can go it alone and, as well as the cooperation funds which supports businesses in trouble and finances expansion and international activities. Member cooperatives may also be assisted into diversification - since 1956 we have had only one total failure of a cooperative.

**DL: Is it difficult to manage the different activities and such a wide range of companies?**

**OG:** There is a very mature organisation working

in three main functional activities – the financial, distribution and industrial areas. Each area is as well divided into different divisions with a Vice-President leading each one. The companies belonging to a division are managed by a Managing Director and each company produces executive business plans which are yearly approved by the general assembly and aligned with 4-yearly business plans. Horizontal structures supporting the sectoral orientation allow a very flexible and effective approach to the market, as well as a very stable positioning with our products.

**DL: And who are the main customers for the automotive unit's products?**

**OG:** Modules and components: GM-Opel, Renault-Nissan, PSA, Honda, VW, Mercedes, BMW, Ford, Bosch, Continental...

Machinery and tools: GM, Renault, BMW, Land Rover-Jaguar, Tata, FAW, Mercedes, Volvo Trucks, Avtovaz, Ford, VW...

**DL: I see that Mondragon has a very strong historical attachment to the Basque region. Has that held back internationalisation of operations? Can you say something about your strategy for international operations?**

**OG:** The automotive sector is a very globalised sector and therefore we have been following our customers in their internationalisation programs. We have our main footprint in the Basque Country, Spain, Western and Eastern Europe - with a very high exportation level.

In the last ten years we have been establishing manufacturing facilities in Brazil, Mexico and China. The recent crisis situation and the lack of financial

# Q&A with Oskar Goitia – MD at Mondragon Automocion



resources has idled some expansion activities, but we are strongly committed with our members to increase and ensure employment in our companies.

This means that a better positioning in the automotive world gives us sustainable growth and guarantees our employment goals in our long-term business strategies.

The latest car sales figures shows that some of the emerging countries – BRICs - will contribute more to global automotive growth in the future and therefore Mondragon has already successfully set up some industrial parks in those countries and will continue expanding its activities.

**DL: Are you continually looking around the world for other cooperative companies to link up with?**

**OG:** The Mondragon Group is always open to all kinds of cooperation and is permanently in contact with all institutions around the world with which we may share experiences as well as developing businesses together with entities that have similar principles as we have. This does not mean that we only cooperate between cooperatives; we do have joint ventures with other private capital entities as well around the world.

**DL: How does the Mondragon bank - Caja Laboral - fit in? Does it provide finance to member cooperatives more cheaply than other banks? Can it help with overseas investments?**

**OG:** Caja Laboral (CL) is a part of the financial business of the Mondragon Group but as a general policy in Mondragon Corporation, the companies are working also with some other banks and financial



institutions worldwide. CL is there and can provide support, but it is not the only option for member companies. Also, Caja Laboral is not only providing finance only for Mondragon companies – it is a major competitive bank involved in all the kinds of things that the big banks do.

These days only 20% of the bank's business is inside the group. It is open to the rest of the world.

**DL: If a company chooses to join the Mondragon Cooperative, what are the main benefits?**

**OG:** A very strong organisation focused on supporting participative management models which

can operate in any field with a very reliable and high quality standards. The cooperative offers support from the management point of view as well as skilled personnel coming out of the University. There is also a strong Mondragon-owned pension fund and social welfare cover that includes extraordinary support to all members of the cooperative.

**DL: Can non-cooperative companies join Mondragon?**

**OG:** No. However, that does not mean that Mondragon belonging companies cannot establish joint venture companies with other non-cooperative companies. The resulting entities are subsidiaries

# Q&A with Oskar Goitia – MD at Mondragon Automocion



from the Mondragon member company, with the participative management model implemented also. It can be understood as a form of indirect participation in the Mondragon Corporation.

## **DL: Is Mondragon an example of a mainly Basque phenomenon or are there other cooperatives in Spain?**

**OG:** There are other cooperatives in Spain, but those belonging to Mondragon are basically in the Basque region. Mondragon Group is number one in the Basque country, in terms of business and employment and it's the seventh-biggest business group in Spain. There are many smaller agricultural and consumers' cooperatives spread out in Spain and around the world, but with our unique industrial organisation we believe we are the world's biggest – at least in terms of our industrial activity, financial and industrial. I am not aware of another cooperative group like ours. There are other cooperatives in places like Italy and the US, which are more business associations based around purchasing cooperatives, but none are quite as diversified as we are or structured as we are.

## **DL: Are you always looking for other cooperatives to hook up with?**

**OG:** That is not a priority and the way it has to work is that a company looks at us and says 'we would like to join your club'. The initiative should come from the company that sees how we operate and our principles and wants to be a part of it. They just have to meet some requirements if they want to join – it is open and there are no restrictions, but obviously a company that wants to join must meet the cooperative criteria.

There are other cooperatives in places like Italy and the US, which are more business associations based around purchasing cooperatives, but none are quite as diversified as we are or structured as we are.

## **DL: Is it difficult for a workers' cooperative to shed workers when rationalising capacity in a recession?**

**OG:** This comes back to the basic principles governing our activity. Actually, a member of a cooperative of Mondragon does not lose his job and the solidarity process among all companies in the corporation allows us to relocate most of the members in other activities thus retaining jobs.

At the beginning of the international economic crisis most of the affected companies resized the workforce by cancelling the contract of the temporarily employed persons (which by law cannot exceed 15% of the total employed persons in the company). After this, there is salary reduction, relocation and other similar measures are taken to avoid any other employment and jobs reduction.

We manage our workforce in a different way to conventional companies as we are owned by the workforce and there are no unions. It is a participative model and maintaining employment and creating the business conditions to grow and employ more people, helping to develop economic activity in a socially useful way are key.

## **DL: What happens to profits?**

**OG:** If a company makes a profit, that profit is shared by the group and the group uses the money for two main purposes: one is to support the university and

education, also including innovation projects to invest for the future; and the other is solidarity with the other companies not doing so well, to reinforce the balance and stabilise the projects financially.

So companies not doing well are supported by those who are, thus maintaining the overall objectives of the cooperative.

Another part during the profit sharing process goes into new activities and new business promotion. The rest is dedicated to associates and companies to reinvest in the cooperatives.

## **DL: How do you see prospects for Mondragon's automotive business in the future?**

**OG:** The main worry at the moment are prospects beyond the end of this year when European incentive or scrappage schemes start to expire. A progressive reduction of incentives rather than a sudden ending may help our companies to adapt to the new situation. If schemes suddenly finish that could create a big fall in volumes – over 10% or more, which would be bad for the whole sector.

We are supplying OEMs across Europe, so what happens in the big manufacturing centres where we supply – Germany, France and UK, as well as in Spain – very important for our business.

However, the strong position of our companies – especially in the emerging markets - as well as our focus on innovation makes us quite optimistic about

# Q&A with Oskar Goitia – MD at Mondragon Automocion



the future. We are committed to our automotive strategies, strengthening our position in the market and working very closely with our customers. All of these things will bring us more and better business opportunities.

And we believe that cooperation between all players in the automotive business will be increasingly required in the near future due to limited financial resources. This cooperation will maximise the output of the synergies we have developed.

Our participative model as employee-owned companies with committed teams allows us to keep a very competitive position in the market for these new and challenging times.

I think we will see more companies increasing the participation of their employees in the future – it's a trend we are already seeing.

Overall, next year we expect to keep the same level of business though it will be three or more before the market gets back to pre-crisis levels figures in Europe. It's a similar situation for our plants in the

NAFTA area. The growing areas for us will be India, China and Brazil.

**DL: What gives you the greatest satisfaction in your role?**

**OG:** After 20 years in the automotive business with very demanding market conditions, we are now in the middle of a new era. We are in the middle of a complete revolution with new mobility concepts using advanced clean technologies. This scenario gives me the opportunity to develop myself by creating sustainable employment and develop business in this new era.

Innovation and cooperation are now values which are more and more demanded in order to be successful. Having practised these values in our organisation and our personal lives, it gives us a very good starting position for this new part of the race.

Those challenges, as well as being protagonist of this worldwide automotive change, are the most satisfying part of my job.

**Source:** just-auto.com editorial team



## Oskar Goitia Zubizarreta

In his current role, Oskar Goitia is Managing Director for Mondragon Automocion, a corporate structure that coordinates the activities of Mondragon's automotive firms. Prior to that, he worked as CEO of Loramendi Group – a Mondragon member – that specialises in manufacturing machinery for the manufacture of cast iron engine block and aluminium engine blocks and heads. He also worked for other Mondragon automotive firms after studying Mechanical Engineering at Mondragon University. He speaks English, German, Spanish and Euskera (the Basque language).



**LOTUS**  
ENGINEERING

For more information, feedback or other enquiries  
please contact:

Lotus Engineering  
Hethel  
Norwich  
Norfolk  
NR14 8EZ  
United Kingdom

Editor: Peter Morgan

**proActive**  
The official e-magazine of Lotus Engineering

**Website** ▶

Lotus Engineering

**E-mail** ▶

[proactive@lotuscars.co.uk](mailto:proactive@lotuscars.co.uk)

© 2009 All content copyright  
Group Lotus plc