A focus on the latest in technology, innovation and sustainability

Ricardo partners BMW to develop “world’s best” motorcycle engine

Interview
Hideaki Watanabe
Head of zero emission vehicles, Renault-Nissan

Volvo cuts CO₂
Ricardo calibration plays key role in successful DRIVe model line-up

Bus efficiency
Exhaust energy recovery can help cut fuel consumption
New generation, NOT re-generation

The JCB Ecomax T4 engine meets Tier 4i emissions legislation without the need for a Diesel Particulate Filter. This innovative, highly efficient design will provide OEMs with improved packaging, significantly lower operating costs and up to 10% better fuel economy compared with Tier 3. With outputs from 74-173hp, peak torque up to 553lb/ft and a team of highly experienced Applications Engineers ready to tailor products to your requirements, JCB is the clear choice for OEMs and the leader in engine technology for the new generation.

For further information contact: engine.sales@jcb.com www.jcbpowersystems.com
FEATURES

Motorcycles & Personal Transportation

BMW’s super six ................. 10

In 2006 BMW awarded Ricardo a highly prestigious task – to design a new, six-cylinder engine, from scratch, to power a world-best sports touring motorcycle. Jesse Crosse reports on the programme and the product

Passenger Car

DRIVe – fast forward ....... 16

When Volvo needed to upgrade its super-successful low-CO2 DRIVe models to meet the latest Euro 5 emission standards, it was quick to call on Ricardo’s calibration expertise. Tony Lewin profiles the programme

FEATURES

Motorcycles & Personal Transportation

BMW’s super six ................. 10

In 2006 BMW awarded Ricardo a highly prestigious task – to design a new, six-cylinder engine, from scratch, to power a world-best sports touring motorcycle. Jesse Crosse reports on the programme and the product

Passenger Car

DRIVe – fast forward ....... 16

When Volvo needed to upgrade its super-successful low-CO2 DRIVe models to meet the latest Euro 5 emission standards, it was quick to call on Ricardo’s calibration expertise. Tony Lewin profiles the programme

Q & A

Renault Nissan:

Hideaki Watanabe .......... 08

The corporate vice president of the Alliance’s Global Zero Emission Vehicle Business Unit tells Tony Lewin how electric cars will open up new opportunities

NEWS

Industry news ................. 04

Automotive, motorcycles, trucks, marine, rail

RQ Viewpoint .................. 07

Electric vehicles must be treated as part of the power grid

Ricardo news ............... 24

New business in China; Ricardo wins gold; strategic co-operation with Jaguar Land Rover; bus exhaust energy recovery; Ricardo joins energy research body

The task of RQ is to highlight the latest thinking in global engineering and technology in the transportation and clean energy sectors and related industries. We aim to achieve this by presenting an up-to-date mix of news, profiles and interviews with top business leaders, as well as in-depth features on programmes – both from within Ricardo and other leading companies.

Client confidentiality is of the utmost importance to Ricardo, which means that we can only report on a small fraction of the work carried out by the company. So we are especially grateful to those Ricardo customers who have kindly agreed to co-operate with RQ and allow their programmes to be highlighted in print: without such help from customers it would not be possible to present such a fascinating insight into the development of new products, technologies and innovations.

Ricardo Quarterly Review. Q2. 2011

10
With Fiat’s revolutionary TwinAir taking the International Engine of the Year award and Ford launching a three-cylinder motor – its smallest unit ever – the trend towards low-displacement powerplants is gaining critical mass within the industry. At the same time, Mazda, with its new generation of SKYACTIV engines, is bringing gasoline and diesel technologies closer together with a shared compression ratio of 14.0:1.

Commending the 875cc twin-cylinder engine’s victory in the Engine of the Year voting, Engine Technology International editor Dean Slavnich described its triumph as “a clear signal that less is more, and that people want low-emission, fuel-efficient yet powerful engines.”

Ford’s 1.0 litre EcoBoost, the company’s first-ever three-cylinder, was developed at the Dunton Technical Centre in the UK but will be fitted to Ford vehicles worldwide. Ford claims the turbo gasoline unit will deliver the performance of a larger four cylinder, and features such as a friction-reducing offset crankshaft and a split cooling system mean it is likely to be highly competitive in terms of efficiency.

Unimog celebrates 60 years

Shaped by designers at Daimler’s Sindelfingen centre and by engineers at Mercedes-Benz’s Special Trucks Development team, the Concept Unimog 60 commemorates the 60th birthday of the company’s versatile go-anywhere four wheel drive vehicle. Popular with farmers, the military and the emergency services worldwide, the Unimog first appeared in 1951 as the Universal Motor Gerät and broke new ground with its effective all-independent coil spring suspension – a distinction highlighted on the concept with bright-red coil springs. The concept harks back to the original in another respect, too – the open cab with its high driving position set well forward.
Big operators join solar power race

Two major players in the energy business have recently made acquisitions in the solar sector.

In April General Electric took control of thin-film solar technology producer PrimeStar Solar Inc and plans to open north America’s largest photovoltaic panel factory by 2013. GE said that global demand for photovoltaics was likely to increase by 75 gigawatts by 2016, and that it could be a $2 to $3 billion dollar business for the company by then.

More recently, GE expanded its solar portfolio further with a stake in eSolar, a California-headquartered specialist in tower-based concentrating solar energy. This, said GE, would allow the company to provide integrated solar combined cycle installations worldwide.

Meanwhile, French oil and gas giant Total has made a $1.37 billion bid for the Aquarius wind and solar marine power system will initially be deployed on larger ships but can be scaled down for smaller vessels. A series of rigid sails overlaid with solar panels provide current for propulsion – at up to 8 knots – and to charge the lithium ion batteries used for after-dark operation and to power lighting, heating and catering equipment. Shore power can also be employed to top up the batteries and a small back-up generator is included.

The Aquarius wind and solar marine power system will initially be deployed on larger ships but can be scaled down for smaller vessels. A series of rigid sails overlaid with solar panels provide current for propulsion – at up to 8 knots – and to charge the lithium ion batteries used for after-dark operation and to power lighting, heating and catering equipment. Shore power can also be employed to top up the batteries and a small back-up generator is included.

Solar hybrid ferry selected for award

A tourist ferry running on solar power has been shortlisted for the 2011 Sustainable Shipping Awards, along with a combined wind and solar propulsion system for larger ships. Both are being developed by Japan-based Eco Marine Power and both claim to offer attractive benefits not only for the environment but also in terms of return on investment.

Eco Marine’s Tonbo is a compact ferry aimed at the river and inland waterway sightseeing cruise markets, where its pollution-free, near silent operation will be a major benefit. Two full length roof-mounted solar panels can be angled for maximum solar gain, or to provide a better view for passengers; these panels provide current for propulsion – at up to 8 knots – and to charge the lithium ion batteries used for after-dark operation and to power lighting, heating and catering equipment. Shore power can also be employed to top up the batteries and a small back-up generator is included.

The Aquarius wind and solar marine power system will initially be deployed on larger ships but can be scaled down for smaller vessels. A series of rigid sails overlaid with solar panels provide not only wind assistance but electrical power, enabling shipping operators to reduce the CO2 footprint of their fleets and cut fuel costs and noxious emissions.

News in brief

Highlighting the latest thinking in automotive engineering and technology worldwide

Airbag deploys from above

Leading supplier TRW has developed a new type of airbag to protect the front-seat passenger; instead of emerging from the instrument panel, the restraint system is packaged in the roof and deploys from above. TRW claims the new design helps mitigate injuries and provides more flexibility in dashboard design and interior stowage. An unnamed vehicle manufacturer has already taken out a significant production contract, says TRW.

Electric superbike tackles Peak

The most powerful motorcycle ever to attempt the famous Pikes Peak International Hill Climb will be powered not by gasoline or ethanol, but by electricity. Chip Yates will tackle the 15.25-mile, 12.24 mile (20 km) mountain ascent on his 240 hp battery-propelled SWIGZ.com racer, capable of over 190 mph and fitted with a complex KERS system which mechanically relays front wheel braking torque to the rear drive motor.

BMW, Volvo, explore intersection safety

Volvo is developing a system to help alert truck drivers to the presence of another road user on the vehicle’s blind side when about to make a turn. Laser scanners and ultrasonic sensors monitor the area on the passenger’s side of the vehicle and warn when a cyclist or pedestrian gets too close. BMW’s left turn assistant, still under development, recognises when the vehicle is about to turn across the traffic lane, and can brake the car if it detects an oncoming vehicle – even a motorcycle.

Electric Land Rover goes on safari

Jaguar Land Rover South Africa has produced an electric version of the familiar Defender utility vehicle for use in the continent’s game parks and nature reserves. Axeon, which designed the conversion, placed the batteries and control system under the hood so as to preserve ground clearance. With its zero emission, near-silent operation which designed the conversion, placed the batteries and control system under the hood so as to preserve ground clearance. With its zero emission, near-silent operation the Land Rover can get much closer to the animals and its range on a full charge is three typical safari trips.

European CO2 winners and losers

Portugal is Europe’s most economy-conscious country when it comes to car buying, with its 2010 purchases averaging under 130 g/km CO2, while Germany, Sweden and Switzerland are the biggest polluters at over 150 g/km. The figures, compiled by JATO, also show that among automakers Fiat, Toyota, SEAT and the three French brands are the lowest emitters, with Mercedes at the foot of the table and Volvo as the most improved brand. JATO attributes much of the overall improvement to the new and smaller vehicles brought into circulation as a result of many countries’ scrappage schemes.
High speed rail, 3rd generation

Germany’s Siemens AG has announced the biggest order in its corporate history – a multi-billion euro contract with Deutsche Bahn for up to 300 high speed, long-distance trainsets. Claimed by its makers to be the world’s most modern train, the ICx uses innovative construction and improved aerodynamics to reduce the weight of a 200-metre long train by 20 tonnes.

Energy consumption per passenger is claimed to be 30 percent lower than for existing designs.

The ICx also breaks new ground in terms of flexibility, with up to 24 different configurations possible with its concept of power cars equipped with all the necessary drive units. The seven-part multiple-unit train has three power cars, seats 499 people and operates at 230 km/h; the ten-part configuration has up to five power cars, seats 724 and reaches 249 km/h.

The first ICx trainsets are expected to enter service with Deutsche Bahn in 2016 and will form the backbone of Germany’s future long distance transportation system.

The Siemens deal comes at a time of major activity as the world’s train operators upgrade their equipment or plan new high speed routes to draw passengers away from airlines. Japan is rolling out its new Hayabusa bullet train, operating at 300 to 320 km/h; French operator SNCF is taking delivery of its third-generation Alstom Duplex TGVs, with the same top speed, and China is to trial high-speed services at up to 350 km/h.

Hybrid heavy trucks on sale

Following a successful series of field tests, Volvo AB is embarking on the manufacture of its FE hybrid heavy truck. The limited production run of 100 hybrid trucks will supply customers in 13 selected European markets, and the company has recently completed a sequence of crash tests to ensure the safety of the truck’s hybrid system in the event of a collision.

In one test, the truck was rammed from the side at 46 km/h by a 1600 kg car, simulating a typical urban accident. The side-mounted battery pack, weighing 578 kg, and the 600 volt electrical system handling the maximum charging current, shut off safely and no fires or fluids leaks occurred.

Volvo claims that the hybrid’s combination of a 7 litre diesel engine, rated at 340 hp, and a parallel 120 kW electric motor can cut fuel consumption and CO2 emissions by between 15 and 20 percent, with the biggest savings available in dense urban traffic where the number of stop-start cycles is high. Most advantageous of all is the hybrid’s application as a garbage collection truck: here, the electric operation of the compactor system allows the CO2 saving over conventional diesel-only trucks to rise to 30 percent.

A further benefit of the hybrid truck is very quiet operation, especially in urban areas. Under acceleration the noise level is half that of a conventional diesel truck, says Claes Nilsson, president of Volvo Trucks’ European division.
While there are some significant local environmental advantages to the increasing electrification of road transport – and benefits too in terms of net carbon emissions if the energy is derived from truly renewable resources – there are some fairly significant economic and practical obstacles that stand in the way of a genuinely free, consumer-driven market. For the grid-connected vehicle market to grow from niche to volume, one of the most significant of these obstacles is the ability of the electrical power grid and distribution network to accommodate the increased demands of vehicle recharging alongside a power generating mix that will increasingly be comprised of inherently intermittent renewable energy.

I believe strongly that the energy storage capacity of a future electric vehicle fleet needs to be viewed as an integral part of a future power system. If operational synergies at both a grid and distribution network scale are exploited, some of the obstacles to the mass roll-out of electric vehicles will be tackled and the associated costs of necessary power system reinforcements and upgrades will be minimized. The need for increased grid energy storage capacity to smooth the supply of intermittent renewable energy is well documented and will represent a substantial capital demand for suppliers. In parallel, for the foreseeable future the battery will represent a substantial part of the capital cost of an electric vehicle. Working this asset to realize further value could be important in providing a competitive product to consumers, alongside the significant industry-wide research efforts aimed at bringing down the cost per kilowatt-hour of energy stored.

I am particularly pleased that Ricardo has been able to publish a joint study in this area with National Grid – work that serves to provide genuinely new insights into the potential for the large-scale aggregation of plug-in vehicles to provide grid balancing services. By evaluating the financial benefits and costs of participation in such services, the research team has provided highly useful data that will be of considerable use to the automotive and power industries as they seek to maximize the potential of the future electrification of road transport. While innovation at a vehicle level remains important, the exploitation of synergies between the electric vehicle fleet and power grid of the future via cross-sector innovations will be a crucial enabler of transport electrification.
“We cannot bet on just one technology”

As corporate vice president of Renault-Nissan’s Global Zero Emission Vehicle Business Unit, it is Hideaki Watanabe’s job to promote EVs and seek new opportunities worldwide – tasks off limits to combustion engined vehicles. As Tony Lewin hears, these opportunities could include vehicles operating inside buildings or even ambulances that could drive right into the hospital.

In the medium term, say the next 10 to 15 years, how will the costs of EVs evolve?
The direction will definitely be a reduction, but I can’t say how much; we’re doing everything to reduce costs, but we can’t predict all the technology roadmaps that will appear in the future. But if you think of something like ABS, anti-lock braking, it used to be a very high-cost option but it’s now put on for free, within the car’s price. Airbags, too, appear almost free, though there is a cost. The same thing is going to happen [with EVs] and eventually the costs will be closer to what we have today.

Will an EV ever match a combustion engined car in cost, given that diesel emission control equipment is becoming more expensive?
Already, with the support of government incentives, if you drive 10,000 km a year for five or six years, the total cost of ownership is better for the EVs. If you mass produce 500,000 to a million units a year you will [by then] have the right technology and the right manufacturing system; it will be a combination of manufacturing improvements and technological breakthroughs. The more vehicles there are, the more technology breakthroughs there will be: suppliers and engineers will be more interested. In the future we want to hit the costs so that we will be competitive in total cost of ownership without the incentives.

Is the battery still the main blockage in terms of cost?
If it had been a blockage, we wouldn’t have the Nissan Leaf on the road. It’s not a blockage, but is there room for improvement? Yes there is.

What is the likely shape of the battery cost reduction curve?
I don’t know, but within Nissan we do have a roadmap – though I’m not in a position to disclose the data. But what I can say today is that our battery is already a breakthrough. There are many people contacting me who want to sell me batteries, there are a lot of consultants saying that they have done a battery benchmark. None of this is new to us: we believe our battery is really competitive with what they have outside.

The Leaf has been on sale for several months now. What have you learnt from the experience so far?
On the product side the customer response is extremely positive; consumers are even saying that it looks as well as drives sporty. The trunk space is much roomier than people expected, too. The questions I get are around the charging stations and also the price incentive system implemented in each country – and also how soon the customer can get the car.

What is the owner feedback on range and performance?
They’re saying the acceleration and the handling are superb: unfortunately, we didn’t have too many demo cars, so many of the people drove the car for the first time [after they had bought it]. They already knew from the magazines that it was good, but very positive comments are coming out. Surprisingly, though, we don’t get so much feedback when it comes to range and autonomy. This is probably because the people buying the car already know about this before buying it. But this doesn’t remove the need to do more education towards other customers as we move into the mass marketing stage.
Nissan has three more EVs on the way, Can you say what they will be?
The sports car concept shown at the Geneva show won’t be one of them: there’s no production schedule for it. The first one will be a light commercial vehicle, then comes a luxury car – a sedan – to be sold under the Infiniti brand, and after that, the third car will be a kind of city commuter.

Could the electric sports car come later? It’s what many other automakers are doing.
What we showed in Geneva was a concept car. The role of a concept car is to expand into the next [area] – we’re expanding the scope and the possibilities of EVs. We don’t have an actual production schedule for that car today, but we want to explore the potential of an electric sports car. We’re after feedback – that’s what we do with all concept cars.

Nissan appears to differentiate sharply between pure electric models and combustion engine models, with few hybrids in between. Renault does not appear interested in hybrids, but does Nissan see a role for them?
The approach to the product is different between Renault and Nissan simply because the brands are different. What we can say is that we are both working as a fundamental part [of our strategy] to improve internal combustion engines – including hybrids, for hybrid is one technology that improves combustion engines. Even EV-optimistic company Renault Nissan predicts that in ten years the share of battery EVs in the market will only be 10 percent. Which means 90 percent still falls into the ICE category, so it is important to us to work on ICE – which includes the hybrids. What makes us different is that we are committed to zero-emission mobility, which means primarily EV.

Where do you expect the centre of gravity of EV sales to be in, say, five years time? City commuters, light commercials, sedans, sports cars?
It’s very difficult to say, because we’re getting various requests from various markets. What is important is that we don’t make the EV a niche product: I have a mission to deploy this globally. Region wise, I’m now focusing on Europe, Japan and the US – three major areas – but we will also have to focus on emerging markets as well. From the product point of view, today’s technology will make it difficult for bigger cars [to be effective EVs] – let’s admit that – but within a certain size [group] the EV could be a hatchback, a sedan, an LCV; it could be a sports car.

What about LCVs?
Light commercial vehicles are a big opportunity. You can, for instance, have the vehicle inside a building – for loading and unloading there are no emissions, so you can be closer inside the shop. Laundries, pizza stations and so on – and why not an ambulance that can go closer to the medical areas? Electric LCVs have the opportunity to create a different lifestyle – the potential to open up a different world. Yes, there is anxiety about autonomy, and it is a burden. But we have other opportunities that we don’t get with internal combustion engines, and that will create other business.

How does the Renault Nissan approach differ to that of other automakers?
What’s different about Renault Nissan is that we are the promoter of sustainable mobility, and by doing that we are in the battery business, the recycling business, grid studies, and quick-charging system development.

How do Nissan and Renault split EV research and development?
What is important is not to duplicate development [work]; commonization is one of the ways of reducing costs, and in terms of ICE vehicles it’s a very efficient way to do that. But in terms of EVs we don’t know the way the market will react in reality. This means that we cannot bet on one technology – we should have various options in our hands. This is where the Renault Nissan Alliance is beneficial. By expanding the scope [of development] between Renault and Nissan, we can cover more options for the future.

Hideaki Watanabe is corporate vice president of Nissan Motor Co, in charge of the Global Zero Emission Vehicle Business Unit. The Nissan LEAF EV has been developed and launched worldwide under his leadership. Watanabe joined Nissan in 1989 and has served in various capacities, including roles in purchasing and in the programme director office. Watanabe graduated from the Faculty of Law, Keio University in Tokyo.

“We are the promoter of sustainable mobility, and by doing that we are in the battery business, the recycling business, grid studies, and quick-charging system development”
Designing a new sports touring motorcycle will always be a challenge, but designing a radically new one to be the very best in the world is a tougher one than most. So for its new top of the range 1600GT and 1600GTL bikes, BMW Motorrad drew inspiration from the heritage of its automotive sister by choosing a straight-six engine configuration that would deliver a level of refinement unmatched by any four-cylinder motorcycle engine in existence. Although a number of six-cylinder motorcycles have appeared over the years, they are rare – and the length and bulk of these engines presents major challenges when it comes to packaging and handling. The new BMW would be no American-style straight-road cruiser: instead, it would need to offer world class levels of agility, handling and steering.

Ricardo has enjoyed a close relationship with BMW Motorrad for a number of years and had already undertaken a number of smaller motorcycle projects for the Munich-based manufacturer. Then in 2006 Ricardo was invited to re-engineer the four-cylinder K1200 engine to produce a new family of K1300 motorcycles for 2009 (see RQ Q2 2009). It was a substantial task, quickly and successfully undertaken by Ricardo drawing on expertise at its sites across Europe in the UK, the Czech Republic and Schwäbisch Gmünd in Southern Germany.

Yet even while the K1300 development was still underway, Ricardo...
was awarded a top-secret project to support the design of a new, compact, lightweight six that would rewrite the rulebook of motorcycle engine design. Remarkably, perhaps, Ricardo was awarded the six-cylinder project almost in parallel with the four-cylinder. The two programmes ran in tandem, the six cylinder work benefiting from experience gained during the early design activities with BMW on the K1300 programme. Again, the project was directed from Ricardo’s division in Schwäbisch Gmünd, where the top end of the engine was also designed. The bottom end was designed at the Shoreham and Prague Technical Centres, with the gearbox designed and produced at the Midlands Technical Centre in Leamington, England. The procurement, build, development and validation testing of the engine were all carried out in Schwäbisch Gmünd, together with BMW. The later stages of the programme such as refinement of the engine in the vehicle, smooth driveability, engine management application and industrialisation were BMW’s responsibility.

Key targets were smoothness, impressive fuel economy and NVH characteristics, driveline refinement and shift quality; substantial engine torque (175 Nm) would take precedence over outright power. While six cylinders would be ideal for delivering the exceptional levels of refinement for which BMW is famous, the bikes would still need to corner well: with the six-cylinder engine arranged transversely in the frame, guaranteeing sufficient ground clearance would pose a challenge from the outset. Earlier in-line six-cylinder bikes had been too wide, and manufacturers eventually confined themselves to a maximum of four cylinders for that reason. The target weight for the power train was also challenging, important not just for the agility and handling, but for fuel consumption too.

**Packaged to minimize width**

The vehicle package layout allowed for six cylinders inclined forward, much like the four-cylinder K1300 engine, the basic vehicle layout being similar to the proven and very successful K1300GT bike.
Ricardo was selected as a partner primarily on account of the fact that the development philosophies of BMW Motorrad and Ricardo are very similar. This was confirmed as the project progressed.

Heinz Hege,
project leader,
powertrain,
BMW Motorrad

The project began with detailed concept layout drawings from BMW, outlining how the engine should look and defining the basic package for the engine. “We worked very closely with the BMW team to achieve the look they wanted as well as the technical targets,” explains the Ricardo project chief engineer, Paul Etheridge. The four-cylinder is already a proven package from the point of view of ergonomics, weight distribution and power delivery, so it made sense to maintain those essential characteristics. But surprisingly, the 160 hp six-cylinder ‘drive-by-wire’ engine is very pure in its design and, although it has four valves per cylinder, the cam timing is fixed and the cylinders are fed through a single throttle body with multipoint injection and long ram pipes. This helps to promote torque and flexibility. This is an ideal configuration for a touring bike, which must deliver fuss-free and accessible performance to the rider for hours on end.

The engine drives through a six-speed gearbox with the usual dog engagement in preference to the synchromesh system found in cars. The gearbox is designed as a separate module which can be removed without the need to split the engine crankcase. Rather than being straight-cut in common with most other motorcycles, the gears are helical like those in a car transmission. This design is quieter and leads to a lighter gear shift, both significant benefits for a touring bike.

To achieve the ultimate in refinement and shift quality there are three compliant elements in the driveline, two of which are a torsional spring pack in the clutch and a torsional damper in the driveshaft. There is a third, too, inside the gearbox and fitted to a third shaft – which means the gearbox is equipped with a total of three shafts rather than the usual two. In the later stages of the
Co-operation with Ricardo: the BMW view

Ricardo was selected as a partner primarily on account of the fact that the development philosophies of BMW Motorrad and Ricardo are very similar. This was confirmed as the project progressed.

BMW provided detailed information [specifications for suppliers / drawings / 3D models] in which the engine package and the installed position in the motorcycle were described. Ricardo bore sole responsibility for designing and modelling the basic engine including gearbox and clutch, but the work was carried out in co-operation with BMW. Some important Tier 2 suppliers were integrated into development; production-related boundary conditions were agreed with these parties. Ricardo also bore responsibility for procuring and building the prototype B0 engines (10 parts sets) and the B1 engines (20 parts sets). Functionality and durability were tested on the engine test beds in Schwäbisch Gmünd and, partly with assistance from BMW, the basic Motronic application and power development were progressed.

Development of the intake and exhaust systems and the vehicle cooling were BMW responsibilities, with optimization being undertaken in close contact with Ricardo’s modelling results. B1 engines were installed in vehicles (10 off) at BMW, and BMW used these vehicles to conduct functional trials and endurance tests in the course of which areas for further development emerged in the oil supply, engine acoustics, and in the durability of the gearbox. Pre-release of the component drawings for the basic engine [not including gearbox and clutch - BMW continued modifying these components together with the series suppliers] marked the conclusion of Ricardo’s involvement in development. The task of incorporating minor adjustments into the drawings up to production release was entrusted to a Ricardo designer. Further development and preparation for industrial production from pre-release onward was continued by BMW, with the major issues being the optimization of engine operation, engine acoustics and power development.

Co-operation with Ricardo was very positive overall. It was characterised by mutual understanding and trust. The durability of the basic engine components designed by Ricardo was always unproblematic; component rig tests and endurance runs received positive confirmation with series-production parts. Even closer co-operation would be desirable for future projects, with a higher degree of interaction between designers / test engineers. Similarly, responsibility for development activities up to series-ready status [production release] should be shifted more effectively to Ricardo for future projects.

Heinz Hege
Project leader, powertrain
BMW Motorrad
‘aggressive’ design, says Etheridge, but have been designed to be as efficient and durable as possible – as befits a touring bike engine. Valves sit in a well-proven pent-roof design of combustion chamber and the inlet ports are not symmetrical, but narrow towards the rear of the engine to fit the external dimensions of the engine and vehicle package.

Cylinders are Nikasil-plated with a slightly over-square bore and stroke of 72 mm x 67.5 mm. The engine was designed with a dry sump in order to keep the centre of gravity as low as possible but, unlike the four-cylinder K1300 engine which has a plastic oil tank behind the engine, the new six has an integral oil tank inside the crankcase. This gave BMW more opportunities with the motorcycle package.

Efficiency was the watchword throughout the development programme, with the choice of bore and stroke yielding an effective surface-to-volume ratio for optimum combustion characteristics. A six-cylinder engine is inherently smooth and, unlike a four-cylinder, requires no balancer shafts to achieve high levels of refinement. This reduces frictional losses and gives fuel economy benefits.

Substantial task
While the four-cylinder programme was an upgrade, the clean-sheet design of the six was clearly a much more substantial task. Ricardo had full responsibility not just for the design of the six, but also the development during two stages of prototyping. The task was to deliver prototype engines in two separate phases; also included was all the component procurement. During the programme Ricardo operated as a department of BMW. Indeed, Ricardo is the only BMW supplier with full access to its product development database, using a satellite workstation.

With prototypes complete, says Etheridge, “we were responsible for the base engine development, finally supplying validated prototype engines. The new 6-cylinder engine goes into production at BMW.

### Technical data: BMW 1600GT/GTL

<table>
<thead>
<tr>
<th>Engine</th>
<th>Oil/water cooled 4-stroke in-line 6-cylinder engine, two overhead camshafts, four valves per cylinder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bore x stroke</td>
<td>72mm x 67.5mm</td>
</tr>
<tr>
<td>Capacity</td>
<td>1,649cc</td>
</tr>
<tr>
<td>Rated output</td>
<td>160 hp at 7,750 rev/min</td>
</tr>
<tr>
<td>Max. torque</td>
<td>175 Nm at 5,250 rev/min</td>
</tr>
<tr>
<td>Compression ratio</td>
<td>12.2:1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Oil/water cooled 4-stroke in-line 6-cylinder engine, two overhead camshafts, four valves per cylinder</th>
<th>Electronic intake pipe injection, digital engine management (BMS-X)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emission control</td>
<td>Closed-loop 3-way catalytic converter, emission standard EU-3</td>
</tr>
<tr>
<td>Bore x stroke</td>
<td>72mm x 67.5mm</td>
</tr>
<tr>
<td>Capacity</td>
<td>1,649cc</td>
</tr>
<tr>
<td>Rated output</td>
<td>160 hp at 7,750 rev/min</td>
</tr>
<tr>
<td>Max. torque</td>
<td>175 Nm at 5,250 rev/min</td>
</tr>
<tr>
<td>Compression ratio</td>
<td>12.2:1</td>
</tr>
<tr>
<td>Mixture control</td>
<td>Electronic intake pipe injection, digital engine management (BMS-X)</td>
</tr>
<tr>
<td>Emission control</td>
<td>Closed-loop 3-way catalytic converter, emission standard EU-3</td>
</tr>
</tbody>
</table>

**Performance / fuel consumption**

| Maximum speed | Over 200 km/h |
| Fuel consumption per 100 km at constant 90 km/h | 4.5L (GT) 4.6L (GTL) |
| Fuel consumption per 100 km at constant 120 km/h | 5.7L (GT) 5.9L (GTL) |
| Fuel type | Unleaded super, octane number 95 (RON) |

**Electrical System**

| Alternator | Three-phase alternator 580W |
| Battery | 12V/19Ah, maintenance free |

**Power transmission**

| Clutch | Multiple-disc clutch in oil bath |
| Gearbox | 6-speed, helical gearbox |
| Drive | Cardan Shaft |
powertrains to BMW for vehicle development."

Powertrain testing included performance development, combustion development and basic mechanical development with engine tests and component rig tests for the prototypes. At this stage Ricardo’s work was essentially complete, although its remit included maintaining a presence for any detail design changes that were needed, as well as the validation of subsequent production-intent units. First manufacturing integration was incorporated at the design stage, and Ricardo was also on hand to update manufacturing drawings as required during industrialization.

Rave reviews
The K1600 engine has already been a hit with the press. The UK Daily Telegraph said of the 1600GT, “just a silky delivery of power unlike any four-cylinder rival, with immense strength, too. It’s enormously satisfying, especially as the bike powers forward so rapidly when you spin the motor close to its 8,500 rev/min red line.” Ride magazine was similarly impressed, saying, “It is an amazingly smooth engine, untroubled by intrusive vibes, rattles or shakes.” Motorcycle News simply declared it “one of the most intoxicating engines in motorcycling”.

Fitting tributes, perhaps, for what has to be one of the most refined and neatly packaged motorcycle engines in the world.

As with the K1300 four cylinder engine project, the new K1600 engine and transmission is another very high profile testimony to one of the most effective engineering collaborations in the global motorcycle industry. Bearing all the hallmarks of a truly great bike engine, the six-cylinder K1600 takes premium motorcycling into a new and exciting dimension in which engineering sophistication combines with genuine rider appeal to set new standards in the elite segment.

“We worked very closely with the BMW team to achieve the look they wanted as well as the technical targets”
Paul Etheridge, Project chief engineer, Ricardo

Ricardo’s Motorcycle Centre of Excellence
Uwe Moser was project director for both the K1300 and K1600 engine programmes at Ricardo and, together with the support of Paul Etheridge, he founded the Motorcycle Centre of Excellence in Schwäbisch Gmünd. His focus is on continuing to build this group into a world-leading engineering partner for motorcycle OEMs: “From the first of June we have appointed additional Chief Engineers and Ricardo is very serious about growing in this market.”

The Motorcycle Centre of Excellence has grown steadily over the last few years and while based in Germany, it is a global focus for activity in this market for Ricardo. “Worldwide, the emphasis continues to be on fuel consumption and CO2,” Moser continues. “In Asia, customers are focused on cost of ownership for smaller bikes, and we see a growing demand in this market for an improved quality of small bikes and mopeds.”

The global market is evolving in other ways too. “The market is moving from two directions; in Asia from the simple commuter bikes to a higher level and, for the established European and Japanese brands, a trend for offering smaller bikes as an entry level in the developed markets, and a high end bike for developing markets.” With a global convergence towards motorcycles of 200 cc to 250 cc growing, it seems a dramatic shift in the world market for motorcycles is about to begin.

The development of the Motorcycle Centre of Excellence has proven to be a Ricardo success story as demonstrated not least by the two recent and very high profile BMW programmes, which have been so well received in the market. The team continues to work with its customers in Germany and around the world, with investment in new, motorcycle-specific personnel and new facilities to support the expansion of this important business for Ricardo.
Fast forward to 99
Faced with a tight timetable and the need to upgrade its entire low-CO₂ DRIVe line-up to the latest Euro 5 emissions standards, Volvo turned to Ricardo for specialist calibration assistance. **Tony Lewin** reports on an impressive programme that delivered seven class-leading vehicles in less than 16 months.
XC60 crossover 4x4, joined the range – and much more was still to come. At the Geneva show this March Volvo not only drew gasps of amazement with further-improved versions of the C30, S40 and V50 all undercutting the psychologically and financially critical 99 g/km CO₂ barrier, but also announced DRIVe editions of its biggest cars, the EUCD-platform S60 sedan and V60 wagon, V70 wagon and S80 luxury sedan. With all four sitting below the 120 g/km threshold, these too caused the industry to sit up and take notice, the unashamedly large V70 and S80 being especially impressive at 119 g/km.

Ricardo’s central role

Such across-the-board step changes in environmental performance do not happen overnight, but in the case of the new Volvo DRIVe models the metamorphosis was unusually rapid. Thanks in no small part to the assistance provided at short notice by Ricardo, the three smaller cars were signed off for production less than nine months after Volvo’s original request for quotation was received in early 2010; two of the four big models were completed in just 28 weeks after they were added to Ricardo programme after work on the smaller cars was already under way, with the remaining pair signed off 12 weeks after that.

The project was all the more accomplished for a second reason: not only did the new wave of DRIVe models need to cut headline CO₂ values by some 20 percent, but at the same time they also needed to make the technically challenging step from Euro IV to Euro V emissions levels. And all this took place at a difficult time for Volvo: resources were restricted and staffing levels tight as former parent Ford prepared to sell the Swedish firm to Geely of China.

Instrumental in the programme was Volvo’s senior manager for engine controls and calibration, Johan Hallnéus. The vehicle team had been working on the upgrade programme for about a year before they made the call to Ricardo, recalls Hallnéus: “We took the decision to go to an outside consultant for two reasons – firstly, because of our

“One of the things we have done is modify how the engine uses different injection patterns in order to improve the CO₂ emissions without making other compromises”

Chris Rowe, lead engineer, Ricardo
internal Volvo Car Corporation resource situation, with not enough design engineers, and, secondly, because of a shortage of dyno test rig capacity due to other highly prioritised development programmes running at the same time. In addition to this we were interested in running a calibration programme using Ricardo’s global Design of Experiments methodology.”

**First target: 99 g/km CO₂**

The philosophy behind Volvo’s DRIVe initiative is clear: the label is applied to only one vehicle in each model line, the one that is the cleanest and has the lowest CO₂. And for the small car range nothing but a headline-grabbing value of 99 g/km or lower would do. Yet to make the task of reaching this challenging target tougher still, no changes were permitted to the hardware of the revised engine family – all the improvement had to come from changes to the way the control software operated the engine, plus of course the inclusion of a stop-start system and the aerodynamic and chassis modifications carried out by Volvo itself.

By the time Ricardo became engaged in the programme, Volvo had already done a lot of work on the new 1.6 litre diesel engine. The issue, says Phil Mortimer, performance and calibration manager for Ricardo UK, was that in recalibrating the Euro 5 specification engine to meet Euro 5 standards, Volvo had found that their CO₂ targets could not be met.

“Initially, we talked to Volvo about what we could do, the steps we could take, and how we could use our Efficient Calibration process to improve the base calibration,” he recalls. “At the same time Volvo was working on other parts of the vehicle such as the stop-start system and the aerodynamics.”

After initial evaluations of both the engine and the complete vehicle using the Ricardo V-SIM (vehicle simulation) software Ricardo gained a first impression of what the key areas could be for improvement “You run the model to see where the engine will run during the cycle and then define the operating conditions that we want to investigate
The results speak for themselves, with all three models hitting the 99 g/km CO₂ target and NOx being kept very low.

“Once we have the vehicle we can verify that on the vehicle itself,” explains Mortimer. “What we found was a control strategy that was quite complicated. There are two issues with that: firstly, it gave us great flexibility and allowed us to do some quite clever things with it in order to meet the targets – but it also meant that we had to be quite careful with how we constructed the new calibration to make sure not to disturb other areas or other operating conditions which Volvo had already validated. In a more complicated software structure that is more of a challenge.”

Though for reasons of commercial confidentiality Mortimer and Rowe are not able to reveal too much about
the actual changes the Ricardo team implemented, they do concede that the overview approach of their recalibration was to re-evaluate the whole operating map holistically to get the best trade-off between legislated emissions and fuel economy, as well as considering factors like combustion noise and NVH.

“That’s where the Efficient Calibration process is so powerful,” says Mortimer. “It allows you to simultaneously optimize many different variables – and of course with the many constraints, too, such as minimising fuel consumption and keeping combustion noise at levels compatible with a premium brand product.”

The first-cut calibration data set that emerges from this process is usually pretty good, says Rowe; it is then applied to the actual engine and tested to ensure it actually does what it says it will do, and then it is further refined as the constraints – such as combustion noise – are steadily tightened. “One thing we have to ensure” says Rowe, “is that we end up with a calibration that is robust to engine and vehicle tolerances and also variations in driving style. We had a big focus on this in order to avoid any issues as we went into production: building in robustness is a key part of our approach.”

Again there is an understandable sensitivity when it comes to disclosing the exact nature of the improvements the team finally made. Nevertheless, Rowe describes it as a combination of a lot of fine tuning and some more fundamental changes to the control strategy: “One of the things we have done is modify how the engine uses different injection patterns in order to improve the CO₂ emissions without making other compromises,” is all he is prepared to say. “That was one of the bigger changes we made: the rest of it is fine tuning.”

The results speak for themselves, with all three models hitting the 99 g/km CO₂ target and NOx being kept very low.
encouraging, Volvo managers began talking about extending the 1.6 litre DRIVe motorisation to the company’s larger models based on the EUCD platform. Again, some pretty challenging CO2 targets were in prospect, with Volvo setting the bar at 114 g/km for the S60 sedan – a clear 200-250 kg heavier than the C30 with the same engine – and at 119 g/km for the V60 station wagon and large V70 and S80, each heavier still.

This time, however, both Ricardo and Volvo had more room for manoeuvre: a new gearbox was added during the programme, giving more flexibility to optimize the ratios for the greater vehicle mass and higher road loads. “We basically did the same job on both platforms in the same programme cycle,” recalls Mortimer. “One of the key things is that because we already had the engine response models we had developed for the P1 platform, when Volvo came to us subsequently for the EUCD platform we were able to pick that up very quickly and use the existing models in order to optimize the engine for the other variants. This is one of the strengths of the tool: once you’ve built the model, you can use it to evaluate pretty much any vehicle that uses that engine.”

Again the speed of the work was impressive: engine development began in August 2010, vehicle development in October; by December the S60 and V60 were certified for emissions and CO2.

Larger cars, tougher targets
With the initial results for the smaller P1-platform models already looking low, roughly half of the improvement is down to the new calibration, the rest being attributable to aero and chassis modifications, says Mortimer. He is especially proud of the economy of the V50, a substantial medium-sized wagon: its marketplace competitors have substantially higher emissions and are thus more expensive for the customer to buy, licence and refuel.

The DRIVe line-up

<table>
<thead>
<tr>
<th>Engine</th>
<th>C30</th>
<th>S40</th>
<th>V50</th>
<th>S60</th>
<th>V60</th>
<th>XC60</th>
<th>V70</th>
<th>S80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hp</td>
<td>115</td>
<td>115</td>
<td>115</td>
<td>115</td>
<td>119</td>
<td>163</td>
<td>115</td>
<td>115</td>
</tr>
<tr>
<td>Kerb weight</td>
<td>1363</td>
<td>1391</td>
<td>1413</td>
<td>1490</td>
<td>1537</td>
<td>1724</td>
<td>1812</td>
<td>1546</td>
</tr>
<tr>
<td>CO2</td>
<td>99</td>
<td>99</td>
<td>99</td>
<td>114</td>
<td>114</td>
<td>149</td>
<td>119</td>
<td>119</td>
</tr>
<tr>
<td>Emissions</td>
<td>EU5</td>
<td>EU5</td>
<td>EU5</td>
<td>EU5</td>
<td>EU5</td>
<td>EU5</td>
<td>EU5</td>
<td>EU5</td>
</tr>
</tbody>
</table>

The DRIVe line-up table:

- **C30, S40, S50**
  - Jan 2010: First Discussions
  - Feb 2010:
  - Mar 2010: Order in place
  - Apr 2010:
  - May 2010: Start of development on engine
  - Jun 2010:
  - Jul 2010:

- **S60, V60**
  - First Discussions
  - Order in place

- **S80, V70**
  - First Discussions
  - Order in place
“DRIVe has been a great success. At the end of the day, as a manufacturer we want to consistently reduce CO2 across the board. We don’t stand still.”

Chris Wailes, European product and pricing manager, Volvo cars

“We were able to work with Volvo to make decisions on things like gearboxes,” says Mortimer. “Also, Volvo were able to ask us what level of aero improvement we would need [to hit targets]: with our V-SIM tool we could evaluate this pretty quickly and say how much economy benefit a given amount of aero improvement would give.”

Real-world testing

With such a compressed development programme it was essential to complement the laboratory and test stand work with substantial real-world mileages to confirm the upgrades under a wide spectrum of operating conditions.

Here, Volvo’s practice of always driving the test vehicle fleets to hot and cold climate locations is doubly beneficial, adding the thick of everyday inner-city traffic and the hectic pace of German autobahns to the familiar extreme conditions of the Arctic in winter and Tenerife and high altitudes in Spain in summer.

“We do have to do a lot of driving of the vehicles to make sure there are no glitches,” observes Mortimer. “Volvo and us have done a lot of that. In general, the cars performed as we had expected: all that we had to deal with were a few minor driveability issues on the larger platform, but that was about it. We had to fix these without taking any backward steps in fuel consumption, and we managed to achieve that with no problem.”

Next steps

While both Volvo and Ricardo remain secretive about the next steps in the DRIVe programme, Volvo Cars’ European product and pricing manager Chris Wailes does acknowledge that the company is missing out on a substantial buyer group by not offering automatic versions of its DRIVe models. The challenge he says, is that DRIVe is always the most economical version in the range, and that automatic is usually associated with an increase in CO2.

“We need to do more work to close the gap between manual and automatic, and our Powershift DCT,” he says. “Strategically, it would work if the automatic or the DCT had the same CO2 as the manual. Watch this space.”

Rumours continue to circulate that there is an even more economical version of the C30 coupé in the works, and that DRIVe is under consideration for the United States, too. The latter might entail a shift from diesel to gasoline power, possibly with a hybrid component to give a substantial boost to the vehicles’ mpg – and thus Volvo’s CAFE average.

On all these issues both Ricardo and Volvo retain a firmly professional no-comment, but one thing is for certain. Through the clarity and simplicity of its message and the effectiveness of its engineering, DRIVe is proving a big hit in Volvo showrooms across Europe. One in three Volvos sold across Europe is a DRIVe model, with German buyers the keenest: 40 percent currently choose DRIVe, compared with 36 percent in France and 33 in Italy. In Britain, a recent survey suggests that by combining the low CO2 of DRIVe with the racy looks of the R-Design sports pack, corporate sales could rise to 60 percent DRIVe.

“DRIVe has been a great success,” stresses Wailes. “At the end of the day, as a manufacturer we want to consistently reduce CO2 and emissions across the board. DRIVe is well established as a continually evolving thing as new technology arrives. We don’t stand still.”

with calibration frozen in January 2011. For the larger V70 and S80 the dates were March and April 2011 respectively.

Yet despite the apparent speed of the programme, it was far from being plain sailing. “NOx was a big challenge for the heavier applications,” admits Mortimer.

“NOx was a big challenge for the programme, it was far from being plain sailing. “NDx was a big challenge for the heavier applications,” admits Mortimer.

Despite these hurdles the Ricardo engineers finally achieved a 20 percent reduction in NOx through the new calibration, with CO2 falling by 5 percent thanks to the new software and a further 5 percent from vehicle improvements. Much of the success of the programme was attributable to the positive two-way communication that helped promote synergies between the Volvo and Ricardo teams working on different aspects of the vehicle.
Building on a highly successful collaboration over the past five years, it has been announced that Ricardo will assist Lifan Automobile Group – based in Chongqing, China – with the development of a family of highly downsized gasoline engines capable of meeting future Chinese and international fuel economy and emissions regulations.

Under the new contract two new engines will be developed based on a common 1.2 litre capacity platform offering a competitive balance of performance, fuel economy, manufacturing cost and weight. A ‘mid-boost’ direct injection (DI) gasoline engine variant of the engine will be developed to replace current Lifan products in the 1.5 to 1.8 litre range of naturally aspirated engines, while a premium ‘hi-boost’ DI version will provide even greater levels of downsizing by replacing products of up to 2.0 litre capacity. Both new engines will mark a significant step forward in the realization of Lifan’s ambitions to provide globally competitive products. Engineered to meet China Stage III fuel economy regulations, these engines will also conform to Euro 5 emissions regulations and offer internationally competitive standards of performance and refinement.

“Ricardo is pleased to be able to announce this new project with Lifan, one of China’s most successful and ambitious companies,” commented Dr Simon Stevens, president of Ricardo Shanghai. “This project will see us work together to create two highly competitive downsized DI engines conforming to the latest in emissions and fuel economy regulations while delivering levels of performance and refinement expected of world-class products. In executing this work we will build upon our already very positive and long-standing collaboration with Lifan.”

### Great Wall

In a further development for Ricardo in China, a Memorandum of Understanding (MoU) was signed with Great Wall Motor Company that will see the two companies work together on a range of new products featuring the very latest in automotive technology and innovation.

“The MoU with Ricardo is an important step for Great Wall in our strategy of developing premium products offering high performance, high luxury and high technology,” commented Chairman Wei Jianjun of Great Wall. “Ricardo is one of the world’s best known automotive technology development companies, with a long history in engine and transmission design.”

The collaboration builds upon Great Wall Motor Company’s stated “3-high” strategy, through which the leading Chinese automaker aims to deliver a range of products featuring high levels of performance, luxury and technology. Among the first product programmes to benefit from this collaboration with Ricardo will be internationally competitive powertrain products including an advanced technology gasoline engine and a six-speed dual clutch transmission (DCT).

Signing the MoU on behalf of Ricardo, the company’s CEO Dave Shemmans praised Great Wall and underscored the growing importance of China to Ricardo: “Great Wall Motor Company is an ambitious organization with an extremely impressive forward development strategy that aims to establish the company with a future line-up of world-class products. We look forward to helping Great Wall achieve its ambitions in this area, supporting the company on a range of state-of-the-art, technology-rich programmes. This collaboration is a further demonstration of Ricardo’s commitment to assist China’s automakers by providing the very latest in advanced technology and innovation, along with best in class product development processes.”
Ricardo wins gold

In March this year Ricardo was named as one of a select group of 35 global suppliers, to be recognized for providing Ford Motor Company with the very highest levels of excellence in quality, cost and delivery. Other leading brands named include Autoliv, Denso, Mahle, Robert Bosch and ZF.

The World Excellence Awards recognize suppliers that have aligned themselves with the values and operating practices of Ford, while reaching the highest quality, technology, cost and delivery standards. The winning companies represent thousands of employees who bring diverse cultures, values and ideas to Ford in the products and services they provide.

Ricardo was one of only fifteen companies worldwide to receive the Gold World Excellence award. This was in recognition of the work of the company’s Detroit-based strategic consulting team, which has supported the development and implementation of Ford service parts value management processes. This work forms part of Ricardo Strategic Consulting’s highly successful Integrated Cost Reduction service line, which by September 2010 had chalked up total cost savings in excess of $100 million achieved for clients since the service was introduced in 2005.

“Our Integrated Cost Reduction process has been shown to realize very tangible savings while maintaining and improving upon levels of performance, quality and service,” explains Ricardo Strategic Consulting North America vice president Kevin Hauser. “That having been said, we could not have been so successful without the relentless drive for continuous improvement and the day-to-day support of our client management team at Ford.”

The Ford Gold World Excellence award was followed in June this year by further prestigious recognition for the work of the strategic consulting team, on this occasion with the naming of Ricardo as ‘Consulting Firm of the Year’ by Finance Monthly Magazine for the company’s technology-based due diligence work.

The Finance Monthly Law Award event exists to celebrate excellence in the legal profession across private practice, the public sector, commerce and industry, and the Bar. Considered an increasingly important event in the global legal calendar, these awards aim to provide recognition of the achievements and talents of individuals and teams who consistently deliver excellence.

The award to Ricardo Strategic Consulting recognized the achievements of a high profile due diligence study carried out on El-Forest for Fouriertransform. Founded in 2006, El-Forest had developed a novel form of series hybrid vehicle for forest forwarding applications and market readiness. Key risks were identified, providing extremely valuable and actionable information to both Fouriertransform and El-Forest, as well as the latter’s other investors.

… and is named consulting firm of the year

The work carried out by Ricardo included on-site assessment of the El-Forest machine position and design readiness, and an evaluation of the series hybrid powertrain’s performance and robustness. The competitive positioning of the machine was also assessed, as was the applicability and protection of patented intellectual property.

“...and was extremely pleased with the thorough, technically informed and highly efficient approach of the team at Ricardo to this important due diligence study”, said Christian Zeuchner, investment director at Fouriertransform AB. “Their report provided exactly the level of information and insight that we required in order to make our investment decision.”

Based on the results of this study, Ricardo was able to assess the design in the context of state-of-the-art vehicle development processes – and thus determine the key steps required to bring the machine to production and market readiness. Key risks were identified, providing extremely valuable and actionable information to both Fouriertransform and El-Forest, as well as the latter’s other investors.

Ricardo selected as strategic supplier to Jaguar Land Rover

The selection of Ricardo as a key strategic supplier by Jaguar Land Rover occurs as the UK premium automaker embarks upon ambitious plans to develop new models and drive volume growth.

In November 2010 Jaguar Land Rover declared that it was to invest heavily in a future that will see significant growth thanks to the expansion of its strongest- ever vehicle line-up, the creation of thousands of new jobs and investment in infrastructure, R&D, and advanced technologies. Such plans will require an intensive period of product development activity within a challenging time frame and it is because of these parameters that Jaguar Land Rover has drafted in Ricardo.

“We are extremely proud that Ricardo has been selected as a strategic partner to Jaguar Land Rover”, said Ricardo group commercial director Steve Clarke. “This collaboration builds on a highly successful relationship between Ricardo and these two internationally famous brands and we look forward to working together to develop world-class, premium products for a range of global markets.”

This latest development continues a longstanding and well established relationship between Ricardo and Jaguar Land Rover. The two firms have an established framework for mutual co-operation on product development in a manner which delivers best value to Jaguar Land Rover within common processes of budget definition, programme management and execution. These frameworks enable selected programmes to be delivered to market as quickly as possible.

The support provided by Ricardo will be broad ranging, assisting Jaguar Land Rover across the company’s product design and development organization. This strategic framework of collaboration has already seen Ricardo provide its expertise on the integration of engines, advanced driveline and chassis systems. Amongst the key rationales for Jaguar Land Rover choosing Ricardo was its global presence. This enables Ricardo to provide in-territory engineering services benefitting from an understanding of and empathy with local tastes and norms, in both rapidly developing regions as well as in more mature markets.

Ricardo selected as strategic supplier to Jaguar Land Rover

The selection of Ricardo as a key strategic supplier by Jaguar Land Rover occurs as the UK premium automaker embarks upon ambitious plans to develop new models and drive volume growth.

In November 2010 Jaguar Land Rover declared that it was to invest heavily in a future that will see significant growth thanks to the expansion of its strongest- ever vehicle line-up, the creation of thousands of new jobs and investment in infrastructure, R&D, and advanced technologies. Such plans will require an intensive period of product development activity within a challenging time frame and it is because of these parameters that Jaguar Land Rover has drafted in Ricardo.

“We are extremely proud that Ricardo has been selected as a strategic partner to Jaguar Land Rover”, said Ricardo group commercial director Steve Clarke. “This collaboration builds on a highly successful relationship between Ricardo and Jaguar Land Rover. The two firms have an established framework for mutual co-operation on product development in a manner which delivers best value to Jaguar Land Rover within common processes of budget definition, programme management and execution. These frameworks enable selected programmes to be delivered to market as quickly as possible.

The support provided by Ricardo will be broad ranging, assisting Jaguar Land Rover across the company’s product design and development organization. This strategic framework of collaboration has already seen Ricardo provide its expertise on the integration of engines, advanced driveline and chassis systems. Amongst the key rationales for Jaguar Land Rover choosing Ricardo was its global presence. This enables Ricardo to provide in-territory engineering services benefitting from an understanding of and empathy with local tastes and norms, in both rapidly developing regions as well as in more mature markets.

Ricardo selected as strategic supplier to Jaguar Land Rover

The selection of Ricardo as a key strategic supplier by Jaguar Land Rover occurs as the UK premium automaker embarks upon ambitious plans to develop new models and drive volume growth.

In November 2010 Jaguar Land Rover declared that it was to invest heavily in a future that will see significant growth thanks to the expansion of its strongest- ever vehicle line-up, the creation of thousands of new jobs and investment in infrastructure, R&D, and advanced technologies. Such plans will require an intensive period of product development activity within a challenging time frame and it is because of these parameters that Jaguar Land Rover has drafted in Ricardo.

“We are extremely proud that Ricardo has been selected as a strategic partner to Jaguar Land Rover”, said Ricardo group commercial director Steve Clarke. “This collaboration builds on a highly successful relationship between Ricardo and Jaguar Land Rover. The two firms have an established framework for mutual co-operation on product development in a manner which delivers best value to Jaguar Land Rover within common processes of budget definition, programme management and execution. These frameworks enable selected programmes to be delivered to market as quickly as possible.

The support provided by Ricardo will be broad ranging, assisting Jaguar Land Rover across the company’s product design and development organization. This strategic framework of collaboration has already seen Ricardo provide its expertise on the integration of engines, advanced driveline and chassis systems. Amongst the key rationales for Jaguar Land Rover choosing Ricardo was its global presence. This enables Ricardo to provide in-territory engineering services benefitting from an understanding of and empathy with local tastes and norms, in both rapidly developing regions as well as in more mature markets.
Ricardo has been invited to join the Energy Research Partnership (ERP), a highly influential group that aims to enable the UK to become a world leader in the development of innovative new technologies. With a membership drawn from the country’s public and private organisations with a role in energy innovation, ERP provides within the UK a high-level forum for collaboration.

ERP brings together key funders of energy research and innovation from Government, industry, academia, plus other bodies with relevant interests, to work together towards shared goals. In doing so it acts as a generator and sounding board for ideas across the full spectrum of energy research and innovation. Ricardo has been invited to join this important UK organization alongside fellow members drawn from the power generation, distribution, and energy sectors.

“The energy sector is an increasingly important aspect of Ricardo’s business as we strive to help our auto industry customers reduce the carbon intensity of road transportation as well as serving the research, engineering and product innovation needs of new customers in sectors such as power generation and renewable energy,” explains Ricardo chief technology and innovation officer Prof. Neville Jackson. “I look forward to being able to make progress to our collective goals to promote innovation, growth and increasing sustainability in this important part of the country’s economy.”

Ricardo is part of a UK consortium that aims to further reduce power consumption and CO₂ emissions in hybrid diesel-electric buses through exhaust energy recovery.

The three-year “TERS” (Thermal Energy Recovery Systems) project will utilize market-leading technology to research, design and integrate pioneering thermal management concepts into hybrid diesel-electric buses. The project aims to reduce vehicle CO₂ emissions by 10 percent through the use of waste heat recovery systems while also reducing the average power consumption of air conditioning systems by half, further improving fuel consumption.

In addition to Ricardo, TERS partners include project leader, Wrightbus, along with Queen’s University Belfast and Revolve Technologies. The team has secured the necessary funding for this important work from a research and development competition managed by the government-backed Technology Strategy Board. The objective of the partners is to demonstrate the opportunity for improving bus fuel consumption and reducing emissions through the capture and use of heat otherwise lost during bus operation; this is seen as a potentially important step forward in public transport technology.

“Heat lost in the exhaust of a modern diesel engine can represent up to 40 percent of the available chemical energy content of the fuel used by the vehicle,” explains Ricardo project director for research and collaboration, Nick Owen. “A major current focus of Ricardo’s R&D efforts is therefore on the development of robust and cost-effective solutions aimed at harnessing this currently wasted energy in order to improve fuel consumption and reduce CO₂ emissions in both hybrid and conventionally powered vehicles. We are extremely pleased to be able to play an active part in the TERS project research, which will see the tangible demonstration of technologies on a modern hybrid bus.”

Getting the first generation of devices safely up and running will be no mean feat. The consortium aims to have a production ready system available within a six-year timeframe.

Ricardo joins energy research body
Ricardo Seminars & Events
Related to the automobile and clean energy industries

Advanced technology seminars, workshops and training courses

Ricardo is recognised worldwide as a leading authority in the development of the latest power systems for automotive and clean energy applications. While best known for our engineering and consulting programmes, an increasingly popular service is our regular series of seminars and training courses through which aspects of the company’s knowledge and expertise can be shared with customers. These events are typically hosted at Ricardo Technical Centres and are led by some of our most experienced engineers and research scientists.

We constantly strive to develop new seminars and courses reflecting the very latest thinking and most topical areas of power systems technology and product development. We also strictly limit delegate numbers in order to create an environment conducive to discussion of aspects of particular interest to participants. Modestly priced, our Ricardo seminars and courses provide exceptional value for money but are consequently in high demand.

Our current programme of seminars is listed to the right. Most of these will be hosted at the Shoreham Technical Centre, further presentations may also be made at other Ricardo facilities or at customer sites subject to demand.

For more information about our current seminar programme or to discuss individual company-specific training requirement, please contact: seminarinfo@ricardo.com

Seminar programme:

Automotive Transmissions Fundamentals:
19-20 July 2011
A two day seminar covering the fundamentals of automotive transmission technology. The seminar will cover the main types of automotive transmission and is aimed at engineers who wish to gain a broad understanding of transmission technology, applications and future trends.

Batteries for Automotive Applications:
6-7 September 2011
A two-day seminar discussing recent developments in battery technology for hybrids, plug-ins and electric vehicles. Covers the latest in electric motive technology and an overview of recent trends and advances in battery pack technology, the key enabler of the electrification of the vehicle network.

Internal Combustion Engine Fundamentals:
27-28 September 2011
Two one-day seminars covering the fundamentals of gasoline and diesel engine combustion and technology. The seminars are aimed at engineers and scientists who wish to gain a broad based knowledge of engine technology, and who wish to broaden their understanding of engine combustion, emissions and related issues.

“An excellent discussion and course, great flexibility and time for discussion.”
FOR WORLD CLASS PRODUCTS
CHOOSE A WORLD CLASS DEVELOPMENT PARTNER

With a Global capability in advanced propulsion systems and enabling technologies, trust Ricardo to make your hybrid and electric vehicle programmes a reality

www.ricardo.com/HES
Delivering Value Through Innovation & Technology