

Germany: Ricardo means business

Ricardo acquires PROTOtechnik-IFT, which counts Porsche among its prestigious customers



Gasoline's 20% saving

LBDI® technology cuts consumption using today's parts and processes

G5QA

How Ricardo technology helps carmakers achieve world-class gearshift quality

Interviews

Louis Schweitzer
Chairman and CEO, Renault

Hiroyuki Watanabe
Head of worldwide R&D, Toyota

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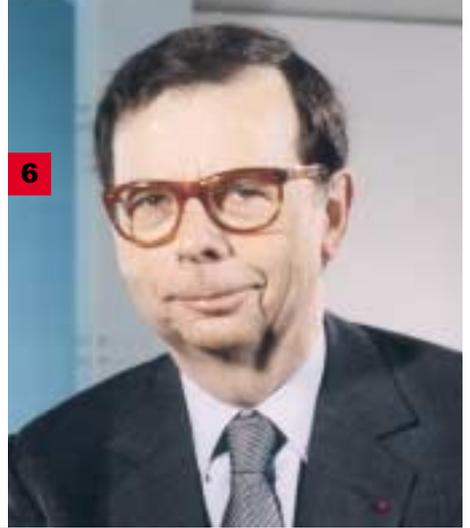
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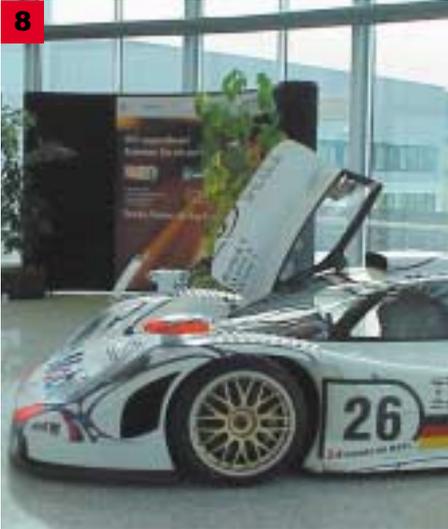
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● in brief

Piezo goes gasoline

The piezo-electric injectors pioneered by Siemens for DI diesel engines are now being adapted for use in gasoline engines, where they are expected to generate fuel savings of up to 20 per cent.

Valeo sees bright future

Automated parking systems are tipped for a bright future by Valeo. "The dream of cars that drive themselves will begin with parallel parking," said CEO Thierry Morin, predicting that such systems would begin to be available around 2006. Morin also forecast that Valeo would be a global top-five supplier by 2010, and that it would have number-one positions in ten product areas.

Siemens' innovation drive

Among a flurry of developments announced by SiemensVDO at the Frankfurt auto show are electric impulse charging to boost low-end torque on turbo, frontal sensors for active pedestrian protection, heat-exchanger cooling systems with pulse width modulated control of motors, and a handwriting recognition interface that allows drivers to write commands to multimedia systems and navigation.

Toyota two years ahead

Toyota has brought forward its 2005 goal of selling 800,000 units in Europe to this year, and has set a new objective for 2010 – to sell 1.2 million vehicles in the region.

Solar power for BMW

BMW's 3-series can now be ordered with solar powered ventilation. An array of 24 solar cells in the sunroof panel feeds up to 18W to six fans in the roof lining, helping reduce cabin temperature build-up by 15-20° Celsius when the vehicle is parked, without drawing any power from the battery. The system also helps improve the effectiveness of the standard air conditioning.

Diesel power for Jaguar concept

Jaguar's vision of a near-future compact sports sedan is built of aluminium, has rear-hinged doors to allow a sleek coupé roofline – and is powered by a twin-turbo diesel engine.

Unveiling the R-D6 design study at September's Frankfurt auto show, Jaguar design director Ian Callum hailed the 4330mm long, 1500kg four-seater as "a vision of the future of premium motoring: beautiful, fast, agile, efficient and fun."

Mike Wright, managing director of Jaguar cars, added that the R-D6 was a concept which sought to build on the heritage of the R Coupé, shown in 2001, and further develop Jaguar's new design direction. "We also wanted to showcase the latest technology in lightweight vehicle structures and our potent new bi-turbo common-rail V6 diesel engine," he said.

The 2.7 litre common-rail diesel is a co-operative venture between PSA, Jaguar and Ford, and in the application for the R-D6 has been tuned to what



Jaguar R-D6 concept takes diesel power into the compact sports sedan segment

Jaguar says are "beyond roadgoing levels" to give 230 hp – enough to provide 0-100km/h acceleration in under six seconds and a maximum speed regulated at 250km/h.

Very similar in weight and dimensions is Audi's Le Mans quattro concept. Taking its inspiration from the company's triumphs in the French 24-hour classic, the Le Mans quattro uses an aluminium space frame to house two occupants and the mid-mounted direct-injection

gasoline engine. Again with two turbochargers, the five-litre V10 unit sends its 610 hp to all four wheels to allow a theoretical top speed of 345 km/h.

Further innovations include Audi's magnetic ride damper system and an instrument panel which can be switched from its conventional roadgoing analogue condition to track mode where a plan of the circuit is displayed and GPS satellites indicate the next bend and even compute the car's lap times.

Particle filters gain ground

Diesel particulate filters are beginning to achieve broader market breakthrough as carmakers seek to ensure their products are seen as environmentally clean as well as low on CO₂ emissions. For some producers, the fitment of a particulate filter – pioneered by PSA in 2000 – is the key to compliance with Euro 4 emissions standards which come into force in 2005.

New models to include PM filtration systems include the Mazda 3, Ford Focus C-Max, Volvo S40 and several Volkswagen derivatives. BMW, too, is introducing filtration on its larger diesel engines, allowing the

whole model line-up to become Euro 4 compliant. Describing its move as a breakthrough in filter technology, BMW says its maintenance-free catalytic system requires no additives and enables



even its larger and more powerful diesel cars to meet Euro 4. Smaller BMWs, says the company, can comply without the need for the filter.

A similar view is held at PSA Peugeot-Citroën, where Gilles Michel, executive vice president for platforms, engineering and purchasing, says that by 2006,

filtre à particules systems will be fitted to all the group's diesel models over 100 hp.

However, at Denso, the world's number-three component maker, global sales director and board member Hiroshi Uchiyama insists the company's 1800 bar common rail direct-injection system (illustrated left), with its five injections per cycle, gives such clean combustion that the diesel filter is unnecessary. Denso will soon add piezo electric injectors to its technology portfolio, a development also being undertaken by Delphi and Bosch following SiemensVDO's big success in pioneering the system in 2001.

Europe's micro-hybrids arrive

Citroën's new C2 small hatchback and its existing five-door C3 will be the first volume production models to feature Valeo's start-stop system, operated through a belt-driven starter-alternator in the position normally occupied by a conventional alternator.

"This is the first step on the road to [volume] hybrid vehicles," said Valeo chairman and CEO Thierry Morin at the Frankfurt auto show in September. The start-stop option, which is claimed to save between 7 and 10 per cent on fuel bills, combines Valeo technologies in three areas and marks an important move into power electronics, said Martin Haub, group vice president for R&D and marketing. The engine, which shuts down when the vehicle is at a standstill, is restarted in 400 msec when the driver releases the brake (automatic) or engages gear in a manual, when clutch operation is fully by-wire.

Continuity of air-conditioning



Citroën's C2 is the first volume model to offer start-stop system, supplier Valeo claiming a 7-10 per cent saving on fuel bills

operation during engine stop is assured by a further Valeo development, Stop-Stay-Cool. An additional evaporator in the circuit stores what Valeo describes as 'cold energy' in an unspecified 'cost-effective material'; this cooling effect is later released into the system without the need for the air conditioning compressor to be running.

Valeo observes pointedly that in Paris, where the red phase of traffic lights is as long as 45

seconds, cars can spend as much as 35 per cent of their time stationary. A major secondary benefit of the start-stop system is thus improved comfort and refinement, noted PSA's Gilles Michel.

Further advantages of the stop-start system include the elimination of the starter motor and the potential for energy recuperation through regenerative braking, though this is not enabled on the present system.



A message from the Chief Executive

The acquisition of the PROTOtechnik-IFT group of companies by Ricardo in June of this year underscores the importance we attach to Germany, Europe's leading automotive market. This move significantly increases our regional presence, providing the necessary infrastructure, complementary technology and critical mass to deliver full powertrain and vehicle integration programmes from a local German base and team.

In this issue of RQ we present the background to the acquisition and highlight our vision for the future of Ricardo in Germany and the benefits that this will bring to our German customers.

In addition to this exciting news about our company I am also pleased that we are able to describe a significant technical achievement in the development of the Ricardo LBDI® gasoline engine. With demonstrated fuel consumption and CO₂ emissions reductions each in excess of 20 per cent and without compromising vehicle performance, the LBDI® concept offers the prospect of a major step forward in gasoline engine economy from technology that is already viable.

Toyota's second take on the hybrid

A useful extra benefit of the gasoline-electric hybrid powertrain is highlighted by a new Toyota concept car presented at the IAA Frankfurt auto show.

Outwardly a mid-engined two-seater roadster, the CS&S in fact houses an additional pair of seats below a slide-back fairing, while under its bodywork lies a novel twist on the Hybrid Synergy Drive engineering theme of the second-generation Prius, making its sales debut in Europe in the fourth quarter of this year.

Whereas the Prius mounts its 1.5 litre gasoline engine, trans-

mission, generator and motor all within one large assembly, in the CS&S the elements are differently divided. The centrally mounted engine drives the rear wheels, while the electric motor is moved to the



front axle to provide four wheel drive and improve weight distribution. This gives scope for significantly

improved handling and roadholding.

A further novel feature of the CS&S prototype, though entirely unrelated to its hybrid operation, is its so called Toyota Space Touch control system.

Holographic projections which appear to float around the driver provide information about the car's multi-media system, its air conditioning and other tasks such as internet access and navigation. Touching these virtual-reality displays allows adjustments to be made – in a manner which Toyota claims is both intuitive and straightforward.

Alliance architect

In his eleven years in the driving seat of Renault, Swiss-born Louis Schweitzer has turned the company into a design leader and taken control of Nissan, Dacia and Samsung to build a world Alliance selling over 5m vehicles annually. **Tony Lewin** spoke to him at the launch of the second-generation Scénic in Stockholm

Nissan has become a huge success under Renault's management. Is there a danger that it becomes the bigger partner and, in some way, the more glamorous company?

We knew from the start that Nissan was bigger: it was 50 per cent larger than Renault when we took it over. There were only nine months during which Nissan was worth less than Renault on the market and these were the nine months during which we negotiated our controlling stake! The day we announced the agreement, this changed. Now, it would be the most stupid thing to try to achieve a better balance by making Nissan less successful. I am not preoccupied with this issue.

Will both marques be full range suppliers for all market segments or will there be some things like 4x4s where it is Nissan only?

No, but you may have strong points and, purely for example, in Europe SUVs are Nissan's strongpoint and we are a full-line volume market player. In other countries, say Mexico, we are more upscale and Nissan is in the full line value for money sector. Market by market it may be different.

When Carlos Ghosn comes to Paris to take over your job in 2005, will you want to have a Japanese person running Nissan?

He has stated quite rightly that he will have a Japanese COO in Nissan. Carlos will remain Chief Executive; how long will this last is something that will have to be addressed in a pragmatic way.

In cash benefit terms would it not be right to say that the way that Nissan has turned out in its financial performance was almost like winning the jackpot?

A jackpot is a one-time win, and the idea for Nissan is a recurring win which is slightly different. Outside Renault it was considered as a high risk bet which paid off handsomely. The interesting thing is that nobody else was prepared to take the risk. It was not as if there was a bidding contest for Nissan.

Do you take personal credit for it, for having taken that risk and won?

Quite frankly, yes. There is a French saying, attributed to a Marechal called Joffre in the First World War. He won the battle of the Marne during the first German invasion in 1914 and was asked 'Who won the battle?' He answered: 'Well I don't know who won it, but I surely know who would have lost it!'

How do you feel your new design direction has gone down with the Vel Satis and Mégane hatchback?

Mégane is doing well. Everywhere in Europe the design is a major element of choice. It's doing what we hoped it would do so we are very happy with it. The Vel Satis was less successful.

Does the failure of the Avantage mean Renault's ideas of high

design have to be toned down a bit?

No I think there are different issues. Clearly Avantage was a niche car and it was meant to attract a small number of people – not a thousand or two thousand a day. Design was a positive and not a drawback for the car. The Mégane is in a segment which is considered even more conservative. Golf is the traditional leader of the segment, and we felt that we had to make a statement on design in the same way that Ford did with the Focus, which did very well. We made our statement with Mégane and it is exceeding its sales expectations.

But in the future will you take the same risks with design?

I think there is no such thing as a policy without risks. Bland does not mean success: bland, no risk, is a certain failure – but it can be a very discreet failure because nobody notices it!

You've been strong on safety and design. What about powertrain and chassis?

I believe we are good on chassis, and if we look at the press or what our customers say I believe we are fairly good in [getting] the balance between driving pleasure and comfort – though of course we do not put the same balance in a 2-litre Clio as in a Scénic. Ten to fifteen years ago we were not leaders in engines; we have had issues with reliability of diesel engines, but we have been moving ahead. From the fuel efficiency point of view we are good, but on the gasoline side the issue to be addressed now – as for a number of our competitors – is to find direct injection which really delivers value for the extra cost. To date we have seen more announcements than results. In 1996 and 1997 we, in common with the whole industry, completely underestimated the potential of diesel and overestimated the potential of direct injection gasoline.

Renault's BeBop concept, Frankfurt, September 2003





Louis Schweitzer, chairman and CEO, Renault

1942 Born, Geneva
 1970 *Inspecteur des finances*, French government
 1981 Chief of staff under prime minister Laurent Fabius
 1988 Joined Renault as chief financial officer and head of strategic planning
 1989 Executive vice president
 1990 Chief operating officer
 1992 Chairman and CEO
 2003 President of ACEA for 2003

means having other markets than Europe. Yes, I believe we will bring forward an offering, probably in the C-segment, as a 4x4 crossover.

When we look at French companies we often find ourselves comparing you with PSA. Why are your margins less good?

Currently PSA has had a very successful product range with a number of exceptionally successful models, in the same way that the Scénic was exceptionally successful for us. They are at a good point in their product cycle. We are today at a lower point of our product cycle. In the long run there is no reason that the operating margins of Renault and PSA should be significantly different. Of course we do have a little extra which is Nissan.

You talked about your product cycle: what is the average age of your fleet?

It is moving down. I believe with the Scénic it will go down and, with the launches of the Scénic and the full Mégane family, we will arrive at 3.5 years. We want to keep it between 3 and 3.5 years. In our best year for results we were at slightly over 2.5, and in 2001 and 2002 we were in the vicinity of 4.5. You see on average a fairly good correlation, all things being equal.

What are your plans for Dacia? Will it become a key brand for you in Eastern and Central Europe?

The first plan has been to turn the company round, and I think we are moving ahead there, but it's not easy. To give an idea, Dacia's labour cost is between 1 and 2 euros per hour all-in, compared with between 20 to 25 in Europe and 40 to 50 in a UAW plant. On the new product we are on schedule: this is the X90, the so called 5000-euro car. And once we have these two things I think we have a good base for expansion. ■

How will hybrids and fuel cells fare in the European theatre?

The so-called mild hybrids will bring additional savings, but at a significant cost because for them to be fully efficient you would need 42 volt batteries. I cannot see 42 volts not happening eventually, and once it has happened it would be stupid not to have the mild hybrid. If you look at hybrids in general the feeling is that from a fuel and cost efficiency point of view diesel is a better way to achieve it. On fuel cells there seems now to be a consensus that before 2020 they will not be significant in Europe except if there were genuine quotas saying you should put out specified numbers of fuel cell vehicles.

Where do you see the limit in terms of diesel share in Western Europe? And will the Americans eventually see sense and go for those newer diesels?

As you know, last year the first meeting of all manufacturers of the world took place in Paris in October. One of the issues was diesel and we made the statement in favour of diesel collectively, but I must acknowledge that amongst the Big Three there were clearly opposed views, not on the potential of diesel, but

whether it will catch in the US. I believe at one point in time they will say yes to diesel but I can't say when.

What will it take for them to want diesel?

Maybe to find that diesel in some cases is more enjoyable than gasoline. I think it is significant for the US because the price of the fuel in the US is a non-issue. Coming back to Europe, the limit to diesel is that Euro 4 is making it cleaner but more expensive. Euro 5 when it happens will make it still cleaner and still more expensive, which means that the balance between initial cost and cost of ownership will move more in favour of gasoline.

What is your attitude to SUV models?

We have done it in our modest way with the Scénic RX4 and the Kangoo 4x4. You have to accept that if you are mainly a European player, which is what we are, you do not find the volumes to make a lot of money. If you have to amortise all the development costs only on the European market, you do not make a lot of money. So how do we get out of this? First we may use Nissan technology, which means reducing development costs and, secondly, we may use the fact that we are internationalising ourselves which

Premier-league purchase

The acquisition of the respected PROTOtechnik-IFT Group near Stuttgart propels Ricardo into the premier league in Germany, the world's second-biggest market for outsourced automotive engineering services. **Tony Lewin** looks at the landmark deal and what it means for Ricardo



“Ricardo aims for growth in Germany” ran the headline in the Financial Times on July 1st this year; Ricardo CEO Rodney Westhead was quoted as saying that Germany had been a “serious gap” in the firm’s map.

But while those few bland statements, typical of the FT’s calm and strictly factual style of reporting, were more than enough to earn an approving nod from the financial community, they nevertheless gave little hint of the real significance for Ricardo – and for the auto industry in Germany.

Prior to the acquisition Ricardo had a certain presence in Germany. However its representation was – on its own admission – too small and too far short of the critical mass needed to attract the staff and the business Ricardo’s world-class skills portfolio merited. This had for some while been a source of frustration to Ricardo: Germany, after all, is ahead of Japan and on a par with North America as the world’s biggest market for contract automotive engineering services.

Yet now, following the purchase of the PROTOtechnik-IFT Group – which received widespread and favourable coverage in Germany – Ricardo has catapulted itself from barely-visible visiting side to premier-league home-team player in a division where the most important fixtures invariably go to national German squads. Through the PROTOtechnik-IFT Group Ricardo is suddenly much more visibly and publicly open for business in Germany: doors which were previously hard to budge are now thrown wide open, with the welcome sign hung out for good measure.

The change, as Ricardo plc director Chris Bates admits, is remarkable: “It was imperative for Ricardo to be part of the largest automotive market outside of North America, and our German customers had said that they would like us to be more local.

“We have always supplied the major OEMs in differing degrees across the world,” explains Bates. “The whole rationale for doing this is to meet our customers’ requirements – and our German customers had said to us time and time again ‘you must be closer if



we are going to have a larger and greater relationship with you’. And we have seen since the acquisition that this is likely to come to fruition: it’s more a question of doing a lot more business with existing customers rather than attracting new customers.”

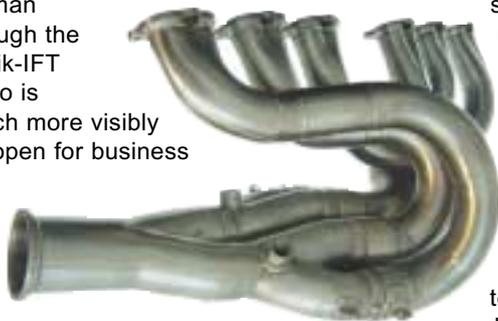
Having said that, however, the PROTOtechnik-IFT Group’s client list could hardly be more impressive: among the Group’s current programmes are the exhaust and induction systems for the prestigious Porsche Carrera GT, the exhaust system for the equally exotic Mercedes-McLaren SLR, and work for McLaren-Mercedes Formula One and Toyota’s Cologne-based Formula One team. PROTOtechnik-IFT also has the durability testing contract for all models from Daimler-

Chrysler’s smart division, and contributed to the same group’s V8 diesel engine programme and numerous racing ventures. Further work has included adapting Audi’s V8 gasoline engine for off-road use in Volkswagen’s Touareg SUV – as well as many other motorsport programmes where the company has agreed not to disclose the identity of the team.

Germany’s premium triangle

If the PROTOtechnik-IFT Group’s client list is the envy of every other engineering services provider, then so too is its geographical location. If you take a map of Germany and draw a

triangle between the three cities hosting the nation’s four most prestigious and profitable producers – BMW in Munich, Audi in Ingolstadt, and both Mercedes-Benz and Porsche in Stuttgart – PROTOtechnik-IFT’s headquarters at Schwäbisch Gmünd is directly on the Stuttgart-Ingolstadt axis, with Munich just to the south. Its offices are just 30 minutes from Stuttgart, 120 from Munich and 100 from Ingolstadt; key Tier 1 supplier ZF is an immediate neighbour, as is



PROTOtechnik-IFT – key facts

- Location: between Stuttgart, Ingolstadt and Munich
- Founded: 1985
- Employees: 250
- Skills: exhaust system design and prototyping; niche exhaust system manufacture; inlet system design and manufacture; tube products; cooling system design; engineering design; engine testing; vehicle testing; motorsport engineering
- OEM clients: AMG, Audi, BMW, DaimlerChrysler, Ford, MAN, Opel, Porsche, smart, Toyota, Volkswagen, Volvo
- Tier 1 clients: Behr, Benteler, ContiTech, Donnelly, Eberspächer, Faurecia, Gillet-Tenneco, Hengst, Pierburg-Kolbenschmidt, Mahle, Mann & Hummel, Phoenix, Valeo, Veritas, Zeuna Stärker, ZF, ZS
- Motorsport clients: Abt, Audi Sport, BMW Motorsport, HWA, Joest, Mercedes-McLaren, Toyota Motorsport, Manthey, VW Motorsport

Bosch, which has many of its major R&D and production facilities in the surrounding cities.

It cannot escape notice that Germany's most important premium players are situated in this southern half of the country, while volume makers such as GM/Opel, Ford and Volkswagen lie further to the north. Yet PROTOtechnik-IFT's blue-chip customer portfolio is not just a reflection of its pole-position location in Germany's premium triangle: it has been earned over the course of many years on the strength of the sophisticated nature of the programmes it is able to deliver.

For Ricardo it is a positive benefit that there is relatively little overlap between the PROTOtechnik-IFT Group's range of skills and its own. Once Ricardo had acknowledged that the only way to expand in the key German market was to acquire an existing player, it became clear that it could be self-defeating to take over a direct competitor. Instead, reasoned Chris Bates and Detlev Baudach, head of Ricardo operations in Germany, a firm offering a different set of skills would be a more logical move, eliminating any risk of duplication either in personnel or in orders with customers.

"We had been looking at various possibilities for about four years," says Bates, "and for the past three we've had our eyes on the PROTOtechnik-IFT Group."

Baudach recalls how, in late 2000 – just two months after he took over the top slot at Ricardo GmbH – PROTOtechnik-IFT first attracted Ricardo's attention. "PROTOtechnik-IFT had asked Ricardo to help with some advanced simulation work it was doing

'The Mercedes SLR McLaren is perhaps the biggest challenge we could have had in exhaust system development'

– Karl-Heinz Gersmann

for Volkswagen – it was pretty significant, as VW had suddenly outsourced a lot of the work and PROTOtechnik-IFT didn't feel capable of offering all those extra services on its own. In the event it didn't turn out to be any real business, but from that point on we began talking to each other."

At this early stage Baudach had the

Porsche Carrera GT supercar (far right) - PROTOtechnik designed and manufacture both the intake and exhaust systems. Here, the V10 engine's exhaust system glows hot in the test cell



grand total of five staff and was only recruiting at a junior level. He explains why PROTOtechnik-IFT appeared to fit the bill so well: "In PROTOtechnik-IFT I could see something already well established in the marketplace, something with an ideal location, and with good experience and a good spread of business – especially things like hardware, which complemented Ricardo's simulation approach. The deeper we looked into it, the more opportunity we saw."

Three-division structure

Reflecting its origins as an organisation founded by talented and enthusiastic engineers, the PROTOtechnik-IFT Group has three divisions, each operating in clearly-defined areas of the market. Much the most familiar in the broader auto industry is PROTOtechnik GmbH, founded in 1985 by Karl-Heinz Gersmann and Günther König: its core business is the design of exhaust systems, and it has also gone on to build up an enviable reputation for the low-volume manufacture of specialised high-performance exhaust systems for racing cars and ultra-high performance road cars such as the Mercedes-Benz SLR McLaren.

"Our biggest business is developing exhaust systems and manifolds for

series production by other companies," explains Gersmann. "Nearly all the big first-tier suppliers in the exhaust business are our customers: we will design, develop and produce a prototype of a manifold with catalyst, and the rest of the system, and we will do all the testing. What we don't do is the real volume production – all we do in terms of manufacture is the niche and high performance applications."

PROTOtechnik does not want to compete with the volume exhaust system suppliers, adds Baudach by way of clarification: instead, it prefers to maximise its value by concentrating on the niche high-performance sector where the volumes are so small that they don't fit production arrangements of the big manufacturers.

Having said that, PROTOtechnik does manufacture some systems in surprisingly high volumes: it makes the

exhaust for the natural gas powered version of the Opel Zafira at a rate of between 10,000 and 13,000 a year.

At the opposite end of the scale are the

Mercedes-Benz SLR McLaren and the Porsche Carrera GT: the McLaren, says Gersmann, is "perhaps the biggest challenge we could have had in exhaust system development. It's a mixture of production and series techniques: from the technology side





it's closer to a racing design."

The Porsche marks an important broadening of PROTOtechnik's activities into induction systems, too. "I think we're the first company in the world to do this – we supply the intake

system as well as the exhaust. Together with Porsche we developed both systems," continues Gersmann. "We call it 'from air to air.'"

One of PROTOtechnik's biggest advantages in the market is the

flexibility born out of its racing experience, says Gersmann. Racing activities used to account for two-thirds of PROTOtechnik's business: "we've all breathed in a lot of exhaust fumes in our lives," he laughs. "It's a special business, and you have to have the right feel for it."

Engineering development

Founded in 1989 by Austrian-born engineer Dr Walter Schwelberger, IFT Ingenieurgesellschaft für Fahrzeugtechnik mbH majors on engineering development, electronics and software design. It also undertakes benchmarking work and other studies for the auto industry.

"I had earlier met Karl-Heinz Gersmann – in 1978 when he was R&D director at Bischoff," recalls Dr Schwelberger. "While I was working as an engine design consultant to Volkswagen in Wolfsburg I became conscious that customers for engineering services were interested in getting more than the prototype hardware – they wanted the design as well as the software for the parts. That's how the idea for IFT Fahrzeugtechnik was born."

"One of our first projects was the design of a special kind of inlet manifold for a six-cylinder VW engine," says Schwelberger, "and then the jobs increased: different tasks within engine design, including Porsche cylinder heads, and other components around the engine."

Other programmes have included the first research work on Mercedes-Benz direct injection gasoline engines, and work on a family of modular engines for the then-independent Daewoo in Korea. Today, IFT Fahrzeugtechnik's principal client is DaimlerChrysler's

'We had the capacity to design the parts and to build those parts... The next step was for us to develop the capacity to test the parts too'
– Dr Walter Schwelberger

smart division, carrying out durability testing on the road. Another recent engineering programme has been the development of the lubrication circuit for the Audi V8-engined Volkswagen Touareg: here, the existing system had to be adapted to perform faultlessly at the high angles of inclination likely to be found in extreme off-road driving.

The Touareg programme also



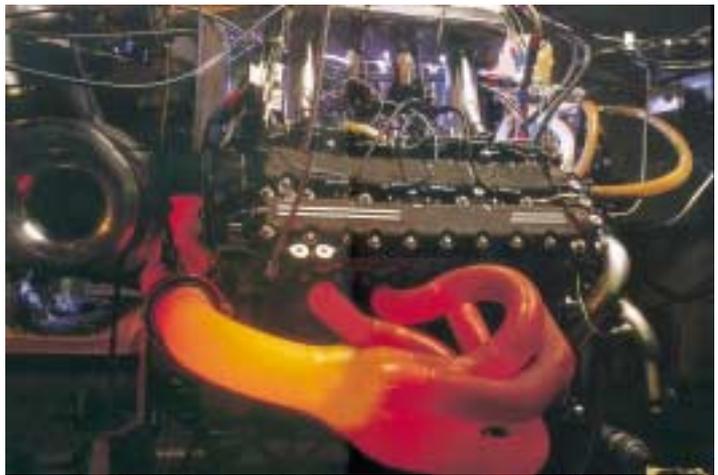
The founders of PROTOtechnik-IFT Group, from left to right: Günther König, Karl-Heinz Gersmann and Dr Walter Schwelberger

highlights the capabilities of the youngest company in the Group, IFT Prüftechnik, founded in 1996 as a “logical move forward for us” to round out the activities of the original firms. As its name suggests, IFT Prüftechnik has testing as its core competence.

“We had the capacity to design the parts and to build those parts,” says Dr Schwelberger. “The next step was for us to develop the capacity to test the parts too.”

The formula has proved very successful: IFT Prüftechnik did all the durability testing on the three-cylinder smart diesel engine, as well as Mercedes’ V8 diesel and Audi’s V8 diesels. The location in Schechingen – just 9 km from the Group headquarters – boasts an array of 12 sophisticated test cells equipped with the very latest measuring and control systems: just over half its work is durability testing, with calibration, mechanical development and component testing

PROTOtechnik-IFT is highly regarded in motorsport circles. Here, an engine destined for the US Indycar Series is put through its paces in the test cell



the Ricardo connection, we are able to undertake bigger programmes and with more sophisticated content.”

Big presence, big opportunities

While Ricardo plc director Chris Bates is enthusiastic about the additional skills and specialisations the

local presence, a service that can be delivered to them in their own language, with an understanding of their requirements in every detail that they could wish for. We can do it more cost-effectively for them, in the sense that we no longer have to ship vehicles to the UK, and we can now give them access to the whole breadth of Ricardo technology to be delivered in Germany, in conjunction with our other operations around the world, and we can give them global coverage to meet their own global aspirations, be it in North America, Germany or the UK.”

Having struggled for several years to achieve organic growth in its German operations, Ricardo GmbH MD Detlev Baudach is the first to welcome this dramatic expansion of the company’s presence.

“When we started to really build the business in Germany we found it quite difficult to recruit the kind of people we needed to provide the appropriate services to our clients: we were far too small for people to feel any kind of security with the company, to feel that they were being offered a good career structure.

“Now, however,” he continues, “we’ve reached that all-important critical mass where we can be a serious force in the market and compete with the established companies on equal terms.”

Prospects

Chris Bates, back at Ricardo headquarters in the UK, is bullish about the prospects for the future: “Our number one strategic aim, set out some years ago, was to become part of the German automotive industry – and this successfully fills that gap. We have work to do to grow it, but it is a very good move for Ricardo, for PROTOtechnik-IFT, and for all the staff involved.” ■

‘In PROTOtechnik-IFT I could see something already well established in the marketplace... with good experience and a good spread of business... the deeper we looked into it, the more opportunity we saw’ – Detlev Baudach, Ricardo



accounting for the remainder.

“Ricardo provides a lot of additional abilities right at the top end of development,” explains Dr Schwelberger. “There are of course some areas where we do almost the same things, but I would say that now, with

PROTOtechnik-IFT acquisition brings to the Ricardo group, his greatest excitement is reserved for the huge new opportunities presented by PROTOtechnik-IFT’s geographical location:

“Firstly we can offer our customers a



IFT-Prüftechnik has carried out the on-road and durability testing of all smart models. Here the Roadster is under evaluation

Chris Bates, a director of Ricardo plc and managing director of Ricardo Consulting Engineers Ltd, is based at Shoreham in the UK. Tony Lewin spoke to him about the acquisition of PROTOtechnik-IFT

What is the strategic thinking behind the German acquisition?

It was imperative for Ricardo to be part of the largest automotive market outside of North America – and our German customers had said that they would like us to be more local. For some while we had sought to grow organically in Germany, but as far as staff are concerned it is difficult to recruit when you are a small company in a new country and are viewed as a UK company. To meet customer requirements and to be able to recruit and retain staff and give them career development, a substantial presence is necessary.

What is the critical mass of the company in Germany that could then snowball and become bigger?

I think we are now there. We have that critical mass. We now have nearly 300 employees in Germany and are looking to grow that to closer to 500 in the coming years.

Can you explain what added benefits your customers will now get following the acquisition?

Firstly we can offer them a local presence, a service that can be delivered to them in their own language, with an understanding of their requirements in every detail they could wish for.

In terms of skills that the group can now offer its German customer base, what extra does the new group bring?

The new group brings in both complementary skills, which are in line with our historical business of engine and vehicle engineering, and a new skill of high performance niche exhaust manufacture and supply. On top of that it gives us a new skill of being able to communicate in the native language with our customers!

So it sounds like language is quite an issue. Is it because you are dealing with people at all levels that the German language helps?

At senior levels of all our customers English is a commonly spoken language. However when you are talking on a very technical level, engineer-to-engineer or even in certain project circumstances, it is much easier to communicate with total clarity when you are speaking in your own language.

The existing customer base and order book must be one of the most valuable assets in the acquisition. Has this opened doors to car companies that were not open before to you?

We very much hope so. We have always supplied the major OEMs in differing degrees across the world. The whole rationale for doing this was to meet our customers' requirements.

So will Ricardo be perceived as a global company rather than an English company in Germany?

We have come from an English base, although we have global operations in North America and in the Far East. I very much hope that we will be part of the German industry and be perceived as part of the German industry, rather than an English company on the edge of German industry.

Was the geographical location of PROTOtechnik-IFT an important factor in your choice of company to acquire?

Yes – apart from it obviously being in Germany, the fact that it is located within the Stuttgart-Ingolstadt-Munich triangle was an important factor in our decision.

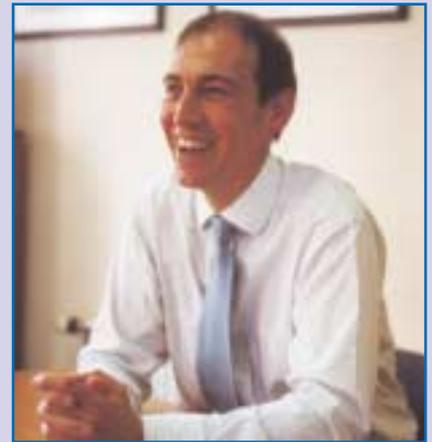
PROTOtechnik-IFT differs from Ricardo in that it has manufacturing capability – how does that sit with the rest of Ricardo's operations?

Very well. We already have a manufacturing capability in prototype and niche transmissions. We have a capability in prototype engines in both the UK and North America, so the niche high performance nature of the exhaust business fits very well with the strategy.

Is it better to work with specialist niche products than volume lines?

Yes. One of the Ricardo's strategies is to be within niche vehicles and niche products. We are not a high volume manufacturer making hundreds of thousands or tens of thousands of products per annum. We concentrate on high value added, high quality niche and smaller series low volume production where Ricardo can add the value. We are not big enough and do not wish to be big enough in manufacturing at that high volume level.

Will you retain the PROTOtechnik-IFT



brand name? I understand it is a respected brand in the German industry.

Yes: the companies are going to be known as PROTOtechnik Ricardo and IFT Ricardo. That may change over the coming years, but both IFT and PROTOtechnik are very strong brands within the German market and we would not wish to dilute that.

Has the acquisition filled the most important gap in the Ricardo portfolio?

Yes it has. Ricardo is always looking to grow: our number one strategic aim set out several years ago was to be part of the German automotive industry, and this successfully fills that gap.

Are there any other acquisitions Ricardo is looking to make?

Ricardo will always look to acquire companies that fit our strategy and portfolio. Over the last year we have seen three acquisitions, with Gemini in transmissions and motorsport manufacturing, and Tarragon in control and electronics. PROTOtechnik-IFT in Germany was the perfect geographical fit for Ricardo. Yes we will look at other acquisition opportunities in the growing areas of the business, be it to fit technical development needs, geographical development needs or customer needs.

You have got good contacts with the Japanese car makers through HORIBA, German car makers through the new acquisition and a well set up organisation in the US. Does this not leave gaps with French, Italian and Korean car makers?

Taking each of those gaps in isolation, we have very good relationships with French manufacturers and we look to grow our presence in France — probably organically, but if there was an opportunity we might look for an acquisition there. In Italy we have a presence through our control and electronics and our vehicle engineering operations, which we are growing organically. In Korea we have representatives, but we need to review what we do in Korea and other parts of mainland Asia in the coming years. ■

Gasoline breakthrough delivers 20% saving

This Ford Focus demonstrator provides a 20 per cent fuel saving over the standard 1.6 – using existing technologies and without the need for significant plant investment. **Anthony Smith** looks at the remarkable new Ricardo Lean Boosted Direct Injection (LBDI®) engine, set to rewrite the rules of gasoline economy

As the automotive industry in Europe strives to reduce its new vehicle fleet average CO₂ emissions in line with the commitment of the European OEM body, ACEA, to achieve 140g/km by 2008, an increasing emphasis is being placed on gasoline combustion efficiency. Since the ACEA commitment was made in 1998, much of the reduction to date in fleet-average CO₂ emissions has been attributable to the increased penetration of diesel engines within European markets at the expense of gasoline.

However, there is a practical ceiling to this trend represented not just by customer preferences but also in the maximum fuel volume split that can be managed by the refiners. The result is that the pressure is now on to develop new and commercially attractive technologies for higher fuel efficiency

(and hence low CO₂) gasoline engines – engines which must deliver on real-world customer satisfaction as well as test-cycle fuel economy.

The challenge of downsizing

Engine downsizing is a well-established concept for the improvement of fuel consumption and associated CO₂ emissions. By reducing the swept volume and increasing BMEP through boosting, friction and pumping losses can both be reduced and, in addition, the lower mass of a downsized engine offers potential cold-start advantages associated with reduced thermal inertia as well as lowering the weight of the vehicle.

But there are potential drawbacks too. The compression ratio must be reduced on a conventional boosted engine in order to control knock, low-speed torque is less than in a naturally aspirated engine of equivalent peak torque and

power, and transient response may be adversely affected by turbocharger lag, particularly in the absence of more advanced boosting technologies.

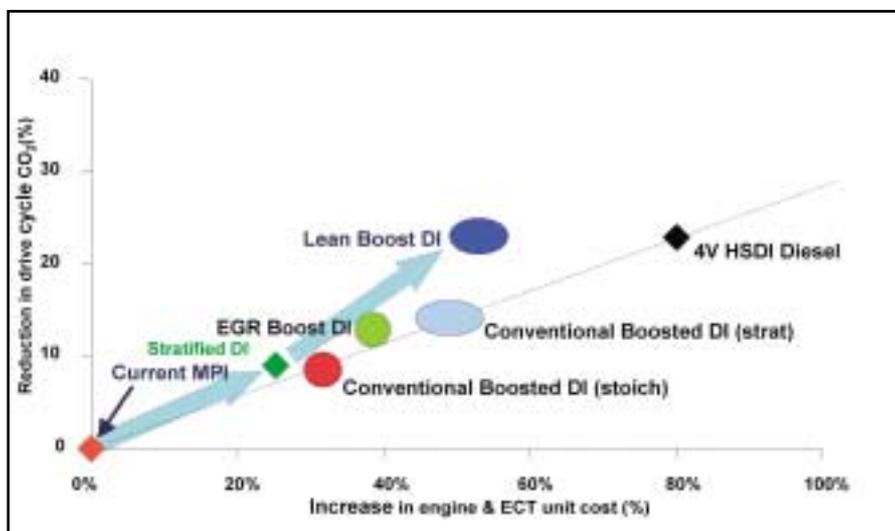
In addition to these drawbacks, there is of course the ever-present economic concern of increased production cost arising from many additional technologies associated with engine downsizing. As such, the challenge is to develop technologies for gasoline engine downsizing which meet the ever-increasing demands of modern drivers for performance, responsiveness and driveability but at the same time matching the CO₂ emission/cost premium position of existing HSDI diesel alternatives. The resultant vehicle is thus potentially profitable for both the manufacturer and the customer.

Meeting the challenge

“In our research programme we examined a range of concepts for downsized DI gasoline engines,” explains Tim Lake, chief engineer of the Ricardo gasoline research team. We made use of advanced engine performance and vehicle simulation CAE codes such as the Ricardo WAVE package and V-SIM, and subsequently, moved into a comprehensive multi-cylinder experimental programme.” Through the analytical and experimental programme the team investigated a range of engine concepts including conventional direct injection (DI) operation, the Ricardo Lean Boost Direct Injection (LBDI®) and EGR Boost Direct Injection concepts. Also explored was Miller Cycle operation based on the use of variable inlet cam phasing to change the effective compression ratio.

Of the concepts investigated, LBDI®

Cost-benefit analysis for low-CO₂ engine technologies



“A downsized 1.1 litre LBDI® engine can provide comparable performance to that of the 1.6 litre baseline car, but the improvements in fuel consumption and CO₂ emissions are more impressive still”

Tim Lake, Ricardo



Ricardo worked with Ford, Bosch and Johnson Matthey to develop a Ford Focus using the LBDI® engine

showed substantially the greatest promise in terms of the trade-off of performance, cost and CO₂ emissions. This concept uses lean operation to reduce full-load octane requirement and hence allows operation at higher compression ratios than is the case in a conventional DI. The lower exhaust temperatures of the LBDI® allows use of a Variable Nozzle Turbine (VNT) turbocharger which gives advantages in low speed torque and reduced lag. Furthermore, Ricardo also found that with the low exhaust temperatures of LBDI® it was possible to use a standard production diesel VNT unit in place of the more expensive gasoline equivalent.

For emissions, the LBDI® concept incorporates a Lean NOx Trap (LNT) in addition to a three-way catalyst (TWC), something which is unnecessary in the alternative EGR boosted DI concept.

However, the CO₂ emissions potential of the LBDI® is sufficient to offset the added expense and complexity of LNT technology, which is in production today with several vehicle manufacturers.

Concept to reality

Considerable development work had previously been carried out by Lake and his team based on a single-cylinder Ricardo Hydra research engine (as reported in RQ, Spring 2002). This programme provided the opportunity to take the concept forward both to a multi-cylinder test bed

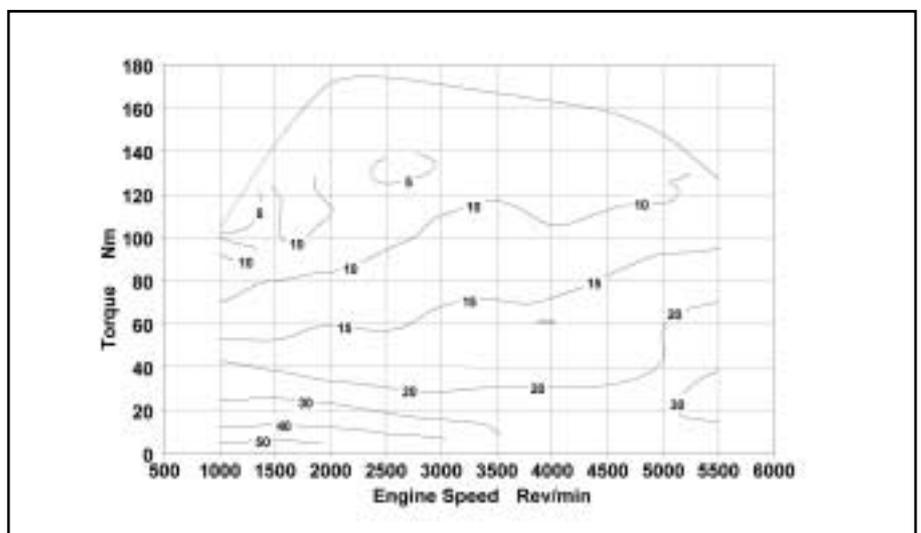
programme and to a vehicle demonstrator.

The selection of vehicle was itself significant, as Lake explains: “C-class or lower-medium size cars represent by far the largest segment of the European market and hence the greatest potential for reduced fleet-averaged CO₂ emissions. It is therefore important that we demonstrate downsizing solutions aimed at this critical sector.”

Together with research partners at the Ford Motor Company, Bosch and Johnson Matthey, the team members identified as their baseline for engine

downsizing a Ford Focus equipped with a 1.6 litre in-line four-cylinder naturally aspirated gasoline engine. The objective was to replace this with a 1.1 litre three-cylinder LBDI® engine offering comparable performance and driveability. Lean operation – especially at higher boost pressures – represents a more demanding environment for stable combustion, so the dual injection strategies developed in the previous single-cylinder work were further optimised in the multi-cylinder programme in order to improve combustion stability. Additional refinements were applied to both air

Contour plot of percentage fuel economy benefit of LBDI® compared with baseline engine



motion and the production ignition system and here too, significant improvements were achieved in terms of combustion stability.

Delivering driveability with a 20 per cent fuel saving

Having completed the test bed development phase, the team progressed to implementation of the vehicle demonstrator. "It was important for us to develop a full calibration for the demonstrator so that we could show the performance of the vehicle was comparable with that of the baseline," explains Lake.

The results of the work in demonstrating that the downsized 1.1 litre LBDI® engine could provide comparable performance to that of the 1.6 litre baseline were highly impressive – but the improvements in fuel consumption and CO₂ emissions were more impressive still. Over the NEDC drive cycle the LBDI® demonstrator returned a fuel consumption improvement of better than 20 per cent below the level of the baseline Focus, with an equivalent reduction in CO₂ emissions.

In order to meet legislative emissions limits the LBDI® engine is fitted with both a TWC and an LNT. In order to achieve a good NO_x trapping efficiency within the LNT the trap must operate within the relatively narrow range of between 250°C and 550°C.

The team was able to show that this window could be maintained both during NEDC as well as under all other off-cycle operating conditions. Within Europe in particular, high speed driving is commonplace and it was important for the team to be able to demonstrate



Downsized 1.1 litre, three-cylinder LBDI® engine in Focus demonstrator matches drive characteristics of standard 1.6 – but with a 20 per cent fuel saving

that even at maximum vehicle speed the temperature drop across the turbine and through the exhaust system was sufficient to provide a safe level for LNT protection.

Real-world benefits and commercial viability

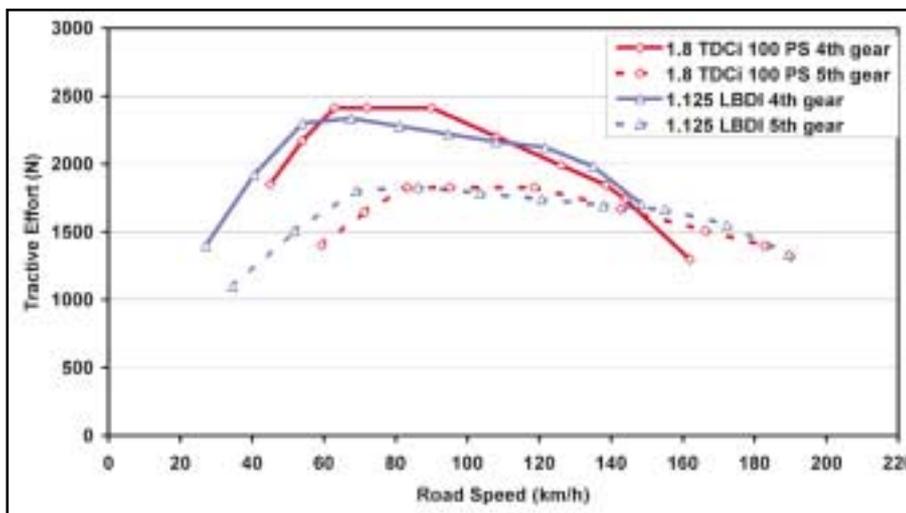
The practical benefits of LBDI® combustion demonstrated by the project are undeniable: an improvement of over 20 per cent in fuel consumption and CO₂ emissions, and the ability to meet Euro IV (and beyond) emissions, while providing similar 0-100 km/h and low-speed acceleration performance to the baseline vehicle.

But given the fact these improvements

are not cost-neutral, how will the consumer respond? "It's a long-established principle that consumers are willing to pay next to nothing for improvements in fuel economy alone," explains Lake, "but fortunately with its large mid-range torque similar to a diesel, LBDI® can also offer punchy high-gear acceleration: customers will pay for performance gains like that."

"If we examine different candidate gasoline technologies in terms of their respective reduction in CO₂ related to the increased manufacturing cost of the engine and its emissions control technology, we see that LBDI® provides by far the best trade-off. Moreover, the system offers CO₂ emissions comparable with those of an HSDI diesel but at a substantially reduced incremental cost."

1.1 litre LBDI® gasoline demonstrator closely matches tractive effort of Focus TDC1 1.8 litre 100 PS Diesel



A bright future

With such a positive cost-benefit trade-off and its 'fun to drive' appeal, Ricardo believes that LBDI® may be as attractive both to consumers as it is to European OEMs in their efforts to improve fleet average CO₂ emissions.

But perhaps the greatest challenge of all will be to change the way in which swept volume is used as a direct measure of attractiveness when marketing vehicles. For this downsized LBDI® gasoline engine, less is definitely more. ■

For further information about Ricardo LBDI® see www.ricardo.com/LBDI

Hybrid pioneer

Toyota is the world's leading promoter of hybrid vehicles, promising to build 300,000 a year. As the second-generation Prius hybrid goes on sale in Europe, **Tony Lewin** speaks to **Hiroiyuki Watanabe**, one of the company's leading engineers



Senior managing director and board member **Hiroiyuki Watanabe**, right, is in charge of Toyota research and development worldwide



What is top of your R&D agenda right now?

It's the environment, and globalisation – in the sense of harmonising standards and technologies.

Within the environmental areas, which technologies are you pursuing most strongly?

There are five areas of technology: three of them are related to engines. The first is the development of clean diesel engines; the remaining two are hybrid technology and the development of fuel cells. Our fourth task is to make vehicles smaller and more compact, and the fifth is the development of information technology to improve safety and reduce traffic congestion.

You serve all the markets in the world. Which is the most important powertrain technology in your view?

We are well advanced in the development of gasoline hybrid powertrains, which are able to reduce CO₂ emissions and produce a much cleaner exhaust. We are now in the gasoline age, and will soon move into the diesel age, and from then

we will pass into the fuel cell age. The hybrid can be seen as just a bridge between the ages, but a more accurate view is that in the end all vehicles will be hybrid, meaning that there will be more different engine types and combinations of engines.

What timescale are we looking at?

We are already in the age of gasoline hybrids, and I believe that within ten years we will have diesel engined hybrids and fuel cell hybrids. It's a matter of using two different power sources in the most efficient way.

What about the fuel cell hybrid?

Efficiency in a fuel cell vehicle can be three times higher than in a gasoline or diesel one. But at certain points in the load range its efficiency decreases: the area of excellent efficiency is limited, and that's where we need hybrid operation.

Why has Toyota stuck with gasoline hybrids and not yet looked at diesel?

It's an issue of chronology. There are two tracks to follow: one is to develop the gasoline hybrid to reach our final goal of an eco-car; the other one is start with the diesel engine. The diesel has a very high combustion efficiency but also large emissions of NO_x and particulate matter. Many carmakers from all round the world have been trying to make the diesel exhaust as clean as that of gasoline, and it's not easy.

How do you see the next ten years in terms of mild and full hybrids and customer acceptance?

It depends on the cost of the performance of each type. The mild hybrid can only improve efficiency by ten per cent and reduce CO₂ emissions by ten per cent. A strong hybrid, as we call it, like Prius, can give a 50 per cent increase in efficiency – but 20 per cent of the energy efficiency increase of the strong hybrid is actually achieved by the regenerative braking system. So in European countries or cities where people drive their vehicles at very high speed or often accelerate rapidly, and where traffic congestion is not such a big problem, I believe the strong hybrid will be a much better solution.

Another point is that strong hybrid technology will eventually lead to fuel cell technology.

What about the high cost of the components in these strong hybrids?

We have been in discussion with a major European OEM over the past five years about hybrid fuel cell technology: they believe hybrid is too costly and want just to concentrate on the development of fuel cells. Our counter-argument is that almost all of the components of the strong hybrid are the same as for the fuel cell vehicle, so if you cannot reduce the cost of the components in the hybrid you cannot mass-produce fuel cell vehicles.

Can you give an idea of the relative costs?

The cost of adding hybrid operation to a gasoline vehicle is roughly the same as that required to bring a diesel engine down to the exhaust emission levels of a gasoline vehicle. ■

Shift work

What makes a gearshift satisfying? What makes it disappointing? This key component of driver enjoyment is notoriously difficult to analyse objectively, but the latest Ricardo GearShift Quality Assessment (GSQA) system is rapidly becoming the industry standard to help carmakers achieve gear change feel that precisely matches their desired brand values. **Anthony Smith** reports

While gearshift quality is something that few people stop and think about, its effect is something that we all experience in our daily lives as drivers. It's also something that we may become rather more conscious of when considering a new vehicle purchase and test driving a range of candidate products. This is reflected in the motoring press where almost any ride and drive report on a new car will invariably contain references to the responsiveness and 'feel' of its transmission. Indeed, in an environment where common powertrain systems are increasingly being offered across a wide range of differently badged vehicle products, gearshift quality is becoming a potentially important branding characteristic.

But to quantify and characterise the attributes that give a vehicle particularly good or bad shift quality – and to use this information to improve its design – is an extremely difficult process. Firstly it is necessary to understand the subjective measures that we all instinctively apply in evaluating an abstract concept such as shift quality. Secondly, in order to be able to develop new transmissions that exhibit positive shift quality attributes and avoid negative driver responses, an understanding is needed of the engineering basis of different shift quality characteristics.

Until comparatively recently, manual gearshift quality was typically evaluated solely on the basis of the observations and assessments of teams of test drivers. This approach suffered from a very high degree of subjectivity due to the many different driving styles, tastes and personal interpretation of each gearshift by each individual driver. Ricardo recognised the need for a more objective process and pioneered its GearShift Quality Assessment (GSQA) system. According to Marcus Fear, principal engineer (CAE) at Ricardo Driveline & Transmission Systems, the guiding objective of GSQA is to reduce the requirement for skilled engineering resource in gearshift quality development, while at the same time improving its speed, accuracy, and repeatability. "Essentially we want to remove the skilled engineer from what was formerly a time consuming process of capturing data and, instead, enable him to be able to concentrate on the more value-added processes of transmission system development, benchmarking and problem resolution."

Shift lever measurement

GSQA comprises a comprehensive package of hardware and software which aims to enable transmission engineers to measure and analyse shift quality rapidly and in an accurately repeatable and objective environment. In addition to this it can be applied in the diagnosis of known operational problems and the validation of engineering solutions.

In terms of hardware the GSQA system comprises all the



Marcus Fear, Ricardo

instrumentation needed to log data of gearshift handball position and forces.

The modular design of the system allows the GSQA to be mounted in vehicles ranging from compact cars to heavy trucks. In addition to a full range of cables, electrical connectors and other accessories, the hardware installation includes a signal conditioning analogue to digital converter. This acquires data and translates it into a form readable by a laptop PC. A total of 16 channels are provided on the base level GSQA system: six are used to convey applied gear knob forces and location in three dimensions, four channels are used for temperature measurements, and the remainder are used for other analogue measurements such as speeds, forces and torques.

The software supplied with the GSQA system comprises two packages, each written as MATLAB® applications, respectively for data acquisition and for analysis. The software gives the capability to assess performance of the gearshift in terms of a range of pre-determined objective measures, replacing the need for subjective evaluation. The system as delivered includes a range of data based upon Ricardo experience but, inevitably, most manufacturers will wish to populate the system with measures which reflect the desired brand characteristics of their own vehicles.

Land Rover: embedded brand values in shift quality

Engineering vehicles with consistent transmission brand attributes is a major focus of activity for David Tilling and Hans Berg, attribute specialists at Ford Premier Automotive Group (PAG) with respective responsibilities for Jaguar and

'Total reliability is important – in particular for benchmark testing, when we may have only one opportunity to test a given vehicle'

– Hans Berg, Land Rover

Land Rover vehicles. "The constituent product engineering teams of PAG have joined forces to ensure that all aspects of transmission performance conform to group standards, while maintaining the brand DNA of each vehicle marque," explains Tilling, "We use the GSQA system principally for two applications: the measurement of competitor vehicles for the purposes of benchmarking and establishing our own

development targets, and in the development of new gearshift systems in the future products of PAG brands.”

Robustness and ease of use are particularly important qualities of the GSQA system to PAG. Time is always at a premium during the product development cycle and the availability of test vehicles can be extremely limited. As Berg explains, “a major advantage of the GSQA system is that we can install the equipment in a vehicle in the morning and carry out measurements, change various components and settings and re-test the vehicle the same day. Total reliability is important – in particular for benchmark testing, when we may have only one opportunity to test a given vehicle.”

PAG also cites the comprehensive nature of the analysis software as a significant advantage of the GSQA system. Like many other OEM users, however, they have embedded their own objective measures within the system. “We have our own guidelines for shift quality which reflect the characteristics of the individual PAG brands,” explains Tilling, “and it’s important that these are used in the development process.”

While GSQA is now very much part of the transmission engineering process at PAG, the company feels that individual users of the system have much to learn from each other. A ‘governance board’ or internal GSQA user group is being formed, aimed at sharing knowledge of the system, establishing best practice guidelines for its operation, and investigating future applications.

Tier 2 suppliers: GSQA validates simulation model

But if GSQA can be put to such good effect by OEM users, how is it used by its many customers in the components sector? As one of the leading manufacturers of transmission components and sub-systems such as synchroniser systems,

‘With GSQA we can offer systematic problem analysis to our customers’

– Ottmar Back, HOERBIGER

HOERBIGER serves a wide range of OEM and Tier 1 customers. It is highly focused on the need to engineer high standards of gearshift quality. According to Ottmar Back, manager of research and development at HOERBIGER Antriebstechnik GmbH, GSQA finds a number of applications within the company: “With GSQA we can offer systematic problem analysis to our customers. Design modifications can concentrate upon the identified root cause and if we have used simulation in our analysis, GSQA can be used to validate the model.”

HOERBIGER has also used GSQA in many new product programmes, including the development of new six-speed manual transmissions, for improved shift quality. As with OEM users, reliability, ease of use, repeatability and accuracy are all important. “GSQA is in our experience easy to install into a vehicle and is easy to use,” explains Back. “The comparison of two systems with two drivers in the same car showed good correspondence.”

Back at Ricardo, Marcus Fear is confident that the market for GSQA will continue to expand. “We have just launched version 5 which has some particularly useful new features. For the first time we can process vehicle CAN bus data which enables a range of control signals and operational details to be recorded in parallel with gearshift data, opening up a wide range of potential new applications. In terms of ease of use, the new automated shift point picking capability will also remove the need for skilled data processing.”

New features of GSQA version 5

- 32-channel compatible software (previously only 16)
- Vehicle Controller Area Network (CAN) compatible software
- Fully automated shift point picking, removing the need for skilled data post-processing
- Fully integrated clutch hysteresis measurement
- Improved plot and scaling functionality
- Improved data import and export routine

But this is far from the last word in GSQA development, or in its growing range of applications. According to Fear, Ricardo is already talking to a number of OEMs from Japan as well as elsewhere in Asia about the potential use of GSQA in engineering versions of their vehicles which are more closely in tune with European tastes. In production too, the company is talking to a number of transmission manufacturers about the potential application of the system in end-of-line conformance auditing.

Longer term, many customers are also considering the application of GSQA in the optimisation of shift quality in new Automated Manual Transmission (AMT) systems.

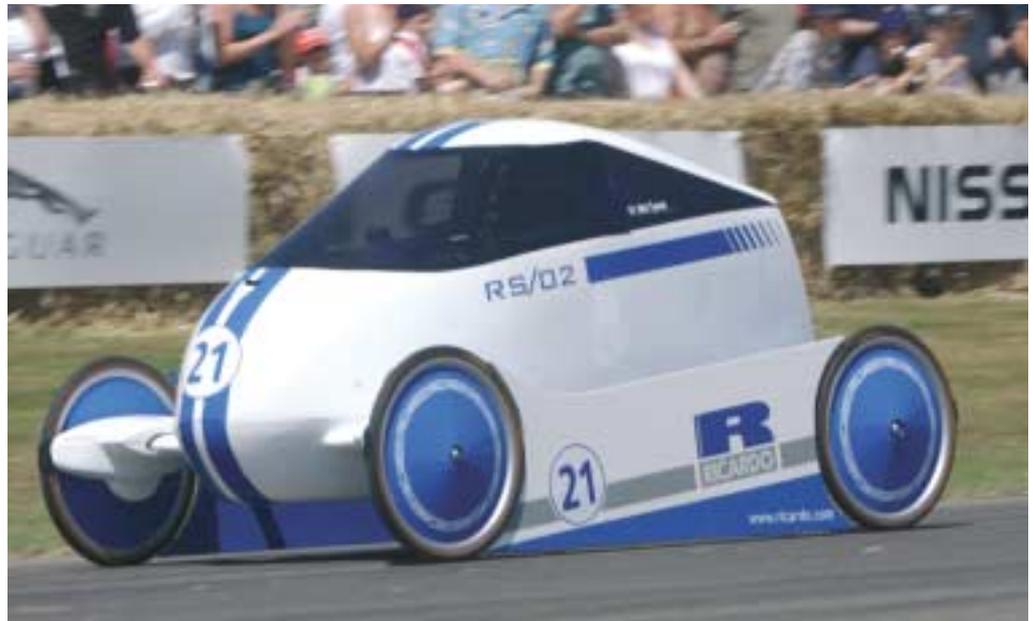
Here the ability to process vehicle Controller Area Network (CAN) bus signals and the 32 channel capability available with the new version 5 of GSQA will open up many more possibilities for engineering desired shift characteristics both in terms of hardware design and changes to the transmission control software. With a customer list that reads like a directory of the world’s automakers it may already be something of an industry standard, but GSQA clearly has potential for growth. ■

Downhill to victory

Now in its fourth year as part of the Goodwood Festival of Speed, Goodwood Gravity Racing Club's Dunhill Challenge draws teams – predominantly of graduate engineers – from many of the UK's leading automotive organisations. From a standing start the vehicles race in pairs, gradually accelerating down Goodwood's 1.13 km normally uphill course, ultimately reaching race speeds over 100 km/h.

The Ricardo graduates who decided to take up the challenge for the 2003 race, developing and racing the completely new RS/02 vehicle, realised they had a major engineering task on their hands. Competition had become increasingly fierce over the previous two years, with many teams applying significant technical resource to the challenge. "When this year's competition was formally announced in October 2002 we realised that it would take a considerable engineering commitment to be competitive, let alone to win the 2003 race," explains Mark Fowler, a graduate engineer at Ricardo Vehicle Engineering.

The team started by designing RS/02 around the



Winning Ricardo RS/02 at its peak speed (101.8km/h) on Goodwood's main straight, above. On bends, right, the vehicle's stability proved a crucial advantage



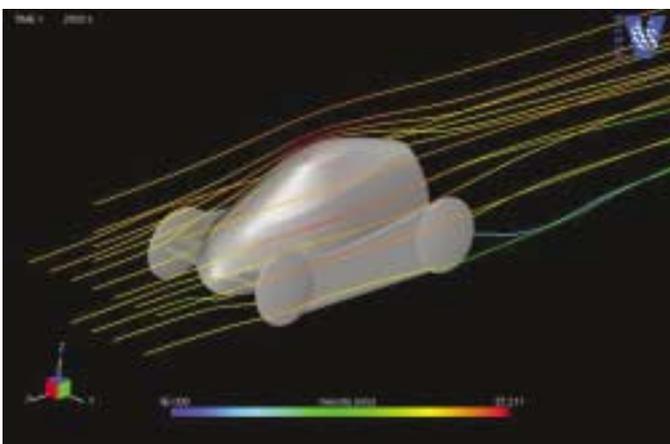
driver, aiming to achieve an optimal fore/aft weight distribution. "We had learned some fairly important lessons from the experience of the 2002 Ricardo graduate team with their RS-01 vehicle," concedes Fowler. "RS-01 had

been fast but it lacked directional stability on cornering. This restricted the speed at which it could travel around bends without risk of spinning off. Our most immediate challenge therefore was to engineer RS/02 for improved stability so that it could tackle bends without braking while still remaining stable." The team achieved this by placing the driver as far forward as possible while incorporating an adjustable rear roll stiffening beam into the design of the chassis.

In the form of a 3D CAD model the external shape was optimised using the Ricardo VECTIS CFD software package. "I had previously used VECTIS as part of my day-to-day work and so was able to apply this technology directly to the

project," explains fellow team member John Cusack. "By using VECTIS we were in effect able to place the RS/02 design in a virtual wind tunnel and, through a process of iterations, we produced an optimised shape which offered the best compromise of stability and low friction. In particular, we were able to evaluate the effect of the full-height side pods that are a characteristic feature of this year's car."

The chassis was modelled extensively using the ADAMS simulation package to optimise its dynamic performance. The final design incorporated fully adjustable roll stiffness and wheel alignment geometry, allowing the vehicle to be tuned to the particular requirements of the driver and the track conditions prevailing at the



RS/02 aerodynamic package was carefully honed in the virtual wind tunnel provided by the VECTIS software. Full-height side-pods emerged as a key feature

event. For the wheels, the team wanted to achieve high lateral stiffness for cornering but at the same time have extremely low inertia in order to maximise acceleration from the start line.

"We came up with the idea of using tough, low mass mountain bike hubs coupled to the lightest weight rims we could find," explains Fowler. This was absolutely critical to us in achieving a quick start and stable cornering." Braking was provided via disc brakes on each wheel, automatically balanced across axles and with fully independent front and rear operability for maximum driver control.

However, to be truly successful in downhill racing requires a vehicle engineered in such a way that the brakes are rarely – if ever – used. Nik Tyson, driver of the RS/02, takes up the story: "In downhill racing it's important to get a good start. We race in pairs against the closest matched rival from the previous run. As such, if you can accelerate quickly you have a chance of taking the optimal racing line ahead of your competitor."

"RS/02 was paired against Lotus but its low inertia wheels gave a distinct advantage in this respect and we quickly moved ahead of them," said Tyson.

Having won the 2003 Goodwood competition the Ricardo graduate team is now looking forward to the challenge of 2004. New members may join the team with this year's graduate intake and some will no doubt leave, but one thing is for sure – the 2004 event will see a substantially new Ricardo vehicle. "We expect that RS/03 will be a 90 per cent new car," predicts Fowler, "and we already have a range of new ideas that we would like to try out."

In a challenge that says as much about engineering innovation as competition, it seems that at Ricardo the will to win remains as intense as ever. ■

Ricardo Inc president chairs Global Powertrain Congress

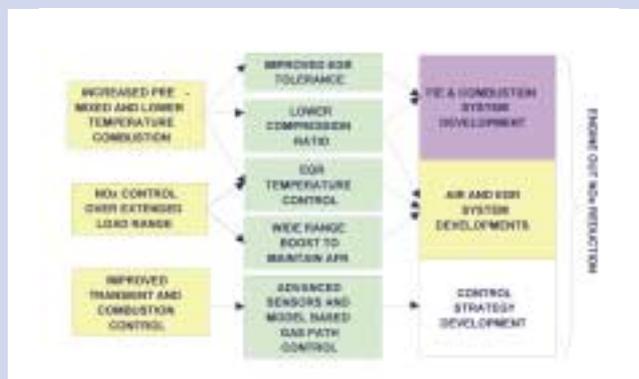
Set to open at Ann Arbor, Michigan, as we go to press, the Global Powertrain Congress (GPC) is expected to attract a high-profile audience of automotive engineering professionals from across the US auto industry, as well as many overseas delegates.

The opening session is entitled *Powertrain Drivers* and sets the scene for the conference by considering an external view of the forces driving powertrain development. Moderated by Ricardo Inc president Jeremy Holt, the session will provide a range of perspectives on the environment, legislation, and consumer and business needs, outlining the various technical options under consideration aimed at providing solutions to these drivers.

Papers are due to be presented from a wide range of sources including engineering research organisations, US government agencies and academia. In his paper *Selecting Powertrain Technologies for Future Light Duty Vehicles*, Peter Brown of Ricardo will outline in detail the processes used by Ricardo in developing its technology road maps to forecast the future take-up of new automotive technologies.

The process described provides for a systematic and objective evaluation of alternative technologies while taking into account the perspectives of consumer demand and regulatory requirements, as well as the competitive positioning of the manufacturer.

In the Advanced Propulsion Systems session of the GPC, a paper by Nick Owen and Marc Wiseman presents the Ricardo view of the role of hybrids in the possible future transition from carbon-based



Diesel ACTION strategy described by Ricardo in the *Advanced Engine Design and Performance* session

fuels to hydrogen. In their paper they build upon the results of previous Ricardo research examining the possible routes to the transition from carbon to hydrogen-based automotive propulsion in the European market.

An outline analysis is presented of some of the economic factors governing early uptake of hybrids. Owen and Wiseman conclude that progressive hybridisation offers an excellent route toward a hydrogen/fuel cell future or a variety of other alternative futures including those featuring the internal combustion engine or breakthrough electric vehicles. The additional cost of this new technology remains a significant factor, but will be reduced as initial investments are recovered and rising manufacturing volumes enable the economies of scale to be realised.

In the Advanced Engine Design and Performance session a paper by Ricardo's Adrian Greaney, Steve Whelan and Brian Cooper addresses the highly topical issue of meeting the challenge of light duty diesel emissions in the US market.

The most significant challenge facing the adoption of diesel engines is identified

as the need to achieve the very stringent requirements of the US Tier 2 fleet average emissions limits to be phased in over the next five years. At the same time, in order to maintain an attractive position in the market the diesel engine must maintain its CO₂ advantage over gasoline and continue to increase power density in order to meet consumer demands for high performance diesel vehicles.

The paper outlines a Ricardo approach known as *Advanced Combustion Technology for Improved engine Out NOx (ACTION)*, aimed at developing diesel engines to meet these criteria.

Based on the philosophy that emissions are best reduced at source, ACTION is being developed to apply to conventional diesels with minimum change cost, using a combination of advanced high pressure fuel injection equipment and enhanced air-handling systems.

In addition, Marco Fracchia, Peter Harman and David Kelly will be presenting a paper outlining their work on transmission development using Ricardo's GSQA (GearShift Quality Assessment) programme. GSQA is reviewed in detail on page 18 of this issue of RQ. ■

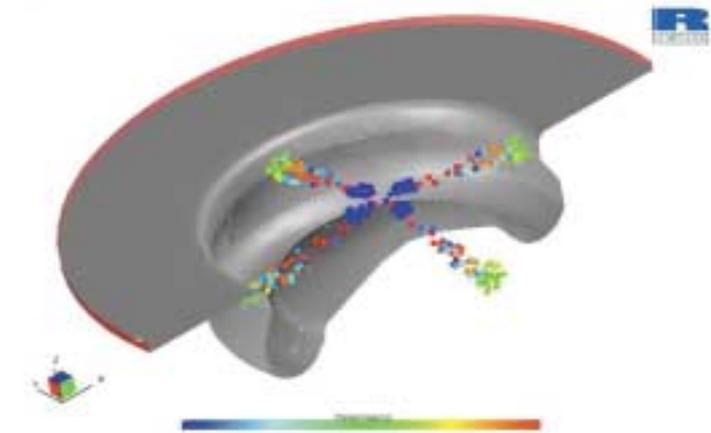
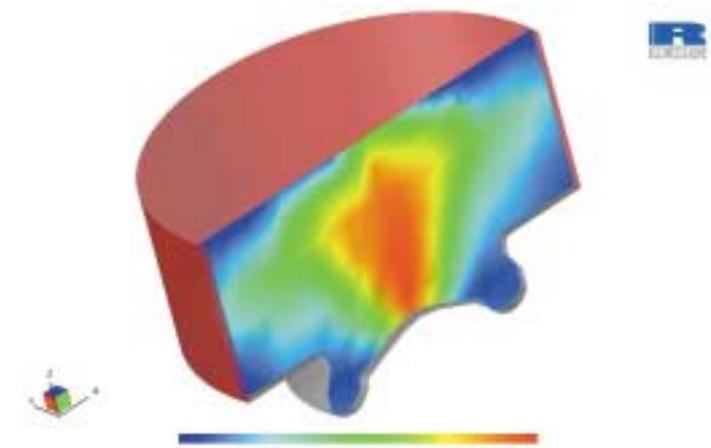
Ricardo Software hosts European conference

Ricardo Software is to hold its first European Users' Conference on November 5th 2003 at the PROTOtechnik-IFT-Ricardo site in Schwäbisch Gmünd (approximately 40km from Stuttgart). There will be no charge for the event. Intended both for existing and potential users, the technical focus of the conference will cover all of Ricardo Software's products, as well as providing an opportunity to discuss recent and planned developments with Ricardo Software's development and support teams. An informal reception will be held on the evening of November 4th for all delegates. For further details and to request registration please e-mail: RS_EUC@ricardo.com.

Chinese distributor appointed

Users of Ricardo Software products in China will benefit from improved training and support provision following the appointment of Beijing Jiu Zhou HiRain Technology Company Limited (HiRain) as distributor of the company's suite of analysis products in that country. Commenting on the move, Ricardo Software president, Dr Richard Johns, said: "the appointment of HiRain as Ricardo Software distributor in China will be of considerable benefit to our Chinese customers, enabling them to benefit from local language and time-zone communications."

Ricardo Software sales enquiries in China should now be directed to HiRain at Tel: +86-10-82011456, Fax: +86-10-62073600 or e-mail: ycji@hirain.com. Full contact address information is available at www.ricardo.com/contacts. ■



Ricardo VECTIS analysis of combustion (top) and spray structure (above) in a DI diesel engine

Seminar to focus on automotive particulates

Ricardo will host a technical seminar entitled *Particulates and particles from automotive sources* at the company's Shoreham, UK, facility on October 23, 2003.

Of potential interest to engineers, research scientists and managers from the OEMs, Tier 1 suppliers, oil and additive companies, industry groups and government agencies, the seminar will explore the emerging issues surrounding particulate emissions from all types of vehicle technology.

Four technical sessions will be presented. The first will cover current concerns and market drivers, including the current legislative frameworks applied to particulate emissions, an overview of engine and aftertreatment technology trends, and a review of health concerns related to automotive particulate emissions. The second session will focus on the methods used to obtain high quality test data.

This will include a review of current methodology for sampling and particle sizing, and the implications of measuring very low particulate mass levels. The recommendations of US EPA 2007 will also be discussed.

Session three will concentrate on the detail of particulate chemistry and the instrumentation and metrics used in particle sizing for both diesel and gasoline engines. The

final technical session will address engine, vehicle and other effects on fine particles. The results of published research work and Ricardo experience will be described in terms of the implications for particulate emissions of various engine types, fuels, lubricant additives aftertreatment technologies, and fuel injection systems.

A panel discussion will be held at the conclusion of the seminar. Informed largely by the presentations and Q&A of the preceding technical sessions, the panel discussion will aim to identify the gaps in the current knowledge of particulates, the most promising abatement technologies on the horizon, and the prospects for future legislation.

Overall it is hoped to discuss the future needs and direction of investment by the automotive industry in particulate emissions research and development of abatement technologies.

The participant registration fee for the seminar is £500 (exclusive of VAT and accommodation). To reserve a delegate place or to receive further information about the seminar, please contact the event organiser, Michelle Mairs (Tel +44 1273 794374 or e-mail seminarinfo@ricardo.com).

As used by Ricardo in the development of the LBDI[®] gasoline demonstrator – see pages 14-16.

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Following the acquisition of the PROTOtechnik-IFT group, Ricardo now has a team of over 300 in Germany Delivering full powertrain and vehicle integration programmes from a local base near Stuttgart.

The combined technical and programme delivery expertise of Ricardo and PROTOtechnik-IFT sets a new standard in Germany.

Nach der Übernahme von der PROTOtechnik-IFT-Gruppe hat nun Ricardo in Deutschland ein Team von über 300 Mitarbeitern, das von einem lokalen Standort bei Stuttgart ein komplettes Programm an Antriebsstrang und Fahrzeugeinbauten liefert. Durch die Kombination aus Knowhow im Bereich Technologie und Lieferprogramm von Ricardo und PROTOtechnik-IFT werden neue Maßstäbe in Deutschland gesetzt.

www.ricardo.com

