



# *pro* **Active**

*The official industry newsletter of Lotus Engineering*

*Issue 19  
March/April 2007*

*BMW plant could  
build Mini*



*Engineering success on  
the track – creating  
the Lotus Sport 2007  
GT3 race car*



# Welcome

It has been an incredibly hectic few months for Lotus Sport. Building on the successes of the 2006 GT3 campaign, in an unbelievably short time we have developed the 2007 race car. And to ensure we stay at the front of the field, this has involved significant engineering changes to the vehicle. Lotus Sport's Louis R Kerr describes how Lotus Sport and Lotus Engineering have used their combined might to leave everyone confident of repeated success this year.

The preparation for this season's racing has not been the only racing-related activity keeping Lotus busy. At the Geneva Motor Show, recently we unveiled the Lotus 2-Eleven and the GT3 concept to thrill our enthusiast customers. In this issue we take a look at Lotus' activities at the show from new products to advanced technologies, and then a wider look at what others in the industry were announcing and launching.

With the motor industry facing the challenge to reduce its impact on the environment, Lotus Engineering is working in many areas on producing technologies for greener vehicles. Motor sport can play an important role in this and Jamie Turner, Lotus Engineering's chief engineer for powertrain research discusses this topic.

Finally there is an insightful interview with Christian Streiff, PSA Peugeot Citroën's new chief executive from our colleagues at just-auto.com.

I hope you find this issue of proActive an interesting read. As ever your feedback is most welcome, please send it to [proactive@lotuscars.co.uk](mailto:proactive@lotuscars.co.uk).

**Chris Arnold, General Manager – Lotus Sport**



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## INDIA: BMW plant could build Mini

A new car factory in India has emerged as the most likely place to boost output of the Mini, the iconic small car that has been revitalised by BMW.

Sited 40km south of Chennai, the modest plant at Mahindra World City has suddenly become a hot candidate as a satellite production centre when demand finally outstrips supply from Oxford, the Mini's spiritual home.

Though the official line from BMW AG is that a lift in capacity to 240,000 units should be sufficient to cope with the expected rush of orders for the latest line-up that will soon include the long-awaited Clubman (extended wheelbase wagon) version, the option of boosting output with supplies from the Subcontinent is under active consideration.

After the roller-coaster ride that has already taken it to more than 70 global markets, the smash-hit model will soon reach showrooms here if a survey by the German group's market planners proves the car to be a viable proposition.

"We are carrying out a market analysis for the launch of the Mini in India. If it is found to be viable, we could have it on sale here in 2009," said BMW India president Peter Kronschnabl at a ceremony held to mark the opening of the factory, set up to assemble BMW 3 and 5 series sedans.

But in a further reference to the study, Asia region senior vice president David Panton explained that big tax differences – 114% on imported cars, compared with 60% on models assembled in India – would also have a bearing on its outcome.

"We started the analysis a month ago and we are keeping our options open to include both the completely built up (CBU) route and assembly from parts that are supplied from abroad (completely knocked down – CKD).

"Going the CKD route would call for a big investment, but of course, we have to take price positioning in the reckoning. It is too early to say what will happen...at this stage we don't know what sales volume would be necessary to make it viable," said Panton.

Asked if higher demand might prompt BMW to open another Mini source, group manufacturing chief Frank-Peter Arndt told just-auto: "We have no plans for further expansion at the moment because we can add more capacity if sales continue to grow. My personal view is that Oxford could be stretched to the 300,000 production level."

Meanwhile, group chairman Norbert Reithofer was keeping faith with his winning formula for expansion when he cut the blue ribbon on the plant.

The former manufacturing supremo defended BMW's cautious approach to growth with a facility that cost just EUR20m – a far cry from the EUR1.3bn that was spent on the group's last European factory opening in Leipzig, Germany.

"Under promising and over delivering are always preferable to running into the problems of over-capacity, and we always like to exceed expectations," he said.

With a total workforce of 150, the Indian assembly operation has been geared to produce 1,700 cars per year on single-shift working and is expected to create a further 600 jobs in the dealer and service network.

"What we are doing here is taking a conservative attitude. We feel it is important to use a plant as a market-entry tool. I would never say we'd never export out of here, but this is not the right point in time for us to do that.

"We are following a process that we started back in 1973 in South Africa – that plant set out with a capacity of 3,000 units and now produces 55,000 a year.



Single shift working to produce 1,700 cars per year

"At Spartanburg, the US plant we started in 1992, current output is six times greater than the original volume and we now need more production capacity at Shenyang, the assembly plant we opened in 2003, after selling 43,000 cars in China last year," said Reithofer.

Last year, BMW Group car sales in Asia reached 136,000 units and volume for the region has been targeted at 150,000 by 2008. "After Europe and the US, Asia is another mainstay of our business. This is where we expect the most dynamic economic growth in the long term.

"Our assumption is that several Asian markets will show above-average growth rates in the years to come, especially in the premium segments. We want to be part of it and if we need more capacity in future, our modular layout means it can always be added," said Reithofer.



Currently, the car market in India accounts for 1.2m annual registrations and experts are predicting vigorous growth to swell the yearly sales total to 2.2m by 2015. Significantly, the premium sector is developing at twice the rate of mass-market segments.

Kronsnabl is keen to challenge German archrival Mercedes-Benz, which established an Indian assembly outpost in 1993 and now accounts for 50% of the country's luxury car sales.

*"Mercedes sold 1,800 cars in the 12 months after starting out here but managed only 2,000 units last year. With a population of 1.1bn and constant growth in the number of households able to afford a premium car, this market is on a roll and we see a lot of potential."*



**2.2m registrations predicted by 2015**

*"We are confident we can do well. We are recognised as a leading premium brand but we have not been accessible here in the past because we had hardly any dealers. Things will be different under BMW India, which will have nine dealers by the end of this year and a total of 12 to serve ten metropolitan cities by 2009," said Kronsnabl, who is aiming for 1,200 sales this year, rising to 1,500 in the medium term.*

According to *Forbes* magazine, India has 36 billionaires worth a total of US\$191bn and more than 83,000 people with financial assets of more than US\$1m.

It's hardly surprising that Audi, Porsche and Lamborghini are setting up assembly lines or sales networks in a bid to tap all that wealth.

**Source: just-auto**

## US: Motorsport industry conference focuses on energy

For those serious about the future of racing, the MIA's Energy Efficient Motorsport Conference, held to coincide with the Mobil 12 Hours of Sebring, proved a significant event. With support from UK Trade & Investment, Shell, Xtrac and SAE, this was the first time that such a gathering had taken place in the USA.

*"We may be a small community in motor racing but we have a huge audience. Therefore, I am very happy we are having this conference in America,"* remarked speaker Ulrich Baretzky, head of race and special engine development for Audi. With the American Le Mans Series announcing a commitment to ethanol fuel, and bio-diesel making its competition debut during one of the SCCA supporting races, this year's Sebring meeting confirmed the willingness of the US motorsport community to embrace energy efficient technology, with the MIA in the vanguard.

The industry has made dramatic progress since the Association held its first energy efficient *"Clean Racing"* conference in the UK three years ago. The way in which the US has been involved in these developments was illustrated by speakers including ALMS CEO Scott Atherton; Doug Robinson, IMSA executive director; Bob Larsen, a director of the Argonne Research Center; John Kasab, from the emissions and fuels technology group at Ricardo; Reece Nanfito, of the Ethanol Promotion Information Council; and Herb Fishel, formerly of GM, but now the Business of Motorsports.

Atherton, in his welcome address, congratulated the MIA on its long range vision for energy efficiency and pointed out that the *"real car of tomorrow"* is not a futuristic concept, or even NASCAR's new development, but the cars currently racing in the ALMS. *"There has always been a welcome mat in ALMS, for new technology,"* he said, *"not just as a breakthrough for racing but also for road car application."* He pointed to the diesel Audi R10 as an example of that breakthrough technology. Baretzky indicated how this car still looks to the future with the plan that, in 2008, it will be running on bio-to-liquid (BTL) diesel fuel.

Richard Karlstetter, director of fuel technology for Audi's supplier Shell Global Solutions, pointed out *"cleaner gas and diesel engines are already here and we will go to hydrogen sometime in the foreseeable future. Whilst the first generation, gas-to-liquid (GTL), diesel fuel gives some benefits in reducing CO<sub>2</sub> emission. "The next generation will go further,"* Karlstetter promised, adding that *"the very first drops of BTL to come from Shell's pilot plant will be used for motorsport."*

Steve Bunkhall, former project director of the UK's EEMS (Energy Efficient Motorsport) initiative, reckons that *"there has been a sea change in the public's attitude to bio-fuels"*.

Doug Robinson indicated that IMSA's rules make it easy for the ALMS teams to bring in new technology. A 10% ethanol content

has already been introduced but a third fuel, perhaps with an ethanol blend of at least 50%, may be available for the beginning of next season.

The Indy Racing League (IRL) will, this year, be using ethanol, and is the first major championship to do so. The presence of Fred Nation, executive vice president, communications at the Indianapolis Motor Speedway, home of IRL, underlined this, as did the talk by Reece Nanfito. Both admit that whilst ethanol is not the final answer, it is a vital first step along the way to energy-efficient motorsport and that alternative fuels will substantially improve the USA's dependence on the Middle East.

A central theme of the MIA's conference was the ideal nature of motorsport for developing energy efficient motoring for the everyday driver. Bob Larsen observed: "Racing represents an untapped resource of engineering talent." Atherton, with the LMP2 Acuras making their debut at Sebring (one was to win its class and come second overall), reported that what brings this leading Japanese brand to the track "is not the amount of times its logo appears on TV, but that this is the right environment to develop and exploit new technology". Baretzky used the example of the Dow diesel particulate filter found in the Audi R10. "In Dow, we found a partner that was prepared to urgently develop new lightweight technology, right at the last minute." This successful technology, proven by Audi at Le Mans, will soon be transferred to Audi's road cars.

Another leading supplier to the R10 has been transmission manufacturer Xtrac, its managing director, Peter Digby, pointing out that the car's gearbox is actually lighter than that of the earlier gasoline R8. Diesel power really demands a great deal from transmissions. His company recently responded to a very different, but still diesel-powered challenge, that of the land speed record breaking JCB Dieselmax. With kinetic energy recovery systems scheduled for use in Formula 1 for the 2009 season, Digby says that there is "a whole new group of energy efficient technologies, relevant to road cars that have yet to be discovered....very quickly".

Here was the overall theme of the conference. New technologies need developing, and quickly, for the automotive industry to meet its greatest challenge. Energy-efficient motorsport may, at first glance, appear a contradiction in terms, but it is anything but. In introducing the conference MIA chief executive Chris Aylett pointed out that the engineering challenge behind the sport had, at its heart, the efficient use of energy. He wanted this event to question and discuss, rather than to find a final solution. "We are," he said, "gaining new momentum and creating new business opportunities."

Speaking after the event, Scott Atherton, CEO of Panoz Motorsport Group, enthused: "Yesterday was one of the most satisfying days in motorsport that I can remember." He admitted to having been unenthusiastic when first approached by Chris Aylett with this concept four years ago, but has had his mind changed by the progress that has occurred since then. "There

is a sweeping, global change that is occurring and all motorsport stands to gain from this."

Source: just-auto

## GERMANY: GM Europe unfazed by CO<sub>2</sub> debate

GM Europe president Carl-Peter Forster has said he is not troubled by the current discussion about energy efficiency and lower emissions. In fact, he sees it more as a 'plus point' for the Opel, Chevrolet, Saab and Cadillac brands.

"The fact that more car buyers are taking the environmental compatibility and energy balance of their cars into consideration is a good thing for us," says Forster.

At the same time, he called for a closer cooperation between motor vehicle producers, the oil industry and politicians so that solutions to climate protection can be found.

Said Forster: "The consumer must be able to afford environmental technology. This is the only way to put it on a broad and effective basis".

Forster said that, thanks to the debate, there is growing demand for the Corsa with 1.3-litre diesel engine, which emits 119g/km CO<sub>2</sub>, meaning that carbon dioxide emissions across the whole model line are reduced. Within the Corsa range, more than 90% of the cars sold in Germany are below the level of 140 g CO<sub>2</sub>/km.

In addition, the entire Astra range has been revised and fitted with new, even more economical engines. Opel will also launch a completely redesigned Agila (a five-seat mini-minivan) next year, which will also boast very low fuel consumption CO<sub>2</sub> emissions.

Looking at future development in Europe, Forster underlined an ever-increasing division in the markets. While the aim in Western Europe's mostly saturated, mature markets is to improve the entry level segment with attractive, well-equipped vehicles, Central and Eastern Europe's markets offer considerable opportunities for growth.

Starting late 2007, the Astra sedan model will be built in Gliwice, Poland. GME expects this additional model will continue to increase Opel sales in the region.

Chevrolet is GME's fastest-growing brand in eastern European countries and it has therefore decided to increasingly shift production from Korea to Europe. Forster said that instead of the 25,000 units originally planned, GME now wants to produce around 70,000 vehicles a year from 2008 at a new plant in St. Petersburg, Russia.

Source: just-auto

## **JAPAN: Nissan launching new variable valve control**

Nissan Motor has introduced a new engine technology claimed to deliver a balance of responsiveness and power, fuel efficiency and low emissions.

The new system combines the technologies behind the vehicle maker's newly developed variable valve event and lift (VVEL) and continuous valve timing control (C-VTC) to deliver significantly enhanced performance.

The VVEL system uses a rocker arm and two types of links to close the intake valves by transferring the rotational movement of a drive shaft with an eccentric cam to the output cam.

The movement of the output cam can be varied by rotating the control shaft within the DC motor and changing the fulcrums of the links. This makes a continuous adjustment of the valve lift amount possible.

The technology will be available in both Nissan and Infiniti models.

Nissan said it would install the VVEL system, which contributes a claimed reduction in carbon dioxide emissions of up to 10%, on its vehicles sold worldwide from fiscal year 2007 under the so-called Nissan Green Program 2010.

The first product to feature VVEL technology is the Infiniti G37 coupé, scheduled to be unveiled at the upcoming New York motor show in April.

While conventional engines control air intake using a throttle valve, VVEL-equipped engines do this directly at the intake valves, continuously controlling their valve events and lifts. C-VTC and VVEL together control the valve phases and its valve events and lifts, allowing free control of the valve timing and lift. This, Nissan said, results in more efficient airflow through the cylinder and significantly improves responsiveness, optimising the balance between power and environmental performance.

The new engine offers various advantages depending on driving range.

***“Nissan said VVEL improves fuel efficiency most effectively in the low-to-medium operating range”***

At low-to-mid load ranges, the system controls air intake at the intake valve, immediately before it enters the combustion chamber, in contrast with conventional engine air intake via a throttle valve, leading to increased efficiency by easing airflow through the cylinder.

In the low- and medium-rpm ranges, intake valve lift is kept low to reduce camshaft friction and improve fuel efficiency.

Controlling air intake at the intake valves improves acceleration response by allowing more dense air into the cylinders from the start of acceleration.

In the low-rpm range, the intake-valves open for a shorter period, preventing blowback of the air-fuel mixture and improving torque.

In the high range, greater intake-valve lift allows increased air intake to deliver greater torque outputs.

Intake-valve timing is optimised on start-up, when the engine is still cool, to quickly raise the temperature of exhaust gases and more quickly activate the catalytic converter.



***VVEL makes production debut in new 3.7-litre V6 for Infiniti G37 coupé being unveiled in New York in April***

Hydro-carbon emissions are reduced in the low-to-medium range by keeping intake-valve lift low, speeding intake flow and dispersing the fuel into a finer mist, resulting in more efficient full combustion.

Nissan said VVEL improves fuel efficiency most effectively in the low-to-medium operating range, and therefore is best matched to multiple-cylinder and higher displacement engines, that typically operate within that range.

Under the Nissan Green Program 2010, Nissan has announced plans to develop petrol-powered engines with CO<sub>2</sub> emissions reduced to levels comparable with diesel engines, to be available globally by 2010. For multiple-cylinder, high-displacement engines, the vehicle maker will combine VVEL technology with the direct-injection system.

***Source: just-auto***



## Lotus at Geneva – exciting new cars and advanced technologies

The Geneva Auto Salon saw the commencement of the round of annual European motor shows.

Geneva has many benefits for its visitors, the first being the easy walk from airport to the exhibition centre. Previous years have seen this walk being a real wake up from the confines of an easyJet flight due to cold air that drifts off the famous lake. This year however was a welcome change as the weather was unseasonably warm.

The main benefit for both visitors and exhibitors to attend, however, is the opportunity to see just about anything and everybody connected with the motor industry – all within the relatively easy walking distance of two main exhibition halls.

From a Lotus Cars perspective, this opportunity exists for us to see what our competitors are offering in the way of new product, options, technology and even stand design.



*Lotus 2-Eleven – for track day thrills*

For those colleagues in Lotus Engineering, the show provides the ability to meet with important clients to whom we sell our wide range of engineering services.

But what is on display on our own stand itself is always of vital importance to both Cars and Engineering.

The space itself is booked many months prior to the show. Even here, where a manufacturer is located is important as to reflect its position in the market place – so being placed with brands such as Lamborghini, Bugatti and Pagani gives us a flying start.

Once you have a space, all that's left is to design a stand around it and ultimately fill it with new product. This year saw us present a brace of new track and motorsport-focused vehicles in the form of the 2-Eleven and the Exige GT3 concept. Both of these cars were

very well received by members of the press and, when coupled with some attractive models, guaranteed a continuous stream of photographers from around the world.

The 2-Eleven is aimed at our true track-day enthusiast, offering race car levels of performance coupled with legendary Lotus ride and handling. Weighing just 745kg and powered by the supercharged 1.8VVTL-i engine producing 252bhp, the 2-Eleven boasts a power-to-weight ratio similar to that of a 1960s formula one car.

The Exige GT3, meanwhile, is a concept road vehicle and our most extreme Exige variant to date, with aggressive styling and a menacing stance. Power is provided by the same supercharged engine that the Lotus GT3 race car employs, producing 271bhp, which can accelerate the vehicle from 0-60mph in 3.9 seconds and onto an electronically limited top speed of 160mph.



*EVE hybrid – retro-integration of hybrid technologies*

Geneva also saw the launch of the Luxury Touring Pack option for the Europa S, which dresses the interior in the smart attire of saddle tan leather, chocolate coloured leather and brown carpets. Leather and carpet also line the boot and exterior additions include the tinted rear and three-quarter glass. This all stretches the Europa S towards the more luxurious end of the spectrum.

Meanwhile, the Lotus Engineering area of the stand was always busy with inquisitive journalists and engineers viewing the EVE Hybrid Proton Gen-2 technology demonstrator and its hybrid engine displayed separately alongside.

The EVE Hybrid (Efficient, Viable, Environmental) vehicle showcases Lotus Engineering's ability to put advanced drivetrains into existing platforms. It features hybrid solutions that deliver up to a 22% reduction in CO<sub>2</sub> emissions and enhanced acceleration performance. The full parallel hybrid vehicle also includes micro-hybrid start-stop technology and it can be powered by the petrol engine only, the electric motor only or a combination of the two.

Once the two press days are finished, we hand the stand over to the Swiss dealers as the show transitions from being an international showcase to a national show. Meanwhile, back at Hethel, the discussions have already commenced as to what we should be displaying next year.

*Simon Croft – Lotus Cars*

## Making a statement – launches and technologies at the Geneva Motor Show

There is arguably a greater feeling of equality at the Geneva Auto Salon, compared to many other motor shows. Perhaps it is because Switzerland does not have its own major car manufacturers but there is none of the host-country dominance that understandably occurs in some of the other shows. Both big and small manufacturers intermingle and all have the opportunity to get their message across. The smaller manufacturers are valued for the diversity they bring and the major players, although prominent, do not overpower the show.

For this reason, Geneva always throws up an interesting mix of exhibits. Concept cars and production launches are the focus but increasingly technology itself is playing its part.

Beyond selling its new models, motor shows are about selling a brand's vision for the future. And inevitably in today's world, environmental impact is a factor. The approaches that different companies are taking are varied and it always enlightening to see where they are going.

As pioneers of hybrids, Toyota continues to stand resolutely behind this technology. The sleek Hybrid-X concept it debuted is aimed at moving the perception away from the now familiar incarnation in the form of its Prius to a more futuristic design. Similarly its striking FT-HS concept clearly says that these technologies can lend themselves to sportier models for greener performance motoring.



*Honda small hybrid sports concept*

Honda, another leader in the hybrid race, was also pushing the performance bias with its Small Hybrid Sports concept. And exploring a parallel technology path, it also showed for the first time in Europe its FCX fuel cell concept, on which it says it will base a vehicle to be marketed in a limited way in the US and Japan in 2008.

So whilst Toyota and Honda are leading the way with their hybrids and with it, they hope, taking leadership of the overall 'green' race, other European brands have a different environmental approach and others were noticeably lacking a clear statement of how they are facing the environmental imperatives.



*Mercedes BLUETEC diesel engine*

Mercedes-Benz was singularly focused on promoting its vision for cleaner diesels. Its BLUETEC technology was shown for the first time in a 4-cylinder engine in the new C-class, the debut of the replacement of its best selling model. Mercedes-Benz claims BLUETEC shows the way ahead for meeting Euro VI emissions legislation.

Meanwhile, Saab has taken its alcohol fuels strategy a stage further with its BioPower100 concept that runs on E100. This fuel is 100% percent bio-ethanol as opposed to the 85-15% split of E85 which can power its production 9-5 BioPower. Saab has also taken the opportunity for its concept car to modify the engine, raising the compression ratio to 11:1 to exploit the potential of the fuel to give 300bhp performance.

Performance-wise, this is no match for Koenigsegg's latest creation. Taking the bio-ethanol theme to greater extremes, the Swedish supercar manufacturer has developed the 1018bhp CCXR. How green such a high output supercar can be is a matter of opinion, but it certainly is far more palatable than an equivalent-sized engine guzzling petrol.



# Feature

Although powertrain and propulsion tended to dominate the technology message, innovation in other areas was also on show. Generating much interest, the Hyundai HED-4 Qarmaq, developed in conjunction with GE Plastics, showcased how new composites can be used in ways which would be infeasible using sheet metals. Hyundai also claims that it is a study into an ecological SUV, exploiting lightweight properties of the plastics used.

Another major plastics manufacture collaborating in the development of a show concept was Bayer MaterialScience. Its glassy yellow Makrolon polycarbonate panels enhanced the exposed feel of the 2-seater, open-wheeled eXaxis concept from Rinspeed the local Swiss tuner. Bayer MS also provided various other materials and surface finishes to suspension, instruments and control.



*Hyundai HED-4 Qarmaq pre-show teaser*

Nowadays there is seldom anything new at motor shows that hasn't been carefully released to the media prior to the event. Nevertheless, premieres of production cars remain the first chance to see new vehicles in the metal.

Already featured in the latest *James Bond* film, and following on from the highly acclaimed S-Max which is based on the same platform, Ford unveiled the new Mondeo. Larger and bolder than its predecessor and continuing its kinetic design language, Ford is hoping for success in the highly competitive D-segment. This was the first showing of the sedan version, the estate having been unveiled at Paris last year

In the premium sector, Audi launched its A5 and S5 coupés together, BMW its new M3, Volvo the V70 and XC70 and as mentioned earlier, Mercedes-Benz its new C-Class, all looking to bolster their ranges in this competitive part of the market. Jaguar released some updates to freshen its XJ offering. More important for the long-term future of the British marque is its rejuvenated design language shown in the CXF and which will make its way into its forthcoming S-Type replacement.

Moving down to B-segment, the new Mazda 2 made its debut. Interestingly, it is smaller (by 2cm) and lighter (by 100kg) than the car it replaces, unusual in these days when cars are getting bigger and heavier despite the need for lighter weight for improving fuel economy.

Another notable small car launch was the new Renault Twingo. Whether it will capture the imagination of Europeans in the way its predecessor did remains to be seen. It arguably does not have the same visual impact relative to the competition that the original had.

It was not only new cars that were generating interest. There were noticeable returning and new brands.

The presence of the famous Abarth brand on its own stand was a welcome return. The scorpion badge will adorn future high-performance Fiat products and racing cars. A 150bhp Grande Punto Abarth is the first reincarnation of high-performance Fiat with a sting in the tail.

*“We should expect to see the emergence at Geneva of a number of similar companies over the next few years but this will only add to the appeal and importance of this motor show”*

Brilliance, the Chinese manufacturer, had a stand for the first time and showed three models including the BC3 designed by Guigaro. Although on close inspection not yet at the quality level of the European brands with which they wish to compete, they are, however, impressive examples of how quickly the Chinese industry has developed. They also sound a warning that it won't be long until they have closed the gap in same way as the Japanese and Koreans did a long time ago now.

We shouldn't be surprised to see more companies joining the party and exhibiting at Geneva over the next few years but this can only add to the appeal and importance of this motor show. The accessibility and diversity will keep exhibitors and visitors coming back, so roll on next year.

*Pete Morgan*

## Engineering success on the track – creating the Lotus Sport 2007 GT3 race car

When George Mackinstosh and Sam Blogg hurtled their Lotus Sport Exige GT3 across the finish line in September's rounds 15 and 16, securing victory in the 2006 British GT3 Manufacturers Championship for Lotus Sport, it wasn't just Silverstone, the venue, which erupted into spontaneous celebration. Champagne corks started popping at Group Lotus' UK corporate and engineering headquarters in Hethel, Norfolk.

Lotus Engineering has been a key part of the team, working hand in hand with Lotus Sport. Its activities included development and calibration of the race engine, optimisation of the race car vehicle dynamics and suspension geometry simulations and FEA analysis of the lightweight rear sub frame and structural carbon rear under tray. This helped the speed and reliability record of the brand new car, that allowed Lotus Sport, with teammates Gavan Kershaw and Barrie Whight, to triumph.



2006 GT3 race car in action last year

Though the Lotus Sport team and its cars ran pretty well like clockwork throughout the 2006 season, developing the 2007 GT3 was anything but routine – even by the often extraordinary standards of top-level international motorsport.

The engineering programme ran to a schedule so acutely compressed that it was to challenge even an organisation as flexible and responsive as Lotus. There were just eight weeks from the programme being formally approved to the first FIA Balance of Performance test at Nogaro, France.

The reason for the rush was that two major changes were necessary to keep the car competitive for a full-scale assault for the 2007 season, both of which needed to be completed before the car was homologated. These were a vital performance upgrade and, more remarkably still, the all-new body style.



Wind tunnel testing the 2006 car

### Conceptual design

A major part of the conceptual thought behind the 2006 and 2007 race cars came as a result of the close working relationship between Lotus Sport and Lotus Engineering. This relationship proved to be of great benefit in achieving the daunting timescales imposed by the programme.

The two major focuses of attention for the engineering programme for the 2007 GT3 car were the reduction of high speed drag and achieving the necessary 350bhp at 7000rpm and 305Nm at 6000rpm for the 1.8-litre engine.

Low aerodynamic drag is a prerequisite for fast laps on FIA European GT's immensely fast circuits such as Monza. In short and intermediate circuits (mostly the British GT championship circuits), the emphasis shifts toward high down force to enhance handling. In all racing series, the rules are very stringent and the cars are very closely matched. Consequently, even minute gains in aerodynamics, power or chassis performance can be truly decisive. Aerodynamic drag has a huge impact on speed. When a car is running at 200mph, improving its drag coefficient by just 0.007 adds one full mile per hour to its speed. So to be more competitive, we had to reduce drag beyond the standard Exige road car.

# Feature

The 2006 car was based on a road-going Exige with extended wheel arches. As a result the road car aerodynamics are biased towards high down force and large radiator inlet aperture for cooling at low speed.

Unfortunately it was necessary to increase the frontal area to accommodate a new 2-inch wider rear wheel. However, the vehicle wake was, in fact, reduced by redesigning a number of other areas, some of which resulted from moving to charge cooled engine, allowing a redesign of the roof, rear clamshell and engine cover.

Consider that on an average OEM vehicle, cooling package (including radiator, intercooler, oil cooler, etc) contributes approximately 30% of total percentage drag, and the exterior bodywork about the same again. It was necessary to revise the front radiator inlet and outlet areas, reducing both cross sectional areas of both. Full front wheel coverage was achieved and the nose extended forward by approximately an inch.

Major design changes are more evident on the rear, with the bodywork growing 3-inches rearward, 5-inches in width and losing almost an inch in height at the rear deck, and moving to a much more conventional 'fastback' design. The GT3's rear deck lid has the effect of a sheered-off tail, giving a no-nonsense appeal but, more importantly, a reduced wake. Integral rear wheel arch vents have been incorporated into the rear clam.

Charles Clarke of Racecar Engineering once said about Lotus Sport – and particularly the Lotus Sport Exige (the V6 GT2 car currently plying its trade on the circuits of South East Asia): “*The ‘In six months’ reply would have been met with howls of laughter,*

*but not at Lotus*”. The entire engineering and build programme for that car took just six months. So the time frame for the 2007 GT3 model of “*in two months*” was met with a wry laugh.... but eight weeks was no joke!

This was only possible to achieve through implementing a concurrent engineering strategy, in which tasks are done in parallel and there is an early consideration for all aspects of a product development process. This strategy focused on the optimisation and distribution of the resources of many Lotus departments, including facilities such as the pattern shop, materials engineering, design and machine shops.

## Bodywork design

The restrictive timeframe meant that to undertake the new body programme, some traditional methods were employed.

A small, dedicated design and manufacturing team was established, consisting of one designer, one studio engineer, one aerodynamicist and a handful of skilled pattern makers. The deliverables were simple; create whole new aerodynamically cleaned and efficient, front clam, roof, engine cover, oversills and rear clam. Pattern work was completed within just four weeks, moulds taken in three days, and parts produced in two days, and to achieve this we revisited a manufacturing technique we have used only once before.

The parts were made in lightweight ZPREG carbon fibre using an innovative mould-making process that featured room temperature curing. The moulds were taken directly from the master clays and the resultant carbon fibre panels were race-ready without



Designer's sketch of 2007 GT3 race car



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having to rely on the costly tooling that customarily is coupled with present carbon fibre technology. The clay was released with a liquid wax as you would a plaster mould but then an axson gel coat and fibrous putty system was used to generate a mould straight from the clay.



*Rear clam (rear three-quarter) pattern view*

This low-temperature curing pre-preg is made exactly the same way as conventional pre-pregs but has a resin chemistry that allows curing to be achieved at temperatures from 60 degrees. The flow profiles of the low-temperature resin systems allow for the use of vacuum bag pressure alone, again avoiding the need for high-pressure autoclaves.

The choice for the ZPREG material was largely dictated by time constraints. Since it is two specific fabrics laminated together, it consists of a surfacing ply and a backing ply. The surface ply consists of a lightweight fabric laminated to dry medium weight fabric stripes of resin. The resin impregnates the lightweight fabric sufficiently to provide light tack, whilst the heavier inner fabric retains a dry surface. This format ensures air is channelled away from the tool surface before the resin strips close. The backing ply is formatted with heavier fabrics for rapid deposition, with resin stripes applied to one surface to provide a light tack for easy lay up. Both surfacing ply and the ZPREG bulk plys handle as if they were 'dry' un-impregnated materials giving excellent drape characteristics. This significantly reduces manufacturing times compared to resin infusion and wet lay-up process. When compared to standard pre-preg processes, the reduction in laminating times can be as much as three-quarters.

## *Engine design*

Lotus Engineering's work on the 1.8-litre VVTL-I 4 cylinder Toyota 2ZZ-GE engine has been pushing the boundaries of just what is attainable from a production road car engine. It has evolved from 189bhp to 243bhp to 252 hp to 285 bhp to 355bhp power with 315 Nm of torque in its 2007 GT3 race specification, an 88 % increase in engine power over its base specification and a colossal 197bhp/litre in race trim. In comparison the Porsche 997 GT3 generates 111.1 bhp/litre and the Aston Martin DBRS9 achieves 82.5bhp/litre in race trim.

## *Rig and vehicle prototype testing*

By early February 2007, the body and engine programme designs were in a definitive form and it was time to commit to hardware for both body tooling and engine dynamometer testing. This date in itself represented additional challenges. It was one week later than planned, but it had been decided to take the extra time to finish optimisation of the vehicle at the expense of compressing the manufacturing time still further.

Just three weeks remained before the 2007 prototype GT3 car's first trials on the Paul Armagnac Circuit, in France – a seemingly impossible schedule. The highly compressed time pressures of the programme were such that it was necessary to carry out a considerable amount of parallel working between design, CAE, prototype manufacturing and testing.

The dynamometer tests and carbon panels were successfully accomplished and the units delivered on schedule. The car completed one day's shakedown on Lotus' own test track, before transport to compete with the high-pedigree European GT3 cars at Nogaro, France. Minimal running in the car would normally be the team manager's worst nightmare, but the team lined up at the start confident that initial positive, yet limited, testing would lead to a decent showing in the FIA Balance of Performance tests. The car successfully completed two days arduous testing at the high-altitude circuit, with only minor teething issues present.



*2007 Lotus Sport GT3*

## *Bring on the first race!*

It all bodes well for the upcoming season. With the same drive, dedication and talent that was on display throughout the successful 2006 season, the ultimate goal for 2007 is the drivers championship. Bring on the first race at Oulton Park.

*Louis R Kerr*

## How to ensure motor sport is relevant in a future grappling with global warming

Lotus has always seen the value of racing with regard to the development of attractive products to a sports-minded clientele. "Racing improves the breed" is an oft-used mantra which in most cases, if true, only really applies to a few marques which can benefit directly from involvement. However, there is another opportunity for racing to improve the entire automotive breed when it can stimulate changes which are beneficial to society at large.

Simultaneously as the world changes and public alarm increases regarding global warming and mankind's role in it, there is a significant danger that motor sport will be seen as out of touch with the zeitgeist and be increasingly marginalised as irrelevant. Worse still, it could become a target for radical groups intent on outlawing it because of a perceived poor environmental image, in a manner similar to the targeting of 4x4 vehicles in some countries.



*Lotus' F1 successes relied on innovation*

If this is to be avoided, then the environmental image of racing in general has to improve. With the success that the industry has had in combating the primary pollutants HC, CO and NO<sub>x</sub>, the car itself is primarily seen as a cause of environmental problems because of the amount of CO<sub>2</sub> it emits. Because the overwhelming amount of this CO<sub>2</sub> comes from fossil-based fuel then one approach to improving the public image of racing that the governing bodies could take is to encourage fuels which can only come from non-fossil sources. Then racing would become a microcosm for what society at large is trying to achieve and could become a standard-bearer for environmentalism instead.

The steps for this could be relatively straightforward. Since great stock is being placed in bio-fuels and bio-alcohols in particular, and since these fuels are arguably better fuels for spark-ignition engines, then encouraging lower formulae to use E85 (85% ethanol and 15% gasoline by volume) in SI engines in the short-to near-term would seem attractive option. By lower formulae we are imagining everything except Formula 1, which is a special case and will be returned to later. Accepting that there is a role to play in motor racing for diesel engines, then racing fuels for such engines should also be made to have a green and renewable image. Rather than mandating a bio-diesel, which may or may not present challenges for fuel injection equipment suppliers as well as OEMs, Lotus' suggestion is that a controlled synthetic diesel fuel be introduced, one which may be made from a biomass-to-liquid (BTL) Fischer-Tropsch process. This can ensure that it is seen as a fully-renewable fuel. Such a BTL diesel fuel is significantly cleaner-burning than a conventional fossil-sourced diesel fuel, and so a second benefit in lower emissions can be claimed.

In a similar manner, the 15% gasoline in E85 could and should be from a BTL route as well. This would ensure unimpeachable environmental credentials for SI and CI engines in motor racing, and, because the specification of Fischer-Tropsch fuels can be tightly constrained, uniformity of FIA-sanctioned E85 and BTL diesel can be assured. It is not without good reason that a great deal of the fuels used during Formula 1's turbo era, when fuel regulations were relatively free, were manufactured by Sasol, the South African oil company which is the world leader in industrial production of synthetic fuels by the Fischer-Tropsch process. The fact that BTL diesel contains less energy per unit volume than conventional diesel can be accommodated in a rule change to the size of permitted tanks; such a rule change would have to be implemented for any switch from fossil gasoline to E85 as well. It is serendipitous that both E85 and BTL diesel contain lower amounts of energy per unit volume with respect to their fossil-sourced equivalents, so we anticipate that this difference can be relatively easily absorbed.

These are the changes that Lotus believes are sensible for all formulae except Formula 1, meaning that, as long as there is a validated biological feedstock for the Fischer-Tropsch process used to manufacture the diesel and gasoline used in the E85, the subject of racing's environmental impact can be taken off the agenda. As previously mentioned, it could actually find itself in a situation to which the rest of society should aspire.

Formula 1 is a special case. Historically it has been seen as a forcing-house for technical innovation, but recently this image has become less valid. The reason here is that ever-stricter technical regulation has been enacted in the belief that this is the way to control costs. This is not necessarily the case. Stricter regulation results in a requirement to spend ever larger sums of money searching for incremental gains from small improvements to an already massively-refined recipe. As a consequence, a mindset is adopted by the commercial interests involved that tighter and tighter rules are to be applauded. In the past, this stopped small

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teams like Lotus and Brabham and others from making leaps of innovation. These smaller teams, which never had large budgets and consequently had to rely on successful innovation instead, had a habit of upsetting the status quo and wrong-footing the better-funded teams following a more conventional path.

With regard to improving its environmental image, the FIA has recently announced new regulations, something which has been called for for some time by many people, including observers from Lotus Engineering. Such a step-change in regulations presents significant opportunity for forcing technical progress in the direction of energy efficiency and a key factor is the promotion of innovation.

The concept that innovation can triumph over convention is exactly the sort of scenario that should be possible in Formula 1, if it is to return to being a hothouse of technical progress. Years ago, Lotus' founder Colin Chapman proposed a racing formula based upon a box that the car should fit in together with maximum and minimum vehicle weights. Beyond this, anything would be accepted – engine, aero, materials, mechanical layout, anything. Lotus refined this idea in 2004 (in an article published in *Automotive Engineering*) to include the concept that there should be a limit to the amount of energy available to finish the race – the actual fuel type itself was free. Therefore, the winner would be the driver who completed a fixed distance fastest on a limited amount of energy, which is analogous to improving efficiency. The relevance of this to the real world – where a journey needs to be completed with the maximum efficiency for minimum fuel consumption – is readily apparent.

***“The concept  
that innovation  
can triumph over  
convention is exactly  
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that should be possible  
in Formula 1”***

Since the energy contained in the fuel is ultimately what propels the vehicle, opening up choices on this front will encourage choices based on the maximum efficiency that can be realised from the fuel. This has direct feedback to engineering passenger cars for reduced fuel consumption, itself necessary for reduced CO<sub>2</sub> output and increased energy security. Such a move would vastly improve the relevance of motor sport to the general public, especially if it were mandated that the fuel should be an FIA-approved one, selected on the grounds of CO<sub>2</sub> impact.

In Lotus' opinion, the permissible fuel list would include any of the alcohols which could be made from a biological route, any BTL fuels or any proportion of the two mixed together. Hydrogen would also be permitted (should anyone believe that the problems of hydrogen storage on a vehicle could be solved sufficient to imagine a racing car fuelled on the gas). Other energy sources could be lobbied for and the role of the F1 Technical Committee would include ensuring an equal amount of energy was available for each car to complete a race.



***Lotus Type 88 – innovative twin-chassis outlawed  
by regulation changes***

The 2004 Lotus Engineering article also called for a lower energy allowance than was typically used in a race under the old formula – say, 75% – and the specific allowance of hybridisation. This point the FIA has already picked up on with the introduction of “kinetic energy recovery” devices, but the regulations limit the amount of power they can supply to 80bhp for less than seven seconds.

With regards to encouraging technical progress, arguably it is needlessly restrictive to set a limit on the amount of energy that can be recovered and the power that can be supplied back to the vehicle. Given the cost of engineering the system, would it not be of more benefit to society at large to encourage F1 engineers to make their systems as capable of as much regeneration as possible? Restricting the devices is in danger of being seen as nothing but a short-term sop to the green lobby by the FIA which will not massively assist the development of road-biased technology.

These proposals would ensure that the image and value of Formula 1 and motor racing in general would become cutting-edge in the modern world, which faces significant challenges in reducing CO<sub>2</sub> output from passenger vehicles. The wealth of expertise and talent in racing would then be focused on driving efficiency up, and for the manufacturers involved, there would be a re-establishment of another old adage – “win on Sunday, sell on Monday”.

***Jamie Turner, Senior Technical Specialist,  
Chief Engineer – Powertrain Research***



## Interview with PSA Peugeot Citroën's new chief executive, Christian Streiff

Christian Streiff, 52, specialises in trouble – high-profile trouble at that. He was the turnaround man at Saint-Gobain, the French glass and building materials where he spent 24 years and rose to chief operating officer in 2004 as a result of his success in turning round troubled divisions.

He then went to the top job at Airbus, charged with sorting out the mess in the commercial airliner business. But he found it impossible to manage the two warring shareholders of French and German governments and resigned within three months to emphasise the gravity of the position and the need for difficult decisions.

He was immediately recruited by PSA Peugeot Citroën to succeed Jean-Martin Folz as chief executive and chairman of the new PSA Managing Board. Folz had also been a predecessor of his at Saint-Gobain. The PSA structure had its own difficulty in that Robert Peugeot, who chairs the holding company managing the family's 44.9% share in PSA, was a member of the vehicle maker's executive board.

His job was director in charge of innovation and quality. When Streiff arrived from his spat with the French (and German) government, he became Robert Peugeot's direct boss, while Robert Peugeot was Streiff's superior as largest shareholder on the supervisory board.

It took a little while to simplify – particularly when Streiff's first 100 days of research into the company's difficulties revealed that major change was needed in product innovation and quality.

Streiff has given ten teams of ten people until the beginning of May to come up with a number of solutions to problems that he has identified.

Problem number one is that PSA is losing market share in Europe and has been for five years. The problem had been masked by success in China, Eastern Europe and South America. It was falling profit that brought matters to a head. After making 3,115,500 cars and selling them for GBP30bn in 2006, the group made a profit close to zero.

*"I am passionate about this business but it is not an easy one. It encompasses fashion trends which have to be created in volume production. And they are very complex products."*

*"The environment in which these products are created is constantly evolving."*



Christian Streiff

### Education

Engineering degree from the Ecole Nationale Supérieure de Mines de Paris.

### Career

#### Saint-Gobain

- 1979 – 1982: Production Manager, Halbergerhütte foundry, Germany (cast-iron automotive components).
- 1982 – 1985: Vice President, Planning and Strategy, Fiber Reinforcements Division.
- 1985 – 1988: Director, Gevetex Plant, Germany (fibreglass for electronics).
- 1988 – 1991: General Manager, Gevetex.
- 1991 – 1994: General Manager, Vetri SpA, Italy (packaging).
- 1994 – 1996: General Manager, Saint-Gobain Emballage, Paris.
- 1996 – 2000: President and Chief Executive Officer, Pont-à-Mousson SA, Nancy.
- 2001 – 2003: President and Chief Executive Officer, High-Performance Materials Division, Paris.
- 2004 – 2005: Deputy Chief Executive Officer of Saint-Gobain.

#### Airbus

2006: President and Chief Executive Officer of Airbus.

#### PSA Peugeot Citroën

7 November, 2006: Special Advisor, reporting to the Chairman of the Managing Board.

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*"Having said that, I have only been here for three months so I have to remain cautious. There is a limit to the number of hard conclusions that I can draw.*

*"We had a good five years between 1997 and 2001. Volume grew from 2,200,000 to 3,500,000 and we managed the renaissance of the Citroën brand. Our international volumes trebled to a million.*

*"We introduced the platform strategy (common platforms and their derivatives for Citroën and Peugeot models) and developed the co-operation strategy." (PSA is the pre-eminent manufacturer for reducing costs by sharing engine development and whole vehicle development with other makers.)*

*"However, from 2002 onwards we have seen a drop in European market share. We know the reasons.*

*"The rhythm of product roll-out was too slow or mistimed; we were not in the right segments and the range did not have the right breadth; the design was missing the vital spark.*

*"There was poor quality and costs were running out of control."*

As a result, profitability moved from the best in the industry to amongst the worst.

Streiff said that quality was the number one priority. Nothing else would work unless the product quality was right. Throughout Europe, both Peugeot and Citroën brands score low on customer and dealer satisfaction indices.

Streiff believes that there is a great opportunity within Peugeot because of the joint venture cooperation agreement on the production of small cars. Toyota is not just the most admired volume car company in the world and the most profitable; it also has the best quality and reliability record. By working together, Streiff believes, Peugeot will learn much from the Japanese giant.

*"Quality needs fundamental change over the next three years. This will remain a key battleground for the next decade and must be a constant priority throughout the company."*

The problem of costs is being discussed with the unions who have already expressed opposition to the closure of another plant. The British plant at Ryton in Coventry was closed last year.

***"We have a good existing base providing an excellent spring board for the future?"***

Despite the declining sales and profit, personnel cost had increased by 10%. The sales decline in Europe meant that fewer people were needed.

Purchasing is the second target for cost saving. *"We must increase the number of winning projects but on a win-win basis with our suppliers."*

The way to reduce the cost of vehicle assembly was to produce even more economic vehicle platforms and to simplify procedures. *"We must make productivity gain an universal obsession within the company."*

It seems that there was too much centralisation of operational responsibility so that within the cost centres there was no culture of preoccupation with profitability.

Streiff said that he had ordered a six-month review of future product plan which would report in September.

The next raft of products had to have reduced costs and development times and all procedures had to be simplified.

The international spread of the PSA vehicle business is strong.

*"We have a good existing base providing an excellent spring board for the future. But to be international we have to act local."* That means using Chinese, Argentinean and Brazilian skills in their own countries.

The main operating board has changed radically. Streiff has created heads of the Citroën and Peugeot brands that both focus on selling. The other two full-timers are a director of programmes and a director of operations.

Gregoire Olivier came from the telecoms company Sagem and had been CEO of Faurecia for just over six months before being plucked out to run vehicle programmes. It is a rapid promotion and potentially makes him a right-hand-man to Streiff.

The head of operations is Roland Vardnega, who is a long serving PSA executive with many years of experience in manufacturing. Frederick Saint-Geours is in charge of the Peugeot brand and Gilles Michel takes charge of Citroën after previously being responsible for platform sharing. Before the Peugeot family recognised the need for change, Michel had looked like a natural successor to Jean-Martin Folz. He also was a Saint-Gobain senior executive.

The executive committee that Streiff chairs runs the broader affairs of the company. Yann Delabrier, who was the CFO, has gone to fill the hole as CEO of Faurecia and is succeeded by Sylvie Rucar, who has risen through the finance department for 30 years.

Innovation is the responsibility of another woman, Isabelle Marey-Semper. She is another telecoms expert, having been recruited from Thomson to do long-range strategy. A third woman is Liliane Lacourt, the very experienced head of communications for the



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group. Streiff has two men to keep him company in that forum – Jean-Luc Vergne who is head of human resources and Jean-Claude Hanus, the company lawyer and head of institutional relations and the internal audit.

The changes will put the responsibility for the product plan in one division. *“We must continue to differentiate the brands but that change will make us more efficient.”*

By grouping together engineering and production in a single team, designers and development engineers will share with the production staff the quest for productivity gains *“that must underpin development.”*

Streiff has personally taken responsibility for purchasing and will have to deliver component cost savings which are always so elusive in the motor industry. Interestingly, he will have to negotiate with Delabriere at Faurecia.

When the working groups report back (some of them have been given six months rather than three) in May, Streiff will then review them for a further 100 days before sharing the grand scheme with 1,000 managers at meetings in September.

That will coincide with announcement of the interim financial results. The expectation is that losses will worsen.

Streiff said: *“Capacity utilisation will remain lower than the new targets and the high cost of raw materials will continue to have an impact.”*

Some of the important models are coming up for replacement and sales could be slower than in the last six months but there is a rich seam of new models coming through. The Peugeot 207 and Citroën C4 Picasso have already been very well received as has the new jointly developed light van (Fiat was also a partner) – the Peugeot Expert/ Citroën Dispatch.

Close behind come the launches of the 207 convertible coupé and the Citroën C-Crosser which is the first attempt at a compromise between SUV and large saloon. There will be three further cars in the year – all in what is described as the profit *“sweet spot”* for the company.

The average age of the passenger car line-up had risen to an unacceptable four-and-a-half years last year. By 2009 it will have fallen to three years. But with new product pouring out of all the major vehicle makers, it will be expensive to maintain and may not even create competitive advantage. But it has to be done.

In this financial year, the product quality initiative will have an impact on warranty payouts, and the closure of Ryton and the ramp-up in Slovakia will cost money that did not have to be spent last year. But the team is budgeting for a saving of EUR600m in manufacturing costs.

Streiff has joined the company at a difficult time. But he looks like he is enjoying himself and expresses no misgivings. When reminded of the difficulties by his interrogators he has a stock answer: *“I do have a certain reputation for turnarounds.”*

**Rob Golding**



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