

Unstoppable!

How Ricardo helped turn
Hummer's military legend into a
mighty SUV for the civilian market



Interviews

Carlos Ghosn,
Nissan
Martin Leach,
Ford

Winter 2002/2003

Software

Version 5 expands
the WAVE envelope



Delphi diesel technology.
More responsive
to the driver.
More responsible
to the planet.

Delphi's EUI and EUP products are sophisticated, electronically controlled high-pressure systems that can help everyone breathe a little easier. By managing the precise timing and fuel quantity required for each cylinder, these intelligent injection systems provide immediate responsiveness for drivers while lowering emissions and helping improve fuel economy — for all of us. Let's work together to clear the air. Visit www.delphi.com.

DELPHI

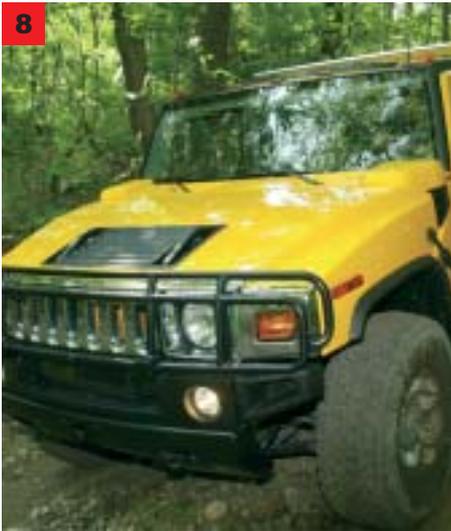
Driving Tomorrow's Technology

contents

Winter 2002/2003



16



8



14



6

NEWS

Industry update 4
Detroit Show: Cadillac's awesome V16; GM embraces hybrids for production; Ford celebrates centenary with sustainable hydrogen concept, and Ricardo chief executive Rodney Westhead salutes Hummer in his welcome message

News from Ricardo 20
Ricardo signs historic accord with Japan's Horiba; i-MoGen scoops key technology award; Detroit Technology Campus opens for business; Ricardo chairman Sir Noel Davies completes centenary London-Brighton run in 100-year-old car

FEATURES

Hummer H2 8
GM's first application of the legendary Hummer name for civilian use had to match the military icon's spectacular all-terrain ability and beat today's luxury SUVs for comfort too – all within a record 16-month timescale. GM turned to Ricardo for chassis, driveline and vehicle engineering expertise – and **Jeremy Burne** tells the story of a spectacular success

Software update 14
WAVE v5 is the most significant software development project ever carried out by Ricardo, making it the most comprehensive engine performance simulation package on offer. **Anthony Smith** reports

Transforming transmissions 18
The Ricardo transmissions business is poised for rapid expansion, with high-profile clients and an ever-stronger presence in top-level motorsport

QUESTIONS & ANSWERS

Nissan Motor Company: Carlos Ghosn 6
Architect of one of the most spectacular revivals ever witnessed in the auto business, Carlos Ghosn presides over what is now the world's most profitable volume carmaker. **Julian Rendell** asks Nissan's celebrated leader about the secrets of the turnaround, and what the future holds

Ford of Europe: Martin Leach 16
One-time development engineer Martin Leach has raced through the Ford ranks to become European president and CEO – and is now responsible for bringing 45 new models to market in five years. **Tony Lewin** asked him about the daunting challenges that lie ahead



Ricardo enquiries: UK: +44 (0) 1273 455611
USA: +1 (734) 397 6666
Germany: +49 (0) 711 806082-20
Czech Republic: +42 0296331150

Business development: busdev@ricardo.com
Head office: Ricardo plc, Bridge Works,
Shoreham-by-Sea, West Sussex
BN43 5FG, United Kingdom

Conceived and produced for Ricardo by TwoTone Media Ltd
Editor: Tony Lewin
Contributors: Julian Rendell, Jeremy Burne,
Lucienne Brown, Anthony Smith

TwoTone Media Ltd contacts:
Anthony Smith AVSmith@2tmedia.com
Tony Lewin tonylewin@2tmedia.com

● in brief

CAFÉ tightens on US light trucks

The White House has given the green light to long-awaited proposals for tighter light-truck fuel consumption standards in the US. Under the proposals, 2005 models would have to average 21.0 mpg, compared with the 20.1 which has been in force since 1996. 2006 models will have to achieve 21.6 mpg, and 2007 versions 22.2.

Driver-assist systems come closer

The European market for driver-assist systems such as night vision and intelligent cruise control will be worth 1.4 billion by 2010, according to Frost & Sullivan. Already, BMW has shown details of its ConnectedDrive plan, which includes online parking space reservation, programmed parking, active accelerator pedal and alertness monitor.

Fuel cell car struggles with cost and weight

GM's pioneering fuel cell vehicle, the Hy-Wire, is facing formidable cost and weight hurdles, according to GM vice president for R&D, Larry Burns. Quoted in *Automotive News Europe*, Burns said the model was still too heavy, at 1900kg. Nevertheless, GM still believes the 2010 volume build target to be feasible.

MINI scoops US award

The BMW-group MINI Cooper has been voted Car of the Year 2003 by a panel of American motoring journalists at the Detroit auto show. This is the first time a British car or a model from outside the US or Japan has taken the award.

France overhauls Germany

French auto plants have pulled ahead of German factories in productivity, according to McKinsey & Co. France's lead came as a result of greater in-house component production, said the report, though both nations still lagged Japan and the US in overall efficiency.

Detroit split on hybrids

New technology programmes at January's North American International Auto Show reveal sharply differing visions of how engine design will evolve in the near future.

General Motors, in a major change of strategy, has opted for gasoline-electric hybrids in a bid to improve fuel efficiency. President and CEO Rick Wagoner unveiled three hybrid powertrain families, raising the possibility of one million sales by 2007.

Ford threw a more speculative engine concept into the ring, with its supercharged, hydrogen-fuelled Model U seen, like GM's hybrids, as a bridge between today's piston-engined vehicles and the fuel cell models of the next decade.

DaimlerChrysler, for its part, declared its faith in the diesel engine as the most realistic and cost-effective route to reduced fuel consumption in the North American market. Launching the diesel version of the Jeep Liberty (Cherokee in Europe), Chrysler group CEO Dieter Zetsche said that the extra cost and weight of hybrids meant that they had not shown a strong, convincing business case.

Last year, Chrysler cancelled plans for a hybrid version of



Rick Wagoner announces GM's hybrid programme (above); Lexus Hybrid Synergy Drive is performance oriented (right)



the Dodge Durango light truck.

GM's Rick Wagoner also conceded that the extra cost of hybrids would be "several thousand dollars more than conventional vehicles". The three propulsion systems would, he said, help explore the market for the technology.

The first of the three systems to be offered will be an integrated starter-generator on large pickups from late 2003 for fleet customers and from 2004 for retail buyers. In 2005 the Saturn Vue will include the option of dual

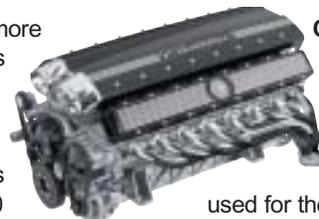
electric motor assist to boost its composite fuel efficiency by up to 50 per cent, while for smaller models from 2006 a single, belt-driven assist motor will combine with VTI transmission to reduce consumption by nearly 15 per cent.

Toyota, currently the world's leading producer of hybrid vehicles, revealed gasoline-electric versions of its new Highlander and Lexus RX300 luxury SUVs. The 4WD platform is already used by Toyota for its limited-run FCHV fuel cell vehicle.

Luxury boom sparks technology war

Not to be outdone by its European super-luxury competitors BMW Rolls-Royce and DaimlerChrysler Maybach boasting powerful twelve-cylinder engines, GM's prestige Cadillac division neatly combined company tradition with modern design when it unveiled the sleek Sixteen limousine concept powered by a V16 engine. Displacing a mammoth 13.6 litres, the aluminium engine is claimed to give 1000

horsepower, more than five times the power of its 1930s namesake. Peak torque is stated at 1000 lb.ft (1356 Nm), and GM claims the fully dressed motor, at 311kg, weighs less than the group's 8.1 litre V8. The giant unit is said to meet emissions requirements with ease. While pushrod actuation is



Cadillac V16: recalls firm's heritage

used for the two valves serving each cylinder, variable valve timing and cylinder deactivation help reduce fuel consumption under cruise conditions. GM says that the V16 would make close to 20 US mpg (11.3 lit/100km) in four-cylinder mode.

Ford U signals change

A supercharged four-cylinder ICE engine running on hydrogen may be the headline technical innovation on Ford's Model U concept, shown at the Detroit NAIAS show in January, but the model's importance extends well beyond this deliberate link with post-2010 fuel cell power.

Celebrating both Ford's 100th anniversary and the Model T that made the company world famous, the U Concept seeks to mimic the Model T's versatile, flexible approach, but with a 21st-century sustainability to the materials and processes used. The U's interior is fully reconfigurable, allowing different seating and equipment patterns, and permitting regular upgrades as the vehicle goes through its life, or perhaps changes its use; the materials employed advance a new 'cradle to cradle' approach to sustainability and do not move down the value chain when recycled.

Ford claims to have solved the age-old problem of inadequate power from gasoline engines fed on hydrogen. Using a centrifugal supercharger and a two stage intercooler, the 2.3 litre I-4 engine gives 118 horsepower



at 4500 rev/min; this is allied to the 25kW of the modular hybrid transmission system's assist motor to give a consumption of 45 miles (72km) per kilogram of hydrogen – which Ford claims is equivalent to 45 US mpg (5.0 lit/100km). The hydrogen tank can store 7kg of fuel at up to 10,000 psi (690 bar) and, says Ford, the powertrain's efficiency is 25 per cent greater than that of a gasoline model. CO₂ emissions are cut by 99 per cent, giving compliance with PZEV standards.

Unusually, the second-stage induction intercooling uses the vehicle's air conditioning system to dissipate heat. Also innovative are the wireless

gear shifter – it can be placed in a variety of locations, though the pedals are fixed – and the conversational speech interface, which allows full-vocabulary natural (rather than scripted) voice control of on-board systems.

Safety systems include pre-crash sensing, while adaptive lighting, active near-infrared diode laser night vision and cameras mounted in the side mirrors improve hazard perception for the driver under adverse conditions.

The fruit of high-level collaboration with 19 suppliers, the Model U's technologies are deliberately forward-looking and radical. The vehicle is suitable for mass production, says Ford.



A message from the Chief Executive

The Hummer brand has developed something of an iconic status throughout North America in the past decade, with the first civilian derivative, the 1992 Hummer H1, becoming both a favourite of the most extreme off-road enthusiasts and a 'must have' fashion accessory of the super-rich. In the latter part of 1999 Ricardo was approached by GM to assist in taking this brand forward into potentially much larger markets through a completely new and more compact vehicle: the Hummer H2. While many will be familiar with the H2, only those close to the programme will be aware of the scale of its achievement: a completely new, segment-defining vehicle developed in only 16 months. As ever, we are grateful to GM for granting its permission to bring this story to readers of RQ.

World Engine adds US production site

Chrysler Group president and CEO Dieter Zetsche described as "a true melting pot of cultures" the DCX group's plan to add a US production facility to its Global Engine Alliance programme.

Speaking at the Los Angeles Auto Show, Zetsche said that the plant would be co-managed by executives from all three of the participating companies – Mitsubishi Motors Corporation, Hyundai Motor Company and, in the lead, the Chrysler Group.

The family of fuel and

emissions-efficient four cylinder aluminium engines are claimed to be state of the art in their design. Annual output across the three facilities in Korea, Japan and the US will be in excess of 1.5 million, making the Word Engine potentially the highest volume unit in production.

A decision on the US plant's location has yet to be taken, but the facility is set to begin production in 2005. Hyundai's Korean plant will be the first on stream in 2004.



One of the most outrageous concepts shown at Detroit was Dodge's Tomahawk, described as a "four-wheel, single passenger vehicle; a rolling sculpture." Power comes from the Viper's 500 horsepower, 8-litre V10

'Le cost-cutter' delivers

Carlos Ghosn surprised analysts with his bold 1999 Revival Strategy for Nissan after Renault took control earlier the same year. Still more were amazed when Nissan achieved its ambitious targets a year ahead of schedule. Today, Ghosn's Nissan enjoys the highest margins of any volume carmaker and is poised for profitable growth in partnership with Renault. **Julian Rendell** spoke to the Nissan CEO as the first new-generation Micras rolled off the Sunderland production line.

How would you describe the new Nissan created under your leadership?

It's a company with Japanese essence, but opening up and embracing global management practices. It will be the most global Japanese company. Not in terms of the style of its cars, but in its management.

Nissan's total production is close to Honda's and growing. When will you overtake Honda?

It's not our objective. We never put our objective to be number one, two or three. Our objective is to be one of the most profitable car companies ever. Ranking is a consequence of this. If you start putting size as an objective, you start making the wrong decisions.

What objectives do you have?

Instead, we have some quality objectives. Such as being in the top three for quality. And profitability targets. We are very happy to have the second largest market capitalisation in the car industry after Toyota. Three years ago we were at about number ten. It means there now is a lot of shareholder trust.

If Nissan is gaining market share, is this through aggressive sales practices?

Our market share is going up in our main markets. But we are not getting it by putting [out] the best deals in town. We are getting it by putting out some attractive products.

Nissan's operating margin is 10.6 per cent,

one of the highest in the industry. When you became CEO three years ago, did you expect to achieve this so soon?

Since 1999 you can see in all my statements I have always said the potential is huge; I've never been shy about it. And the fact that it is 10.6 per cent is very refreshing. But what is more promising is that I think there is a lot more potential.

Where will future growth come from?

Certainly the US. Our product offensive hasn't really started there. You're going to have the G35 coupe, the Infiniti FX45 and Murano crossovers, and the Maxima sedan. The Maxima is part of the bread and butter of Nissan. Then there's the new Quest minivan. Now we are not participating in the minivan segment in the US, worth 1.1m cars.

So what does this mean for profitability?

All these cars are not entry-level models. I'm talking about segments of the market that are very profitable. But how much operating margin we will reach? I don't know. Our commitment was to be at the top level of profitability. And we are there now. What happens next? It depends on the economic environment, obviously. But with Nissan 180 [stage two of Ghosn's restructuring plan] we will be up there.

How is the progress with Nissan 180?

Very good. We have the dynamic and the momentum from the Revival Plan [Ghosn's initial restructuring plan]. When I first talked about 180, it was May 2001. At that moment [the] operating profit of the company was 4.7 per cent. Announcing an 8 per cent operating margin was bold.

Maybe you should change the 180 plan to take account of your success?

On the contrary, when I showed our financial results to the analysts at the end of October, some of them asked: 'Don't you think you're going too fast.' I

say you can't change it. If you announce a plan, you have to stick with it.

The car industry is one of the most regulated in the world. What are the next big legislative challenges?

I think it depends on the country. It will be very different between Europe, the US, Japan and China. But I think the most difficult and challenging is going to be about the environment.

How ready are you for this next step?

It's not something that shocks us. But you want to make sure that the regulation on the environment is effective. When I say effective, I mean addressing the real issue. For example, from time to time there is a confusion between the technology and the consequence.

Can you explain that?

We should be specific about the consequence on the environment and not just specify the technology. I don't know if the electric car or the hybrid car or whatever is the answer. I need to know exactly what kind of emissions are allowed and then I can select my technology. But I don't want the regulator to tell me what sort of technology I should use. The regulator doesn't know the technology. It is a tool, not an objective. The public doesn't care about the technology; the public cares about the consequences.

Which direction do you think legislators will go?

Frankly, one of the challenges we face is [that] there's a lot of confusion between the consequences and the technology. What is [the level of] CO₂ emissions that is acceptable? What is the fuel efficiency? What NO_x will be acceptable? And in terms of regulation, there are going to be a lot of debates about this.

You have worked at both Renault and Nissan. How would you rate the potential of Nissan compared to Renault?

Renault has a lot of potential, too. But the





Carlos Ghosn

- 1976 Graduated from Ecole Polytechnique, Paris
- 1978 Graduated from Ecole des Mines, Paris; joined Michelin
- 1989 President and CEO, Michelin North America
- 1996 Joined Renault as executive vice president
- 1999 Joined Nissan as chief operating officer
- 2000 President of Nissan
- 2001 President and CEO, Nissan
- 2002 Appointed to Renault board; vice-president of Renault-Nissan Alliance board

assembling. This is no secret. What is important is to have a proper debate. Put all the stakes on the table. Anyway this is a decision that is going to be taken by the UK people. The government has been very clear about that. So whatever the UK people decide, they carry the consequences.

What are your hopes for Nissan's sales in Europe next year?

Hopefully next year we will have our highest volume of sales ever. Our previous highest was 550,000. We should beat that. And the new Micra will be an important part of that. We are replacing a car that is ten years old.

Are you worried about a possible slowdown in the US market next year?

I am not worried because I'm expecting it and it is already part of our plan. Anything between 16m and 16.5m cars is expected and would be OK. Now, below 16m everybody is going to suffer, but I'm not seeing any sign of that. For the last four years, since I've been at this company, everybody has been pessimistic about the US. And each year the US becomes stronger than the year before.

Do you think Nissan's 15 per cent cross-holding in Renault ought to change?

Fundamentally, I believe that if you want to create value, you have to respect identity. I think nothing should be done, one way or another. I think a full merger will destroy value. And frankly, when I look around at full mergers, I don't see much competition with this statement. Look at the shareholder value we have created compared to mergers.

Do you feel the pressure of masterminding one of the car industry's greatest-ever turnarounds?

Obviously I always feel the pressure. But it's not outside pressure, it's inside opportunity. We have the team, the leadership to go for it. And we're going for it.

Julian Rendell is a senior car industry writer

point is that I don't think Renault has ever been mismanaged as Nissan was.

You have installed capacity for 500,000 units at Sunderland. When will you reach that figure?

When we need it. With the Micra, Almera and Primera we have planned 360,000 to 370,000 units. So we negotiated with the unions to have the possibility to have the organisation approved by them in order to have the 500,000. Essentially we can move from two to three shifts.

Sunderland would need another product or derivative to reach 500,000. Is that going to happen?

We don't talk that way. The plant is here to serve the product; not the other way around. So if we have a product we will do it. But we're not going to fill Sunderland just to get to

500,000. The 500,000 capacity is much more a flexibility, an opportunity not an obligation.

What is the next big decision at Sunderland?

That will be the investment for the next Almera. We will make a decision this summer.

How will you decide?

Obviously the issue of the Euro is very important. Although we invested in the Micra in Sunderland, we switched most of our parts purchasing to the Euro. We used to buy 20 per cent of our parts in the Euro. Now we buy 70 per cent. In some cases that meant sourcing on the Continent, but some UK-based companies agreed to accept payment in Euros.

So what is the long-term implication of Britain staying out of the Euro?

It is not just our parts purchasing, but also

The tough get going

The only thing tougher than the Hummer H2 was its design brief. GM's first application of the legendary Hummer name for mainstream use had to match the extreme rock-crawling, river-wading indestructibility of the military icon, yet provide the on-highway luxury expected by affluent SUV customers – all from a clean sheet of paper, and in a record 16 months.

Jeremy Burne recounts how GM chose Ricardo as a pivotal partner in this mighty success

Vehicle manufacturers are on a constant quest to maintain competitiveness.

Among the associated challenges are how to leverage brand identity, and how to design and develop new “must-have” products and bring them to market quicker. Equally vital is to know how to make best use of resources and how to leverage supplier capabilities.

The Hummer H2 is a vehicle that has taken on all these challenges. Of course, it took some unconventional approaches to make it happen, but the end result is a vehicle that, even though it is still young, is already being credited as a huge success for General Motors. A team of engineers from Ricardo became central to the project at an early stage, and shared in the experience of helping GM achieve some significant industry firsts as this programme was brought to fruition.

The genesis of the H2 lies firmly in the Hummer brand identity, and in General Motors' recognition that the brand could be developed into the next-generation military spin-off for enthusiastic off-roading consumers. The Hummer brand belonged to AM General, a contractor with a long history of building military vehicles,

including the High Mobility Multi-Purpose Wheeled Vehicle (HMMWV) commonly known as the “Humvee”. This vehicle spawned the consumer version Hummer (now known as the H1) in 1992 – a favourite for hard-core off-roaders that was glamorised by celebrities such as Arnold Schwarzenegger.

It seemed a good idea to GM's product planners to try to develop a less intimidatingly vast – and thus more practical – model that married Hummer ruggedness and off-road authenticity with the comfort and utility of today's ubiquitous sport utility vehicles. After all, DaimlerChrysler had successfully co-opted the military heritage of the Jeep into a modern brand icon, so why shouldn't the same possibilities exist with the Hummer brand?

GM quickly saw a market niche and initiated negotiations with AM General. At first GM wanted to license the brand only, but AM General had determined that it would like to expand its manufacturing business. A memorandum of understanding was signed in June 1999, and a final agreement between the two companies was reached six months later. GM would design what was to become the H2, while AM General would manufacture it on GM's behalf on a fee basis.

In many ways, that was the easy part. The

Vehicle performance

- Best-in-class off-road performance
- Climbs 16-inch (400mm) vertical wall
- Fords 20-inch (500mm) river
- Scales 60 per cent slope
- Traverses 40 per cent slope
- Seats 6/7
- Range 567km
- No direct competitor

principals at GM and AM General had set themselves some tough challenges that would need to be overcome in bringing their shared vision to reality. These were some of the absolute essentials in the H2 equation:

● **Brand integrity:** it was paramount that the H2 embody the rugged mobility of the Hummer brand. It needed to excel in the most extreme off-road conditions. It would have to prove to the automotive media and consumers that the H2 was not just a badge-engineered sports utility. The HMMWV gained massive exposure from the Gulf War – the H2's military ancestry is the basis for its brand heritage.

● **Driveability:** The H2 needed to be a comfortable and pleasant drive on the highway and around town.

introducing a barrage of “must-have” new products with innovative design, of which the H2 was one of the first tantalizing offerings. Bringing in Bob Lutz as vice chairman underscored the company's desire to fulfill this promise. GM's reputation was at stake.

● **Speed to market:** GM had wanted to reduce its vehicle development programme times from 48 to 24 months. The H2 was to go even further – 16 months from design freeze to “Start of System Fill” – when production parts first arrive at the plant. This was unprecedented for a GM vehicle.

● **Leveraging resources:** GM needed to leverage both outside suppliers and existing truck platforms to reduce the cost base and to meet the demanding schedule of deadlines.

Tackling these challenges head-on was further complicated by the lack of internal resources that faced both GM and AM General. Neither company could contribute sufficient staff to complete the project internally, so it was imperative that outside expertise be brought in to become part of the team and move the process along.

It rapidly became clear that the only way to achieve the objectives

● **Manufacturing:** Production of the H2 would necessitate a brand new greenfield manufacturing plant dedicated to the product, with an all-new workforce.

● **Marketability:** it needed some rugged sex appeal to reach its intended customer base. GM could not afford the exterior design to be anything but totally authentic. Furthermore, GM had been promoting an aggressive strategy of

was through a dedicated team of professionals from all disciplines, drawn from GM, AM General and suppliers. The whole team needed to share the vision, share the work and share the urgency that was required to meet these challenges.

Jumping in at the deep end

While there were many who contributed to the successful H2 programme, every team requires a leader.

When you have multiple teams, you need a diplomatic leader. GM appointed Bill Knapp, a long-time GM employee with a

Programme performance

- 16 month programme from styling freeze to Job 1. Usual GM process is 36 to 48 months
- Unique programme processes and rapid tasking through existing GM IT and component release systems.
- Brand new truck in a new brand portfolio for GM
- Ricardo engineering team assembled within two months from the UK and US
- Ricardo team did all chassis and powertrain engineering, design, analysis, validation sign-off
- Set performance requirements suitable for broad ability spectrum of the truck
- Full portfolio of corporate & federal testing and validation
- Addressed all resulting engineering requirements in less than 12 months
- Testing of mule vehicles in mountains and deserts
- Located suppliers who could react to timing and integration performance requirements
- Production launch engineering and production support

career's worth of experience in trucks, and made him programme engineering manager for the H2. He recalls getting the offer to take on the task: “I was approached by the boss who asked me ‘would you like to be the leader of this project – oh – and other than [the fact that] it's going to be a new Hummer – you are on your own!’

“That's quite some challenge,” remarks Knapp. “It's got to be a Hummer, look like a Hummer and act like a Hummer – oh, and by the way we want you to do it faster than any other programme we have ever done at GM! Not only that, but you have to work with a partner, AM General, with whom we've never worked before, *and* we are going to build a brand new plant in a greenfield somewhere!

“So I said, ‘sure – I'll give it a shot!’ It is a once-in-a-lifetime opportunity for anyone in the automotive industry to work with a greenfield plant, an exciting new brand, and a brand new product. You can either walk away and think it would drive you crazy or you can take it on and see what you can do.

“The first thing we had to do was nail down exactly what we wanted this product to be,” continues Knapp. “I did not have a background in off-road vehicles. From a technical perspective I had to do some learning on my

own as to what it means to build an off-road vehicle. You have a wide range of what people think off-roading is, from a dirt two-track cottage lane to some of the most extreme trails that we put this vehicle through during the development process.”

Bill Knapp and his small team of GM colleagues assigned to the programme set up office in Pontiac. There they began the first key process of finding the partners needed to provide the manpower and engineering expertise for the project.

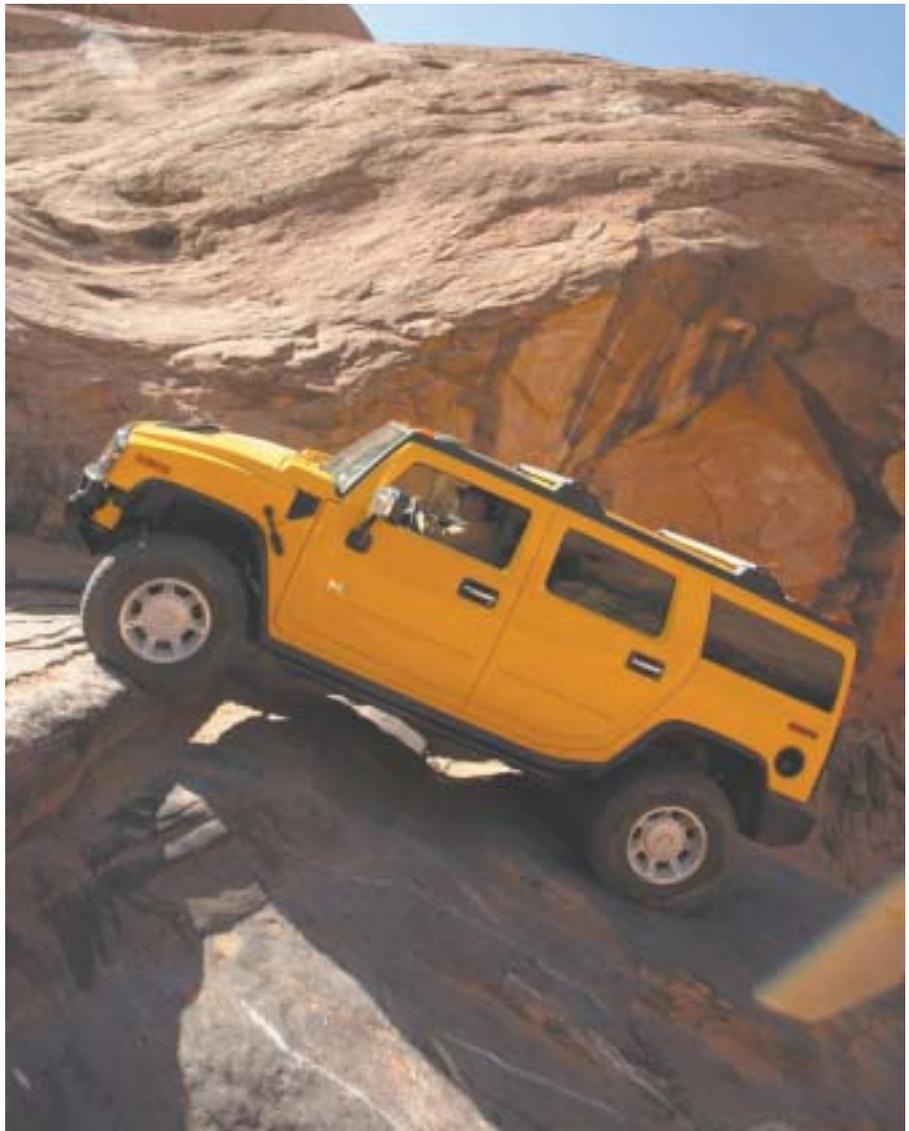
“This programme was put together really fast – when you go back in time from a GM resource perspective this was a project created in a hurry. When we looked around we had a lot of other things going on at the time: from the truck business side of it we had the GMT-800 product still in the development stage and we were just one year into the GMT 360 line – so from a resource and technical perspective we were tapped out.

“We didn’t have the design-release engineers, we didn’t have the development engineers to pull this project off.”

Building the H2 team

“At the time [autumn/winter 1999],” remembers Knapp, “we only had a half dozen technical people we could assign to it – and that’s where the second part of the marriage came into it with Ricardo and EDAG. The target was set in December ‘99 – we wanted a vehicle in production by the first quarter of 2002. So I took as much liberty as I could and set a start of production date as March 29, 2002.

“That meant we had two years to gather up a team, design and develop a vehicle, and support the building of a greenfield plant, while



Beyond traction control: the H2’s seven clever transmission modes

Electronic management of the H2’s four wheel drive transmission, its transfer gearbox, engine throttle control and ABS braking system allow exceptional on and off-highway performance, even under extreme conditions.

The system’s intelligence allows it to distinguish between different types of surface to select the appropriate parameters for the drive and braking system, while five driver-selected transmission modes cater for everything from highway driving to deep mud and sand or climbing over logs and boulders. Selecting low ratio puts the engine’s drive-by-wire throttle onto a different map, with a deliberately more gradual response to the pedal. There is even a special throttle response setting designed to optimise towing performance, while an additional traction control mode, TC2, allows what experienced off-road drivers already know – that a certain degree of deliberate wheelspin is useful in getting through loose or deformable surfaces such as sand.

Driving conditions	Mode	What the system does
Street and highway, moderate off-road	4HI	Permanent four wheel drive, high ratio
On and off-road, snow, sand, wet surfaces	4HI-LOCKED	For semi-slippery areas, eg boat launch ramp. Locks front and rear outputs at same speed
Severe off-road use; negotiating logs, rocks	4LO-LOCKED	Low-ratio crawler gear for tricky conditions; more torque, more measured throttle response curve; maximum power to all four wheels
Deep sand or mud	4LO-LOCKED+TC2	TC2 traction control map allows extra wheelspin to drive through loose surfaces
Off-road, long, steep grades, rocks	4LO-LOCKED+ REAR DIFF LOCKED	Optimises rear traction for optimum slow-speed climbing performance over tricky obstacles
Deep sand or mud	4LO-LOCKED+ REAR DIFF LOCKED+TC2	As above, but with additional tractive effort for loose surfaces
When H2 is being towed	NEUTRAL	Allows H2 to be towed with all four wheels on the road



“From a GM perspective there was never a project that was developed, designed, released and brought to fruition as quickly as this – Bill Knapp, GM

working with an outside source that we'd never worked with before – not only the design engineers but AM General: we had never worked with them before, either. They were in the same boat in that they had hired a whole new workforce too.

“I had experience with many of the companies who bid for the project, such as Magna, MSX, Hawtal-Whiting. I had experience with everyone except EDAG and Ricardo,” continues Knapp. “I had heard of Ricardo but had never personally worked with them in the past. So I did what anyone would do when they put their career on hold for three years – I made a few phone calls. I called some people I know in GM Europe and some people in the Detroit area, and discovered Ricardo had been doing work in the engine side of the business with GM but not so much in the chassis end of it. All I got was positive feedback, so within a week we made the decision that this was the team to go with.”

With an engineering group manager and a multi-disciplinary team of chassis, powertrain and CAE engineers drawn from three separate Ricardo offices, the Ricardo team was charged with designing and integrating all of the chassis and powertrain systems, including the completely new front and rear axles, transfer case and driveline, traction control system, suspensions, chassis frame, induction, exhaust and fuel systems.

The decision to appoint the Ricardo team was clearly one that Knapp does not regret.

“From a GM perspective there was never a project that was developed, designed, released and brought to fruition as quickly as this project – and that's a first for General Motors.”

The United Nations of H2

GM's choices for partners led to an international team of dedicated engineers that became jokingly known as the “United Nations”. The team was comprised of Americans, Germans, British, Irish, Czechs, Polish and Japanese. Ricardo sent in Tom Reedy, its engineering group manager for GM, to team up with Bill Knapp – and AM General's director of engineering, John Smreker, was busy with building the new plant and the manufacturing engineering issues. He

remembers the challenge of working with people from such a variety of countries:

“It was almost comical at times – the Japanese guys trying to speak to the Hungarian guys in English: sometimes it got a little weird. Many of the people hadn't worked in the GM system before and the idea was for Tom Reedy and his colleagues at Ricardo to come in and function as GM engineers. The product was released into the GM engineering system, they created the bill of materials, GM found and contracted all the suppliers and then the parts were sent on consignment to AM General – we would build the vehicle and then send it back to them. We never took ownership of the parts, which all belonged to GM. So the only function AM General were providing at this point was the vehicle assembly. We had to train all these people from diverse backgrounds to work in the GM system and to perform all the GM quality checks, engineering and management functions. And of course on the AM General side we didn't know anything about those processes either!”

Bill Knapp also recalls the early days in the programme: “The main struggle during the first four to five months was to find a common language and culture. In the early days I had people speaking Japanese in one corner, German in another corner and the English guys in another corner and sometimes I didn't understand any of them! The positive that came out was that we got back to basics – we started calling things what people really call them, we didn't start making acronyms – we called a fender a fender, not an outer body panel. Basic language.”

To gain early hands-on experience of the demands that would be placed on the vehicle, the team of engineers from GM, Ricardo and AM General decided to do some testing. Taking a small fleet of Hummer H1s and a range of North American trucks, the team went off-roading in Kentucky. John Smreker recalls the immediate impressions after testing:

“At the end of the day, all the H1s were parked in one area and the regular trucks in another. The AM General technicians simply got out the garden hose to wash off the H1s to get back on the road and drive back. Meanwhile the GM technicians were beating

fenders out of wheel wells and trying to make doors open again and so forth. We had a wrap-up meeting to discuss what we had learned and to determine the key product characteristics that had to be carried over into the H2. The H1s had been off-road all day and they were ready to go home after a good wash – nothing else required. That's where we wanted the H2 to be. As an H2 customer you should be able to go out and do whatever you want to do all day long and the only thing you need to do to get ready to drive home or to church is wash the truck. And so that was always kind of a focus for the performance of the vehicle.”

Process violations permitted!

Bill Knapp knew early on that in order to bring this programme to fruition, it would mean breaking a few rules. “I told Bob Lutz that to get this done I would probably end up in GM jail because I was breaking every process rule in GM that's documented. He laughed and said if you can pull this off, that's the kind of people I want working here. So he took his business card and signed on the back “Process Violation Permit – Bob Lutz” and he told me ‘anytime anyone gives you a hard time about breaking a rule on the project, you have them give me a call and we'll talk about it.’ Fortunately I didn't have to use this card for anything, because I was given the green light to do whatever it took to get this project done.”

John Smreker and the team not only had to learn the GM system, but how to get around it. “GM has various vehicle-building templates. When we got there they had typically done a 48-month programme. They were executing some 24-month programmes that were not completed yet, so they didn't know if that was

Hummer H2 and H1 compared

	Hummer H2	Hummer H1
Engine	V8 gasoline	V8 turbo diesel
Horsepower @ rpm	316 @ 5200	195 @ 3400
Torque @ rpm	488 Nm@ 4000	583 Nm@1800
Length	4821mm	4674mm
Wheelbase	3119mm	3302mm
Width	2062mm	2197mm
Vertical wall climb	406mm	559mm
Wading depth	500mm	750mm
Incline climb angle	60%	60%
Incline traverse angle	40%	40%
Approach angle	40.8 deg	72.0 deg
Departure angle	41.8 deg	37.7 deg
Breakover angle	27.5 deg	35.0 deg
Ground clearance	272mm	406mm
Fuel tank	32 US gal	25+17 US gal
Kerb weight	2909 kg	3252 kg
Trailer weight	3182 kg	2955 kg
Price from	\$49,190	\$117,500

Source: Hummer, GM.
H2 figures include optional air suspension;
H1 figures are for wagon version

Rocker tubes to support the whole vehicle weight

A key part of the H2's chassis is its rocker protection, essential for extreme off-road applications. Ricardo was challenged to find the optimum configuration for the rocker tubes:

Knapp: "On the chassis we knew that the rocker panels on our trucks got damaged in extreme use from pivoting around rocks, and needed to be strengthened. We had about three or four iterations of the tubes along the side of the truck."

Smreker: "There are two tubes that are mounted into the frame very securely – we tried it on the body, and the body is itself extremely robust; we tried various configurations and it turned out it needed to be mounted on the frame. We went through a number of iterations to make it strong enough to survive."

Reedy: "The rocker protection is unusually strong. It's really part of an extreme off-road protection package for the truck, which not only protects the chassis frame and the driveline components but also the bodywork, since it sticks out either side of the chassis frame. It took a phenomenal amount of design resource. It may be just a tube, but it's a phenomenally strong tube."

We used a significant amount of design analysis to model this as a structural system as part of the chassis frame. You can actually jack the truck up off the ground at any point along this rocker bar without the bar deforming or bending. You can hinge the truck around rocks and boulders by skidding the rocker tube along rocks and boulders – and that's what it's there for."



Structural analysis was used to design rocker tubes strong enough to support the whole vehicle weight without damage



"The H1s had been off-road all day and they were ready to go home after a good wash. That's where we wanted the H2 to be."

**– John Smreker,
AM General**

really going to work. They had a template for 18 and they wanted us to do the 18.

"We found out later if you read the assumptions that it says 'Thou shalt never build a new plant on a 24-month schedule.' Well, we went to the 18-month schedule and built a new plant with a new workforce, so we were even more aggressive than that. And then one day the design manager at GM said he had been doing a little arithmetic and that this 18-month programme is actually a 16-month programme when you go back and start counting."

"I was the only on-site AM General person at Pontiac so I would get all the calls. My task there was to look after the design of the vehicle – and to participate as a consultant on the manufacturing issues. But early on I spent a lot of time just trying to unravel the GM system for our guys back in South Bend. It was kind of like reading a mystery novel."

"Bill Knapp knows the GM systems inside out; he wrote some of the procedures. But for a lot of us this was the first experience, so we would be bouncing along thinking we were in pretty good shape and then Bill Knapp would come along and ask if we were prepared for a 'Quality Valve' meeting next week. 'What's the Quality Valve, Bill?' It's actually a meeting where you decide whether or not to go forward with the project. GM does that on all its projects. So we'd have to scurry off and figure out what that was and what we had to do to prepare for it. Then we'd get by that hurdle and it would be "How many guys do you want for your FE event? Then we would have to go off and learn about that!"

Chassis design

Getting through the GM system was, of course, only one of the hurdles. The engineering team had to meet the significant chassis design challenge. Bill Knapp and the team from AM General and Ricardo started to look at what parts from existing platforms could be utilised in the H2, and what needed to be developed from scratch. While the H2 was a "clean sheet" design, it made commercial sense to integrate existing parts from GM's family of trucks where possible – this would help reduce development time and costs. However, while there were

many components on the H2 that were already proven in GM vehicles, most required some form of modification.

"The first critical step was rough packaging. The first rule in building an off-road car is you get the biggest tyres you can, then get even bigger ones, and essentially we started out from a ground-up philosophy. Then we started on the chassis, which is where Ricardo comes in, while the designers set to making it look like a Hummer." Tom Reedy knew that Ricardo would have a significant technical challenge in engineering and integrating the complex GM Class II controlled chassis and powertrain systems, given the H2's performance targets: "The H2 is coming into the marketplace with some unique selling points which give it what I would describe as a new, previously unexplored market niche. These are that it's a very broadly capable SUV because it performs like a Cadillac Escalade on the freeway – drives very smoothly, very competently and handles beautifully around city roads and in traffic – while off-road it is enormously competent. We engineered the H2 to perform well on Class I to Class V trails in the US. This typically spans a sand-gravel desert track where you can exceed speeds of 85mph over bumps, potholes and washboard features – to a two-day rocker-bar-grinding crawl over the 8.5 mile Rubicon Trail with huge boulders, 100 per cent grades, desperate side slopes, eighteen inch multiple steps and deep holes. Our first Rubicon and Moab test trucks had the



standard H2 9000 pound winches fitted and we never needed to use them.”

To achieve that mix of performance in a vehicle means that you have to consider and integrate particular technologies in the chassis and drivetrain system which may not be on a vehicle that, for instance, is more highway-biased, such as a Toyota Sequoia, Range Rover, Ford Explorer or Lincoln Navigator.

“The mule vehicles, the first ones we ever built, started off with orthodox truck suspension but we rapidly found that we needed to do some tuning work,” says Reedy. “So we used ADAMS analysis.”

ADAMS is a tool Ricardo uses to model chassis and powertrain mounting systems to determine compliance, loading and modal performance. It enables engineers to optimise powertrain mountings for refinement and structural performance and tweak suspension systems for vehicle dynamics.

Tom Reedy and his team from Ricardo set up a full-vehicle ADAMS model – starting with front and rear suspension models, which were eventually joined together as a complete vehicle system. Ricardo did a significant amount of ADAMS work to design the geometry of the suspension, which was completely re-thought at the rear and tweaked at the front.

“Of all the design analysis work we did early on, probably about 70 per cent of our time and effort went into designing the chassis frame – and wherever possible we strove to lead the design with the analysis. For example, we would look at a basic package layout of a bracket and its requirement for performance stiffness and mobility, we’d analyse it, we’d look at the weak points on that bracket and we’d redesign it and start committing to soft tools, then go off to test the vehicle with the soft tool part on it. Because we led the design with analysis and because we had defined what the truck had to do from the start, we could get a lot of things right first time.

“We took some of the very expensive parts from the GMT-800, where it made sense from a performance point of view, and used them on the H2. That’s basically the hydroformings, the bent parts of the chassis. We built the rest of the frame around those hydroformings. We made the frame extremely stiff so that the suspension can be tuned to the ultimate performance without worrying about the frame moving around. That’s crucial for both on-road refinement and off-road performance and mobility.” Some of the more intricate chassis challenges were the chassis and underbody protection shields, rocker bars and general off-road protection.



Full articulation: suspension design for extremes

The suspension system presented several engineering challenges. To achieve optimum integration of the axle Ricardo did a significant amount of advanced ADAMS pre-analysis work. Ricardo specialists analysed the elastic and kinematic performance of the suspension, changed all the bush rates and all the jounce (bump stop) and rebound stop rates, and made the brackets as stiff as possible. They also had to accommodate an air suspension option.

John Smreker: “One of the hallmarks of the Hummer is that it’s ‘overbuilt’ and



offers extreme cargo-carrying capacity. So a decision was made relatively early on to make this about an 8600lb (3900kg) GVW truck.

Tom Reedy: “The decision to use the five-link suspension in the 2500 configuration was made in advance. But the rear-beam axle was a fundamental clean sheet redesign that we did from scratch – all we had was the ring and pinion to start with – it’s a brand new rear axle. We also then took the existing links and fundamentally re-engineered the geometry of the rear axle – where the links mount on to the axle, where they mount onto the chassis frame, the angle of inclination, to give us this full articulation ability on the axle.”



“It’s a very broadly capable SUV because it performs like a Cadillac Escalade on the freeway – handles beautifully around city roads and in traffic – while off-road it is enormously competent.”

– Tom Reedy, Ricardo

The H2 delivers

In the end, the team from GM, AM General, EDAG and Ricardo is rightfully proud of its accomplishments. The H2 has been well received by the media and consumers alike, and looks set to meet all expectations.

For Ricardo Vehicle Engineering managing director Dr Clive Hickman, the Hummer H2 programme was a key success, not only on a technical level but also in terms of rapid-response integration with a major customer’s systems and procedures. “The Ricardo engineering team was assembled within two months from the US and the UK to work within the GM system to deliver this new product,” says Hickman. “The targets were immensely tough in what was an exceptionally wide-ranging challenge, perhaps, but one which Ricardo, with its extensive vehicle engineering

programme experience, was confident to take on board.”

Bill Knapp also credits this highly flexible and integrated approach as a success factor. “One of the good things was that Ricardo was extremely responsive to the need for people. If we got to a pinch point in the programme where somebody was overloaded, they were very good at bringing someone in to get the programme back on track.

“Ricardo provided a great team of engineers, they worked extremely hard and they had a great attitude.

“As the manager of the programme,” added Knapp, “I found that extremely helpful to me and it’s one of the things I learned that I took back to GM – that if you can bring people in and out in a timely manner as needed, you can really move things along.”

The new WAVE

It's approaching midday on November 20th and about 40 Ricardo CAE staff at Shoreham are awaiting the start of an internal briefing by Ricardo Software. The timing represents a compromise between the working day needs of Greenwich Mean, US Eastern Standard and Central European Time zones as the presentation is being simultaneously webcast over a secure internet link to Ricardo technical centres throughout Europe and North America. The subject of the briefing and the reason for this level of interest is the latest – and potentially the most significant ever – release of Ricardo's market-leading WAVE engine performance simulation package.

Ricardo Software President Dr. Richard Johns introduces the briefing by announcing that WAVE v5 has been the largest software

development project ever undertaken by Ricardo and that the new product will be released to customers on November 26. Achieved in the space of only 18 months, this development has been a tightly co-ordinated effort by a team of 25 multi-skilled software engineers based at the Chicago, Shoreham and Prague technical centres. The result has been the most significant root and branch development of the product since its first launch in the late 1980s.

Anthony Smith attended an internal company briefing on the new product and afterwards, spoke with Ricardo Software President, Dr. Richard Johns, about WAVE v5 and his plans for future development

development project ever undertaken by Ricardo and that the new product will be released to customers on November 26. Achieved in the space of only 18 months, this development has been a tightly co-ordinated effort by a team of 25 multi-skilled software engineers based at the Chicago, Shoreham and Prague technical centres. The result has been the most significant root and branch development of the product since its first launch in the late 1980s.

Co-ordinated roll-out

The launch of WAVE v5 is being supported by a programme of user seminars in Europe, North America and Japan based on similar material to this internal briefing, backed up by a number of individual in-company sessions. The aim of all of these sessions is to bring users quickly up to speed on the new features available to them in WAVE v5. In addition, a range of training options are offered and a comprehensive WAVE v5 web site has been launched at www.ricardo.com/WAVE5 providing details of new features, applications, training courses and a range of other essential information for users.

Commercial Changes

Apart from the many technical enhancements, WAVE v5 signals some significant commercial changes in approach for Ricardo Software. Previous versions of WAVE have been offered with a range of optional modules from which the customer could select – and pay for – just those which would be of use to each individual licensed seat. This led to some very confusing licence structures for both customers and Ricardo. Moreover, from a marketing standpoint, prospective customers would sometimes tend to add the cost of all the modules together – even those that they would never use – and would be put off by what Johns terms “sticker shock”. In a bold move which matches the significant technical enhancements, Ricardo has decided to bundle the complete WAVE v5 product as a single package (excepting the

highly specialised diesel combustion CFD solver) at a price comparable with that of a typical current installation. Johns believes that this puts the complete WAVE v5 installation in a very competitive market position and, as he puts it, “with the capabilities available in WAVE v5, the product offers an unprecedented level of functionality at a modest price.” And for existing licensees, too, there will be some pleasant surprises as they receive improvements both in the functionality of the modules they already license, together with access to the remainder of the package across the whole of their installed user base.

Competitive strategy

But what is the competitive strategy for WAVE in the marketplace? Johns is bullish about future prospects, identifying two distinct areas. Firstly, he is clear in his determination to support the existing user base: “We have many long standing and loyal customers and our first responsibility is to provide them with the capabilities and level of support that they need to maintain their products at the leading edge.” Secondly, he wants to extend the market both into new areas of application and to penetrate geographical territories not previously served well by commercial simulation products (the distribution agreement with Sumisho Electronics Co Ltd of Japan is just one element in this strategy).

On technology strategy, Johns feels that he now has an infrastructure in WAVE which is open to development in a far more flexible manner than ever before. He also claims to have achieved the optimal balance between operating a market-focused software company while benefiting from its positioning within a leading edge engineering services business. “We are able to review all of the research and development work going on throughout Ricardo and can pick which areas we want to incorporate within WAVE, where necessary drawing upon the expert assistance of specialists from those areas to support our development team.” With this approach, Johns

New features in WAVE v5

Pre-processing:

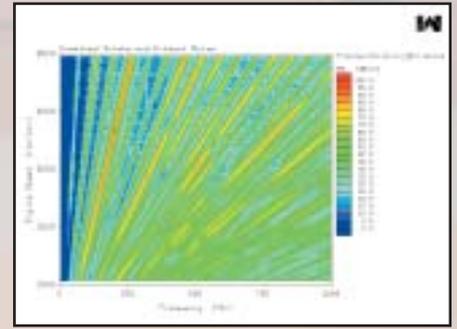
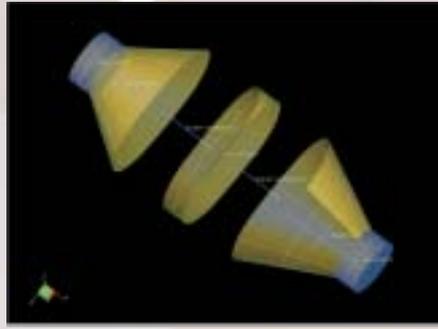
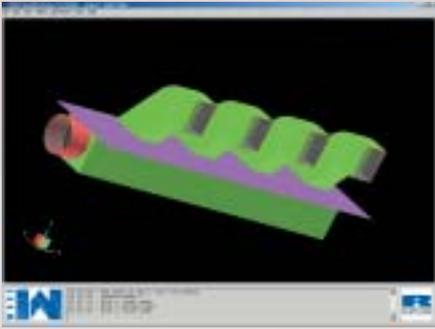
- CAD mesher from STL import
- Component design and database
- Graphical turbocharger maps preprocessor
- Model auto-calibration and design space explorations using built-in DoE
- Intelligent defaults for input parameters
- Auto-calculation of junction geometric data
- Parametric design
- Input fields formulae evaluation
- 3D component modeller and automatic mesher
- XML input file format

Physical models:

- 3-Way catalyst
- Diesel 3D (built-in CFD solver)
- Improved driveline modelling
- New gasoline hydrocarbon emission model
- Variable Geometry Compressor (VGC) model
- Variable Valve Timing (VVT) enhancements
- Load-compensating heat transfer model

Post-processing:

- WAVEPOST - completely integrated with WAVE output
- Integrated design space optimization
- Animated network dynamic plots
- Turbine and compressor operating point visualisation
- Exporting engine model networks to image formats including JPG and PNG



claims that he is able to leverage a massive knowledge base from within the global Ricardo organisation and integrate new developments into WAVE that would be impossible without the strengths of the Ricardo engineering business.

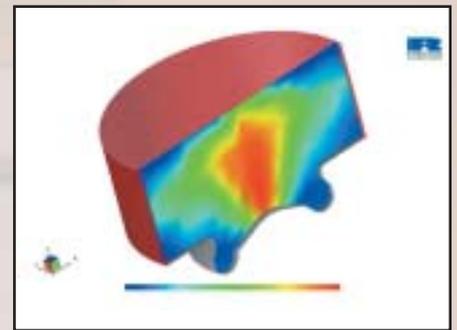
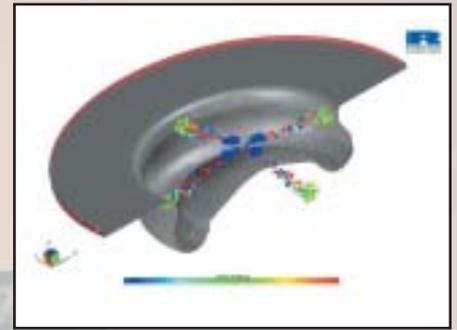
WAVE v5 also contains functionality that is found in other third party products, such as CFD and optimization. "We're not trying to replicate commercial general purpose product functionality," says Johns, "but aim to embed within WAVE an integrated and easy-to-use level of functionality that is required by most users in order to make the process of analysis and optimisation as straightforward, effective and efficient as possible."

But where does WAVE go from here? Johns views development as a continual process of communicating with customers, understanding their needs – present and future – and delivering against them. The new version of WAVE is a significant step forward in the market for engine performance simulation, but it's not the end of the story. There is little doubt

Above (left-right): The new CAD mesher, 3-way catalyst model and intake/exhaust noise results. Right (middle-bottom): Spray structure and combustion in the diesel CFD model

that there will be further enhancements to WAVE as signposted by the features such as the beta release of the WAVEBUILD 3D module. Clearly Johns believes that he now has the correct mix of skills and technology at his disposal in order to keep WAVE ahead of the game. As competitors vie to emulate the innovations in WAVE v5, Ricardo Software will no doubt be busy keeping the enhancements coming – and staying ahead of the game.

The one undeniable truth is that in a dynamic market place where the customer can only benefit, WAVE v5 has significantly raised the bar for the future efforts of both Ricardo Software and its competitors alike.



WAVE v5 innovations

There are far too many technical improvements to cover in the space available in this magazine. The following is therefore a brief overview of the main points. As ever, full details are available on the website www.ricardo.com/wave5.

Pre-processing

Some of the most immediate improvements certain to be noticed by WAVE v5 users are in the pre-processing options. The CAD mesh generator allows geometry to be directly input using the industry standard STL format. Once the CAD data is imported, the user defines how the major geometric sections are to be broken up and the mesher generates the WAVE network data. A second level of 3D pre-processing is also available in the automatic 3D mesh generator WAVEBUILD 3D, released in beta form in WAVE v5 and ultimately planned to replace the pioneering but now eight-year old KADOS system.

Component-based data is a major theme of WAVE v5, with the ability to manage data

in the component design database. This includes the ability to store and cross reference model data using information, such as part numbers, not required in the analysis but nonetheless extremely useful to design teams.

For optimisation studies, WAVE v5 contains an integrated Design of Experiments (DoE) and Optimiser module, enabling users to either auto-calibrate models to known or target data or to optimise the design. The pre-processor will automatically set up and manage the runs needed to populate the design space with data and the user can then perform "what if" experiments in the post-processor.

Of less immediate impact but of great benefit to all users, is the incorporation of 'intelligent defaults' for input parameters. Here the user is offered a range of hard and soft variable limits which provide traffic-light style visual warnings of the appropriateness of the values chosen by the analyst. Given the workloads that CAE staff typically work under these days, and the cost of getting it wrong, this simple enhancement offers real benefits to hard-pressed users.

Physical models

Like all CAE analysis packages, WAVE is essentially a mathematical idealisation of a physical system, of which the quality, accuracy and usability of its physical models are its ultimate measure. WAVE v5 is not short on innovations in this area. A new 3-way catalyst model has been implemented, based on the results of research work carried out by the Ricardo technology research team. This model will enable a much wider range of detailed investigations to be carried out on catalyst systems including, for example, warmup and the evaluation of the effects of catalyst poisoning or degradation. For the increasing use of WAVE for drive cycle evaluation, an improved driveline model is included in which the vehicle is able to follow a defined mission profile.

Post-processing

A single graphical post-processing utility has now been implemented in WAVEPOST. This incorporates the functionality of the previous RPLLOT, TCMAP and, in version 5.1, WAPP into a single user-friendly environment.

Team value manager

Martin Leach, 45, became president and chief operating officer of Ford of Europe in August 2002. He devised Ford's revival programme for 45 new models in five years and is responsible for over 40 per cent of Ford's worldwide output and half of all planned growth in developing markets. **Tony Lewin** spoke to him for RQ

How have Ford's relationships with suppliers changed since the start of the revival programme?

I would say first that the relationships are slightly different on either side of the Atlantic. Our relationship with our suppliers in Europe is cordial and constructive. There is a huge mutuality in having a successful Ford and we are working with them to eliminate waste: we have a deep-seated feeling that there is no mileage in us trying to make a grab for supplier profitability. We need them to be viable and profitable to be with us for the long term.

Is supplier viability one of your key principles?

We are trying to manage our relationship with the suppliers with that as an overriding principle — but that's not to say we are not focused on value. We have done a lot of benchmarking since we started down the road of our European Transformation Strategy, and we launched at the end of last year a new approach to value management in Europe. We call it TVM — Team Value Management — and we get the purchasing people, the engineers, the suppliers and the cost estimators working together to truly understand the value chain and to eliminate waste. It is yielding significant savings opportunities — way beyond the things we have seen previously.

Could this be perceived as a pressure on the suppliers?

I think it is a pressure of doing business, but it is not the OEM putting pressure on the suppliers. It is looking at the value chain and whatever part of the business we are looking at, and understanding how do we optimise that and make it work for everybody who has a piece of the action in between.

Do you think that Ford has perhaps asked the suppliers to do too much and to put too much technological and innovation power in their hands?

Ford in Europe was the leading manufacturer in terms of a move towards full-service supply type relationships. I think there is a common understanding between Ford and the suppliers that there were a number of growing pains as



a result of that. We were definitely pushing the boundaries and in some cases we've had to look at our experiences and ask ourselves whether we can now see a better way. So we are now fine-tuning that strategy the whole time and it will result ultimately in Ford bringing some work back inside the OEM; in other areas it will involve more work going to the suppliers. I think what we have learned is that there isn't a 'one size fits all' relationship.

What might be taken back inside — are we talking anything major?

We are looking at a number of things — those areas where at the total vehicle integration level it is necessary to really control the competencies. One example might be in the area of suspensions. We are very proud of the way our vehicles drive and that is a leadership attribute for us. So we are looking at making sure we have competence right through all of the components and systems that get us to driving quality.

What happens at the moment?

On suspensions, on some products we have moved to a full-service supply relationship with a full modularity, where the suspensions are sourced as a module. Maybe what we need to do is break that down. It's driven by practicality, not necessarily by business *per se* — and I'll give you a fairly simple example. Vehicle dynamics are important for Ford, and a key attribute of the vehicle dynamics could be the rear wheel toe compliance. [Let's say] we have a situation where the toe compliance is outside of our target range. How do we address that? Well, we could address that in the bush, in the arm, in the body structure. If all of those systems are managed within different supply

“A lot of people when they first saw the StreetKa concept questioned whether Ford would ever do the car”

relationships, that becomes a nightmare to coordinate. So where things are important for total vehicle integration it makes sense to control that within the vehicle integration function as opposed to having to manage it across supplier relationships and commercial relationships as well.

Is there much more cost to take out of business?

You mean is there the opportunity to take cost out? There is, and this team value management approach is proving very effective in doing that. We've taken over 1.2 billion dollars of net cost out of our business since we started in 2000, and that is a significant amount. I think we will continue at that pace as we look to the future.

How far have you moved on flexibility in terms of introducing new products and speed to market?

In 2000 when we first announced 45 in 5 [45 models in five years], we were under an awful lot of pressure and people did not have a good word to say about Ford and particularly about Ford's product. We were being criticised for not being bold, nimble and quick enough. I think the StreetKa is a clear example of how that is not a valid criticism now. This is because there

was a concept, we were very nimble and flexible in establishing a business equation, a partnering arrangement with Pininfarina, and got on with the programme. It's not even two years later and we are in the production launch phase of the StreetKa. I think that demonstrates that a number of things have changed at Ford. One is that we had the boldness and drive to do it: a lot of people when they first saw the StreetKa concept questioned whether Ford would ever do the car.

With C-Max we've trailed the way of where we are going in the segment, and I'm very pleased with the result. It is based upon our plans for the future as opposed to looking back into the past.

Will it be built in Saarlouis? On the same line as the regular Focus?

When we introduce the production level vehicle we start the process of changing Saarlouis over to our fully flexible manufacturing concept. It's basically the same concept as Cologne, fully interchangeable, and that's what we will change over at that time.

How are you going to arrest Ford's decline in the D-sector?

I think it is important to understand a little bit about the dynamics behind what is going on in that sector, particularly in the UK. A couple of things have really happened this year. We, as a matter of policy, decided to heavily restrict the number of Mondeos that went to the rental companies. As a result of that we're almost entirely responsible for the decline in the segment, so you have to ask yourself what comes first. If you look at that segment in the UK it is still a larger share of the market than is more usual on the continent of Europe, and I think that is still tied in with the company car culture in the UK. With the change in company car taxation at the beginning of the year, we did see a dramatic strengthening of diesel demand, which we are very well positioned for. I think over time it is not unreasonable to expect that the UK market structure will more closely resemble the market structure on the continent as we see more people becoming user-choosers.

Is that not more threatening in a sense that people are buying increasingly on brand, however good the Mondeo might be?

I do think that some of the premium brands have got a bit of a problem with ubiquity. For me, you can't resist the market dynamics: if you try to resist them, you fail. I think what you have to do is adapt and evolve. With the compact minivan segment you see a lot of people trading out of the D segment, so we are optimistic that with C-Max we would pick up a number of customers.

Do you expect the sub-B segment to gain

“With C-Max we've trailed the way of where we are going in the segment. It is based upon our plans for the future as opposed to looking back into the past”

in importance?

Yes I do. We've seen a significant strengthening of Ka this year and Ka is segment leader. As we get more and more traffic congestion and inner city restrictions, I think that there is a natural pressure on small cars from that dimension. Unfortunately that slightly conflicts with the other major market trend, which is a trend to more space in vehicles — and that trend is a global trend. I have my own hypothesis: I think that space is the ultimate luxury these days, because the cost of space appears to go up, whether it is housing or whatever.

So what you are saying is that in future cars will have to be cleverer, but low in price and big on space?

I think they will. They will always have to deliver value at the consumer level and I think you're right they will have to be cleverer. I think you'll be seeing a trend toward flexibility, adaptability and ease of use.

Are you also saying that the present Ka is perhaps too small?

No: it's interesting, we did extensive research with Ka buyers. They are so in love with their Ka that they say don't change it, keep it the way it is and I will buy new ones. I will be very happy!

But you will have a replacement for that model?

I always say that it has become an icon for us.

And aren't icons notoriously difficult to follow up?

Yes they are: I agree with that, but we will continue to worry about that segment and continue to nurture Ka.

Will this be a European product or will you announce some input from other continents on it? Will it be a derivative of



Martin Leach

- 1979 Joined Ford as body engineer
- 1982 Analyst, Ford of Europe Car Product Planning group
- 1985 Product specialist, Ford of Europe Marketing and Sales
- 1988 Member of Jaguar transition team
- 1993 Director of Sales and Marketing for Commercial Vehicles
- 10/94 Business director, Ford Light Truck Vehicle Center, Dearborn
- 07/96 Director, cycle planning, Mazda Motor Corporation
- 07/97 Managing Director, product planning and design programs, Mazda
- 01/00 Vice president, product development, Ford of Europe
- 08/02 President and CEO, Ford of Europe

the Fiesta platform?

I think it's too early to say anything on that. Rest assured that whatever it is, we think it will be successful.

Returning to cost, taking out \$600 million per year. How long can you continue that? Is it declared policy to take out that much for the foreseeable future?

I think for the foreseeable future, yes. For two to three years we'll continue to target net cost down.

Are you competitive in terms of cost per vehicle, say with GM in Europe?

I believe we are, but we are [still] not satisfied. We anticipate the market pressures will continue. It is a market of winners and losers, [no longer] a historical growth market where everybody who's playing is winning. We believe there is still enough opportunity out there for the best competitors to have a very good solid business.

A version of this interview was published previously in Automotive Sourcing.

Transforming transmissions

Now in its fifth year at the Midlands Technical Centre and less than six months since its acquisition of the operations of Gemini Transmissions, the Ricardo Driveline and Transmissions business is in extremely good shape for growth. **Anthony Smith** spoke to managing director Gerald Andrews about the rapid development of the business and high profile programmes such as the Bugatti Veyron (right)

The Midlands Technical Centre has been a spectacular success for Ricardo. Since opening in late 1998 it has provided a secure base for the formation and development of two new divisions, has become central to the company's well publicised work on the MINI programme, and is now the focus of arguably the world's leading independent transmissions technology business.

It has always been well known and respected for its work in the area of motorsports but, as managing director Gerald Andrews explains, the Ricardo Driveline and Transmissions Systems (RDTS) division is about much more than this. "In RDTS our mission is to provide an extremely high-quality design and development service together with a turnkey and niche production capability relating to all driveline and transmissions application areas. Naturally, people know us best for motorsport," he continues, "and that is significant for us – but it's far from being our only core business area."

To illustrate the strength of the RDTS design and research capability, for example, he points out that the company has registered approximately 30 patents in the past two years alone.

Rationale for Gemini acquisition

So what was the logic behind the acquisition of the Brackley-based Gemini Transmissions business in July 2002? Was it to reinforce the motorsports presence with new product lines, to strengthen the technology and skills base, or to add additional manufacturing capacity?

According to Andrews it was all of these things – and much more besides. "What we have achieved in a very short space of time is the complete integration of the two businesses into a much more powerful, flexible and well equipped entity."

He goes on to claim that it would have been an all-too-easy option to continue running Gemini as a successful but separate offshoot. This, he says, would have missed the real opportunity of restructuring to gain the maximum operating efficiency for the merged business. "We now have a single, integrated and highly efficient manufacturing capability spread over our two sites," he says, "Brackley handles most of the pre-heat treatment activity and MTC concentrates on finishing operations."

This separation of activities has involved the relocation of equipment and people between the two sites, but their relative proximity has undoubtedly helped in the transitional period. Summing up the overall benefits of the acquisition, Andrews cites "a stronger presence in the motorsports sector, increased capacity for major motorsports design and manufacturing programmes up to and including F1, and a world class prototyping capability" as its most significant impacts.

Mitsubishi Pajero Evolution

On its rally raid debut in the United Arab Emirates Desert Challenge in November 2002, the Mitsubishi Pajero Evolution, driven by Frenchman Stéphane Peterhansel, led from start to finish, winning by a staggering 42 minutes. In what is one of the most demanding forms of motorsport this was no mean feat – and it is an achievement that was helped by a transmission system designed and manufactured by Ricardo. The unit is a six-speed sequential or optional five-speed sequential with high/low range configuration.

Commenting on the design of the unit, Mark Barge, director of motorsport transmissions, said: "We at Ricardo were asked to become involved in this project on the strength of our reputation for bringing high technology to



motorsport drivelines and transmissions. With a completely new car in an increasingly competitive field, the Mitsubishi Motorsports team wanted to be sure they had the best and most reliable technology at its disposal."

Following its phenomenally successful debut in the UAE, the car will see action in January 2003 in the most arduous event in the rally raid calendar – the famous Dakar rally across the deserts of North Africa.



“Naturally, people know us best for motorsport – but it’s far from being our only core business area”

Gerald Andrews, Ricardo



Spectacular growth

The physical evidence of business development is clearly apparent in the new test facilities and the capacity delivered through the acquisition of Gemini. “We’ve managed to grow this business in terms of headcount by over 50 per cent since 2000 alone” says Andrews, “and we have charted a sustainable growth path.”

But even if RDTs is now possibly the largest independent provider of driveline and transmission technology, does this imply a steadying of the growth curve, or is the market still developing? Andrews remains bullish as to future prospects. “It’s arguable that there is still considerable market development potential in the area of driveline and transmissions.

“We are extremely fortunate in having been able to develop a large and stable presence in this market in time to benefit from this growth potential,” he continues. But does he see this as a matter of luck, good judgement, or a mixture of the two? “Clearly there was a lot of careful planning and foresight in our development of this business and I’d love to say that it was all down to

our own efforts, but in fairness we’ve had our share of good fortune also. There is little doubt in my mind that the availability of the MTC site gave us exactly the right location at just the right time.”

And it seems that the MTC site is to be the focus of future development. “We have an agreed substantial capital investment plan which will provide for a new heat treatment facility, a new gear grinding machine and a host of other manufacturing and test equipment early in 2003,” says Andrews.

While this will represent very much the technical centre of gravity of the division, increasing numbers of staff will operate from the other Ricardo technical centres in Europe and the USA. “We feel strongly that we now have the right mix of products and services, an immensely strong technology base, and an infrastructure which will enable us to continue to grow at a significant and sustainable rate”, says Andrews. On the basis of the developments of the last four years, an impressive list of high profile projects and a dominant position in motorsports, he may well be proven right.

Bugatti Veyron

Ricardo was chosen by Bugatti as its engineering partner for the complete transmission and driveline system for its prestigious new Veyron supercar. The company’s involvement in this project goes back to 2000 with the development of initial concepts, including the building of a technology demonstrator. In addition to the mechanical system design, Ricardo is also responsible for the design and development of the complex mechatronic system. This controls the seven-speed Dual Clutch Transmission as well as all the active 4WD driveline units, including all new algorithm and software development and a new control unit design.

Ricardo signs historic accord with Japan's Horiba

Ricardo and the top Japanese testing equipment specialist Horiba have signed an exclusive agreement of co-operation. The two companies will work together to build an improved automotive consultancy service to the Japanese car makers and related industries.

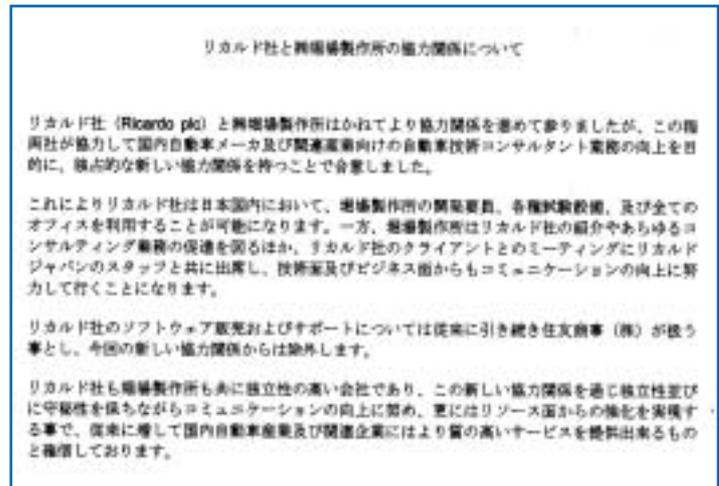
This agreement means that, as appropriate, Ricardo will use Horiba resources in Japan in the form of staff, regional offices and test facilities.

Horiba and Ricardo both pride themselves as independent companies and are

well placed to serve the Japanese auto industry objectively and confidentially.

Horiba and Ricardo will act, as usual, under conditions of utmost secrecy in all business matters with Japanese customers. The two companies are confident that this new cooperation will greatly benefit customers in Japan by providing improved communications and resources.

Ricardo Software sales and support are unaffected by this agreement, this activity continuing on behalf of Ricardo through Sumisho Electronics.



Text of the announcement of the co-operation agreement

i-MoGen wins technology award

The Ricardo i-MoGen mild hybrid vehicle has scooped a top-level engineering award from the prestigious Royal Automobile Club in London. The coveted Dewar Trophy for innovation in automobile development was presented to Neville Jackson, Ricardo Technology Director, at a ceremony in London.

The RAC felt the innovation met the Trophy's strict judging criteria of being 'the most outstanding British technical achievement in the automotive field' in 2002. The Club's judges singled out i-MoGen's ability to achieve fuel consumption of less than 4.0 l/100km (70 UK mpg) whilst retaining the capability to achieve exhaust emissions 50 per cent lower than proposed Euro IV levels. These, the judges said, were particularly relevant to the changing face of motoring by conserving energy and reducing environmental impact.

The Club's Motoring Technical Committee judged the award using five key criteria of technical achievement, innovation and uniqueness, relevance and significance, value and cost saving and practicality and applicability. After short-listing the 14 entries, the technical committee visited the three top candidates to investigate their submissions in more detail.



Neville Jackson (right) of Ricardo receives the Dewar Trophy from Stephen Hammerton of the RAC

"The Dewar Trophy has been a celebration of British technological achievement since it was first awarded in 1906 and this year Ricardo has shown that it is already well on the way to accommodating the needs of tomorrow's motorists," explained Stephen Hammerton, chairman of the Royal Automobile Club's Motoring Committee.

"To develop a powertrain that combines such excellent fuel economy and low emissions that can be installed in Europe's most popular size of vehicle and comfortably accelerate to 100km/h in 12 seconds is an impressive feat. We also commended the fact that it can be manufactured at a cost level that makes full scale production a real possibility rather than just a dream," he added.

Detroit Technology Campus opens for business

Marking a major step in the development of its North American business, Ricardo announced the opening on January 2 of the Detroit Technology Campus. With the completion of the new 77,000 sq ft (7150 m²) two-storey office and engineering facility, the total build area of the site has increased by nearly 100 per cent and the expanded 11 acre (44,500m²) campus provides useful capacity for future growth.

"This significant investment demonstrates the confidence Ricardo places in the future success of its growing North American business," said Jeremy W. Holt, president of Ricardo, Inc. "Our expanded Detroit Technology Campus will help us take automotive technology to the next level and meet the growing demand for globally competitive technical expertise in such areas as advanced powertrain development, vehicle and systems integration as well as diesel and hybrid technology."

Ricardo, Inc. has grown steadily both organically and through targeted acquisitions since 1989 and currently employs 350 people. It expects continued growth over the next three to five years as automakers embrace strategic product development outsourcing. According to Holt, this expansion builds the critical mass necessary for the company to maximize its operational efficiency as it



works on major customer programmes and shares its knowledge and technology among engineering teams.

The new building will be used for design, computer-aided engineering, thermo-fluids, vehicle refinement, controls and calibration engineering teams. This space also includes conference rooms, project offices, a technical library and an area for the company's administrative and support staff. The high-bay area and vehicle workshop occupies more than 23,000 square feet of additional space

and includes secure and confidential vehicle evaluation and assembly areas to meet specific project demands.

The building is designed to complement the extensive powertrain testing operations that will become the focus of the original facility within the campus. With the development of the Detroit Technology Campus the company has been permitted by the local authority of Wayne County to rename the main entrance road to the campus 'Ricardo Drive'.

New appointments to Ricardo board

With effect from January 1, 2003, two new directors, Clive Hickman and Gerald Andrews, were appointed to the main board of Ricardo plc. Respectively the managing directors of the Ricardo Vehicle Engineering and Ricardo Driveline and Transmissions Systems divisions, they will continue with the responsibilities of their existing roles in addition to those of their new plc board appointments.

Clive Hickman is a mechanical engineer with wide ranging experience in

powertrain and vehicle engineering. He joined Ricardo in 1997, having formerly held senior positions with Rover and subsequently MIRA where he was engineering director.

Gerald Andrews is a specialist in transmission systems engineering. Having held senior positions within the former FFD group, he has led the driveline and transmissions business since the acquisition of FFD by Ricardo.

On the main board they will be joined by

Stephen Parker, who was appointed in August 2002.

Stephen Parker has been tasked with the development of the consultancy service offered by Ricardo to encompass strategic issues of critical interest to its OEM and Tier 1 customers.

He is well known and respected in the area of strategic consulting, and before joining Ricardo served as principal of the AT Kearney automotive practice in London.



100-year-old car completes historic run

For Ricardo chairman Sir Noel Davies, Sunday November 3rd was a cold English winter's day that would be special for more than just its unseasonably bright and clear sunshine. Not only was the immaculate maroon machine in fine shape for its hundredth birthday and its 68th running of the 59 mile London to Brighton course, but Sir Noel would also be reliving his student days almost half a century earlier when he himself drove the car, nicknamed Boanerges, or Bo, to Brighton.

"I had done the run twice as driver or co-driver," said Sir Noel, "and I have a special attachment to the car – it needs a lot of maintenance and once as a student I spent most of the summer vacation rebuilding the engine and transmission."

Alarming, according to Sir Noel, Bo has two gearboxes – one for first and third, the other for second and fourth. "It's operated by twin levers and it is possible to get two gears at once," he

This one-of-a-kind 1902 James and Browne has driven the famous London-Brighton run countless times – but the 2002 event was unusually special

commented, with more than a hint that this was perhaps the reason behind his gearbox rebuild.

Other controls are relatively conventional, but the hand throttle and ignition controls demand frequent attention, often from the passenger – making it seem as if two people are driving.

For the 2002 run Sir Noel travelled as an honorary passenger, rather than driver. As chairman of Ricardo and an alumnus of Imperial College, London, he had been invited by the students of the City and Guilds College at Imperial to participate in the centenary run for Boanerges, who – the students insist on treating the car as a person – has been owned and maintained by the Imperial students ever since 'he' was

bought for the princely sum of £40 in 1934.

Sir Noel was also given the honour of taking a goodwill message from the Lord Mayor of London to the Mayor of Brighton. Before the early morning start he said: "The journey will be a reminder of my happy years at Imperial during the 1950s. I'm delighted to see how well Bo has been maintained over the last 50 years."

As for the run itself, the car ran smoothly and without major hitches all the way, successfully coming through a heavy rainstorm half way. "It rained again in Brighton, just as we were taking the Mayor for a ride," added Sir Noel.

Boanerges, whose name comes from the New Testament and means "Sons of Thunder," is the only



survivor of two built by the James and Browne company of Hammersmith in 1902. It is powered by an underfloor-mounted 2500cc twin cylinder engine developing around 9 horsepower and consuming fuel at the nowadays unfashionable rate of about 12 mpg or 23 litres per 100km.

Maximum speed, as Sir Noel testifies, depends heavily on the terrain: "Up Pyecombe hill everyone has to get out and push: it bounces a bit but it's fine at 20 mph if you are very careful – especially with the brakes, which are almost non-existent."



SAFE



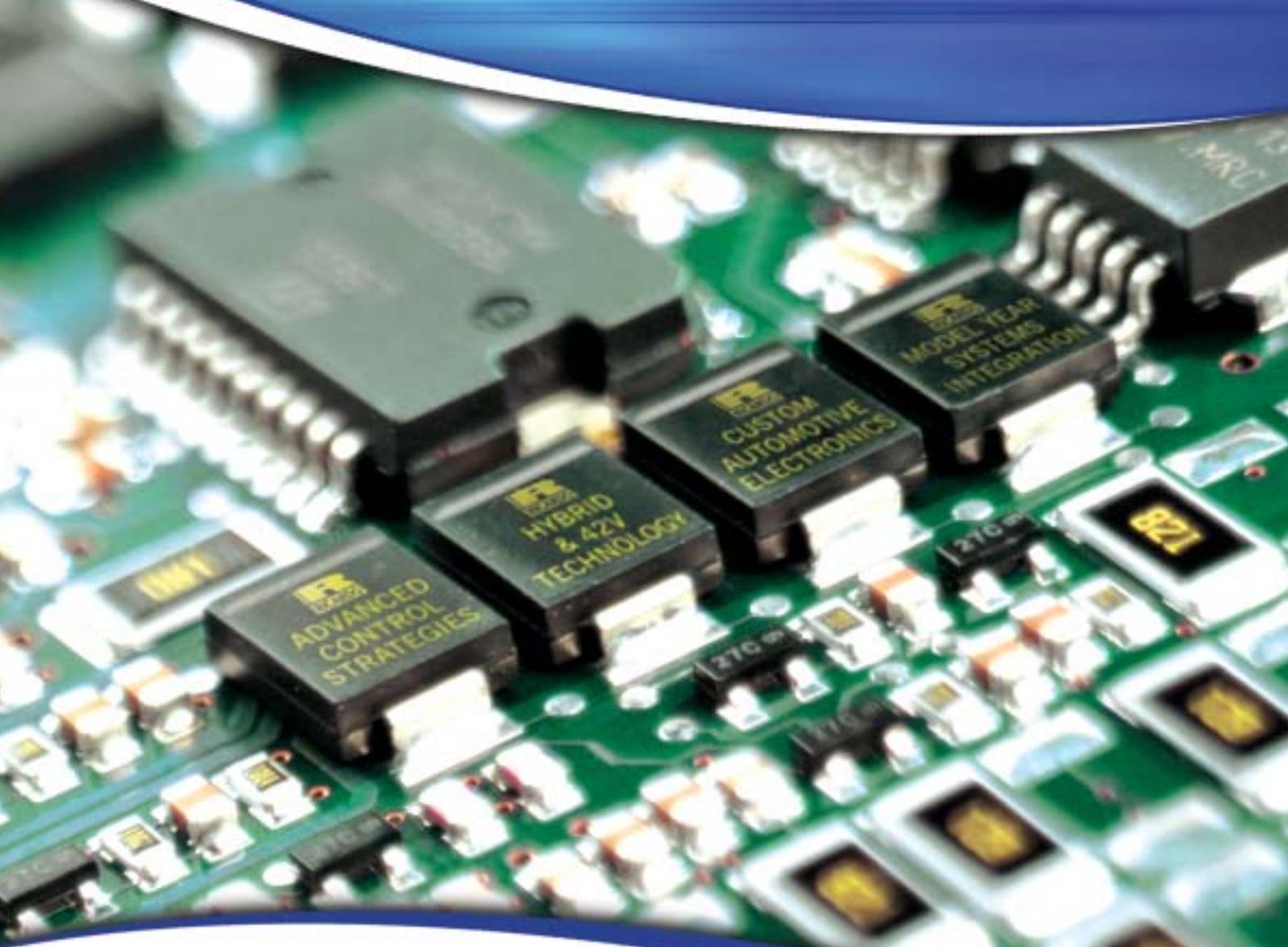
SORRY

Check One.

We've chosen to focus on a driver's safety whenever they get behind the wheel. As a global leader in integrated active and passive safety systems, TRW Automotive is constantly looking out for their well-being. Which is why we'll continue to pioneer work in areas like vehicle stability control, electric steering, smart restraints and driver-assist systems. Because we know that, given the choice, safe is preferred over sorry.

TRW *Automotive*

Power Demands Control



A key industry bottleneck to delivering next generation features and functionality is the ability to design, develop and deliver automotive electronics and control systems to world class quality, timing and cost levels.

The Ricardo global control and electronics team is continually working to move forward the boundaries of innovation and ensure project delivery. The key focus areas are, advanced control systems, hybrids and 42V technology, custom automotive electronics and model year systems integration.

www.ricardo.com

