

Creation of Lotus Lightweight Structures Limited

Q&A with Carbon Motors' Trevor Rudderham

Visible locking nut set to put end to wheel loss



Welcome

It is clear to the staff at Lotus that we are in an exciting period of growth. New clients, new projects, new cars in the pipeline and new recruits to our engineering team all make for interesting times. But most of this is hidden from the outside world. After all, we are in an industry where confidentiality is key – ‘Careless talk costs jobs’ declare the posters at our Hethel headquarters.

Fortunately the wide range of research activity going on within our R&D groups has given us plenty to share in proActive over recent editions. However, two particular announcements made this month highlight other important and public successes for Lotus.

The creation of Lotus Lightweight Structures Limited from our acquisition of Holden Lightweight Structures Limited is a fantastic extension to the capabilities and technologies Group Lotus offers clients in lightweight structures and niche vehicle manufacture. These are our established areas of expertise that also led Spyker N.V. to select Lotus Engineering as its partner in the development of its new models. More on these stories in the news section.

There is also an interview with Carbon Motors, another client that has selected Lotus as its engineering partner for our vehicle engineering expertise and technologies, and another rare example of where we've agreed to make public our relationship.

We seldom disclose who any of our clients are, but it's nice to be able to when we can.

Peter Morgan

Marketing Manager – Lotus Engineering



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Industry News

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Jaguar and Land Rover will retain their distinctive identities and continue to pursue their respective business plans as before

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INDIA: Mercedes-Benz sees CNG opportunity

High fuel prices impacting public sector fleets and increasingly frugally minded retail buyers are encouraging Mercedes-Benz to introduce more Compressed Natural Gas (CNG) powered cars in India.

The Economic Times reported that Mercedes has already imported a couple of CNG-compatible cars in Delhi and Mumbai and plans to bring its globally-successful CNG sedans to India.

“We have some cars running on CNG in India. It's a successful technology and has been developed over the years. We are also trying the biodiesel option on the E Class saloon here. If these extensive trials are successful, we shall introduce these cars in India too,” said a Daimler India senior executive.

It has already launched its B Class B170 NGT and the E 200 CNG sedans in the US and Europe and plans to extend them to India. For its new CNG range in India, Mercedes is banking on institutional sales where vehicles ply largely on CNG technology, the report says.

Source: just-auto.com editorial team



UK: Jaguar Land Rover names new CEO as deal completes

Tata Motors has completed its US\$2.3bn purchase of Jaguar Land Rover (JLR) from Ford in an all-cash transaction, contributing about US\$600m to the JLR pension plans, and named a new CEO for the unit.

Current acting CEO David Smith has been confirmed in the role and replaces Australian Geoff Polites who died recently. Smith has 25 years of experience with JLR (most recently as CFO) and Ford. Before his recent return, he was director of finance and business strategy for PAG and Ford of Europe.

Smith said: “We are very pleased with the association with Tata Motors. We look forward to a sustained bright future for the company and its stakeholders.”

At a handover ceremony at the beginning of June at JLR's Gaydon headquarters in the UK, Tata Sons and Tata Motors chairman Ratan Tata said: “We are looking forward to extending our full support to the [JLR] team to realise their competitive potential.

“Jaguar and Land Rover will retain their distinctive identities and continue to pursue their respective business plans as before.”

Tata Motors said JLR had been acquired on a cash-free, debt-free basis and the deal included the ownership by JLR or perpetual royalty-free licences of all necessary intellectual property rights, manufacturing plants, two UK design centres and the worldwide network of national sales companies.

It said long-term agreements had been reached for the supply of engines, stampings and other components to Jaguar Land Rover while other areas of ‘transition support’ from Ford included IT, accounting and access to test facilities.

“The two companies will continue to cooperate in areas such as design and development through sharing of platforms and joint development of hybrid technologies and powertrain engineering,” Tata said.

Ford Motor Credit Company will also continue to provide financing for dealers and customers for a transition period.

“Tata Motors is in an advanced stage of negotiations with leading auto finance providers to support the JLR business in the UK, Europe and the US, and is expected to select financial services partners shortly,” the automaker added.

Source: just-auto.com editorial team



Jaguar XF interior



London taxis could be turning green

UK: London seeks partner for low carbon taxi demonstrator

The mayor of London, Boris Johnson, has announced funding of GBP1m to trial low carbon technology in London's taxi fleet.

Funding for the project comes from Transport for London (TfL), through its climate change fund, and Cenex, the UK's national centre of excellence for low carbon and fuel cell technologies.

As part of its carbon reduction strategy, TfL's Public Carriage Office is keen to work with vehicle manufacturers to introduce taxis with lower fuel consumption and carbon dioxide emissions. The funding will be used to introduce a low carbon taxi demonstration project in London and vehicle manufacturers will be asked to register their interest in supplying the cars.

Cenex said that suitable low carbon technologies might include stop-start or 'micro-hybrid' technology. London's taxis spend about 40 % of their time waiting at taxi ranks, at traffic signals, or waiting to pick up or drop off passengers. A micro-hybrid taxi could reduce CO₂ emissions by 10–15 %, said Cenex.

David Brown, managing director of surface transport at TfL, said: "We are committed to reducing the impact of public transport on the environment, and have already taken significant steps to clean up emissions of particulates and nitrogen oxides from the taxi fleet. Now it's time to tackle carbon dioxide emissions.

There are over 21,000 taxis in circulation in London."

Robert Evans, CEO of Cenex, said "Cenex is looking forward to working with TfL to procure and trial innovative low carbon vehicle technology in London taxis. We believe this project will attract a great deal of interest from both consumers and the motor industry."

Source: just-auto.com editorial team

UK: New Nissan to replace Micra at Sunderland

Nissan said it would build an unnamed "innovative all-new compact car" at its Sunderland plant in north-east England, starting in 2010.

Reports from Japan said the new model would be a new compact SUV and that the UK government had kicked in a GBP6.2m subsidy to help start-up costs.

"Building on the success of the Qashqai, the all-new product will reinforce Sunderland's role as manufacturer and exporter of high-value products," the automaker said.

Nissan president Carlos Ghosn added: "By delivering on tough commitments, our employees at Sunderland have demonstrated our plant can be a globally competitive centre for the production of high-value products. We are encouraged by the proactive support shown by the UK government to decide new products for the Sunderland plant."

Nissan said the new vehicle would be an addition to its range, taking over manufacturing capacity created when production of the current Micra (March) ends in 2010.

Nissan will remain in the Micra's entry-level sector with a new, dedicated A platform that will be used for at least three models, including the next-generation Micra (and various Renault models), to be built in five of what it calls 'Leading Competitive Countries (LCCs)' – in other words, 'low cost'.

Production sites for this new family of compact cars will include the new plant in Chennai, India, being constructed by the Renault-Nissan Alliance.

Nissan Sunderland produced a record 374,000 vehicles in fiscal year 2007 and the automaker claims to be the largest vehicle exporter from the UK, with around 80% of production sold outside the country.

Together with the engine assembly plant and other facilities, Sunderland currently employs 4,700.

Source: just-auto.com editorial team

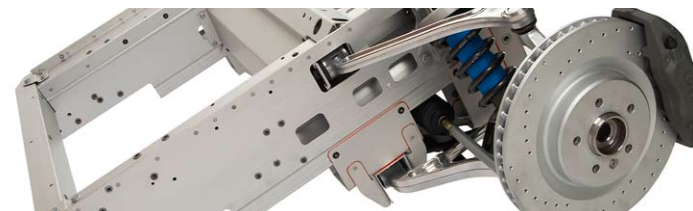
Spyker Cars N.V. and Lotus Cars Ltd Intensify Their Cooperation

Spyker and Lotus have reached agreement on the outline of their intended cooperation, which will include a Parts and Platform Commonality Agreement (PPCA), a Parts and Accessories Supply Agreement pursuant to which Lotus would provide certain parts for Spyker's new C8 Aileron and a concept Design and Engineering Agreement relating to all of Spyker's future models.

Victor R. Muller, CEO of Spyker Cars comments: "Our company has had a very fruitful cooperation with Lotus, developed over the past four years, relating to engineering services in respect of certain components of our cars, as well as in respect of worldwide certification. Spyker and Lotus have now come to the conclusion that they need to intensify their cooperation to the point that we intend to share parts and platforms, as well as an agreement on the supply of parts. Moreover, Lotus Engineering has become Spyker's preferred subcontractor in respect of a number of engineering projects relating to the Spyker C8 Aileron and the Spyker D8 Peking-to-Paris.

Mike Kimberley, Chief Executive Officer of Lotus Cars Ltd, added: "Lotus is very pleased to be identified as Spyker's preferred Engineering supplier for these unique 'high brand image' ground breaking cars. We look forward to working with Spyker to expand our global business opportunities, projects and interests for our mutually synergistic products and technologies. Lotus Engineering has a great heritage and solid track record in developing innovative solutions for clients and we look forward to using Lotus' advanced lightweight vehicle know-how and vehicle dynamics technology to enable Spyker to establish itself as a dynamic premium automotive player."

Source: Lotus Engineering



Lotus Lightweight Structures Limited

Group Lotus plc, announced the creation of Lotus Lightweight Structures, following the acquisition of Holden Lightweight Structures Limited.

Lotus Lightweight Structures, which employs 120 skilled engineers, technicians and sales staff, will be based at the former Holden Lightweight Structures Limited site in Worcester, UK and will continue to manufacture lightweight aluminium and composite structures and components for its extensive client base as well as growing its business globally through the company's association with Group Lotus plc.

Lotus Lightweight Structures will continue to assemble the award-winning Lotus Elise, Exige and Europa aluminium chassis as well as the all-new chassis for the yet to be launched Lotus Project Eagle.

The strategic acquisition of Holden Lightweight Structures Limited and the subsequent creation of Lotus Lightweight Structures enables Lotus to:

- Create, adapt and change its range of products quickly and effectively, catering for changing global customer demands.
- Provide an additional in house manufacturing facility.
- Add an additional manufacturing solution for Lotus Engineering's global client base, providing lightweight aluminium and composite vehicle components and structures.

Mike Kimberley, Chief Executive of Group Lotus plc said: "I am delighted to announce the creation of Lotus Lightweight Structures following the strategic acquisition of Holden Lightweight Structures Limited. With this facility, we will continue to expand and lead the world in lightweight vehicle research, development and production to help our global client base find ways to reduce the weight and cost from their vehicles. Weight reduction is one of the most attainable ways to lowering CO₂ emissions in vehicles today, as well as improving fuel economy and performance, and we have a duty to share our technology with the world's car makers for everyone's long term benefit."

Kimberley continued: "Lotus Lightweight Structures provides additional facilities, capabilities and expertise to the Lotus Manufacturing portfolio. The Worcester facility, and dedicated team, complements our Hethel Headquarters and does not substitute any of the operations in Norfolk, but instead enables our strategic global expansion programme to in the Spring of 2009. The Project Eagle chassis structure will be the first product from our new Lotus Lightweight Structures facility."

For further information on Lotus Lightweight Structures Limited contact Bob Dorney-Smith at bob.dorney-smith@lotuslightweightstructures.co.uk

Source: Lotus Engineering



Lotus excels in alternative fuel challenges

Lotus Engineering is celebrating after the Lotus Exige 265E Bio-fuel and the Exige 270E Tri-fuel proved once again that guilt-free performance can be achieved by winning awards in two of the most prominent alternative energy races across Europe.

The Lotus Exige 265E, the bioethanol research version of the Lotus Exige, won Best Coupé at the 2nd Alternative Vehicle Energy Monte Carlo Rally, while the Exige 270E Tri-fuel research vehicle, fuelled by biomethanol, won quickest Road Car at the Alternative Energy race at Santa Pod Raceway. Both events celebrate ecological vehicles that run on alternative energy and achieve yet more acclaim for Lotus Engineering's research and development into environmentally-conscious vehicles.

The Lotus Exige 265E competed over 900km, covering Switzerland, Italy and France against vehicles such as the Ferrari F430 Spider to be crowned at all three stages.

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The Lotus Exige 265E, the bioethanol research version of the Lotus Exige, won Best Coupé at the 2nd Alternative Vehicle Energy Monte Carlo Rally

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Organised by Automobile Club de Monaco, the rally began in Lugano, Switzerland, as part of the International Conference and Exhibition on Ecological Vehicles and Renewable Energies and concluded in front of the famous Monte Carlo Casino in the Principality.

Representing the highly acclaimed UK television programme *Fifth Gear*, presenter Tiff Needell raced the 270E Tri-fuel over a quarter-mile mile drag race on the famous circuit, posting the quickest time against entrants including the Nissan Silvia and Mazda RX7. Reaching speeds up to 110mph, the 270E was the only road car to post a sub-13 second time, to the delight of the thousands of supporters.

Lotus Engineering is spearheading research into alternative, renewable fuels and the recently introduced Exige 270E Tri-fuel is the latest development towards carbon neutral road transport. The successor to the 265E runs on any mixture of gasoline, ethanol and methanol. Emerging technologies will allow alcohol fuels such as methanol, already a proven internal combustion fuel, to be made synthetically from CO₂ extracted from the atmosphere.

Lotus launches Clark Type 25 Elise SC

Jim Clark is considered by many as the finest and most naturally gifted racing driver of all time. He won the F1 World Championship twice for Team Lotus in 1963 and in 1965.

In total, he won 25 Grand Prix races and was the first Briton to win the Indianapolis 500. Clark won a third of all the F1 races he entered, as well as racing in other formulae such as F2, F3 and Touring Cars. Typically he would race in as many as three different categories per race meeting! How many of the current crop of F1 drivers would do that?

In tribute to Jim Clark's achievements, Lotus, in association with Classic Team Lotus, is producing the Clark Type 25 Elise SC, with a donation for each of these special cars sold going to the Jim Clark Memorial Fund. This Elise, limited to just 25 cars in the UK (25 being the Type number of his 1963 Lotus F1 car and his number of F1 wins), has been authorised by the Clark family and coincides with the 40th anniversary of Jim Clark's death at Hockenheim in 1968.

The Clark Type 25 Elise SC was due to be launched at The Scottish Classic SpeedFair at Knockhill and formed part of a weekend-long tribute to Jim Clark. The Club Lotus Jim Clark Remembrance Weekend took place over the weekend of 7–8 June and was a fantastic celebration of the life of Jim Clark.

Mike Kimberley, Chief Executive Officer of Group Lotus Plc comments: “It is fitting that the latest version of our award winning Elise, the Clark Type 25 Elise SC, should celebrate the life of Jim Clark. It was also an honour to be able to unveil the car at Knockhill, Jim's local circuit where he raced so many years ago. Each owner of the Clark Type 25 Elise SC will be joining an unrivalled heritage that recognises motorsport's greatest partnership, that of Lotus and Jim Clark.”

The Clark Type 25 Elise SC draws upon many styling cues from the Type 25 Formula 1 car that Jim Clark raced to win the World Championship in 1963. The car, with a removable hard top as standard, is finished in British Racing Green with a yellow stripe along the centre and features high-performance Lotus Sport wheels, finished in an historic black and silver design.

The interior is inspired by the Team Lotus Formula 1 cars of the era, with black leather sports seats, trimmed with red leather and all finished off with a fantastic retro wooden gear knob.

The Elise SC is the most powerful production Elise ever produced and offers stunning performance. Power comes from a 1.8 litre non-intercooled, supercharged engine and uses intelligent cam switching technology, enabling the engine to switch to the high performance cam anywhere between 4000 and 6200rpm. This clever feature gives the engine two characters, allowing the car to be driven economically or giving maximum performance for spirited driving.



The Elise's lightweight gives low CO₂ emissions, great handling and affords phenomenal braking. Another benefit of the low weight is incredible acceleration, with the sprint to 60mph taking just 4.3 seconds and with 100km/h despatched in 4.6 seconds. The Elise SC accelerates on to a top speed of 148mph, which is 238km/h.

All Lotus cars offer exceptional handling and the Elise is no exception. The chassis has a seriously light, stiff structure. Combining this technology with the fantastic Lotus ride and handling gives an inspiring driving experience and the mid-engined layout of the Lotus Elise offers fantastic balance and agility.

The Elise SC offers a few technological advances that Jim Clark may have found helpful in his Type 25. Coming as standard on the Elise is traction control, ABS and sequential shift lights; however, all the driver aids are included to improve the driving experience and do not intervene unless really called upon.

The Clark Type 25 Elise SC is currently only available in the UK and Republic of Ireland and is on sale now. Price: GBP35,995 MSRP, and includes GBP5,750 worth of options for just £3,445. On-the-road costs are GBP950 MSRP

Source: Lotus Engineering

An integrated approach to driving dynamics – A workshop by Lotus Engineering

“ We had a steady stream of people asking if there was room for extra participants ”

To an ornithologist, March is often announced by the arrival of the first blue tits. To the Automotive engineer March is often announced by the arrival of the first flyers for the Stuttgart Expo.

This year was no different, but at Lotus we had been thinking about the Stuttgart event for a lot longer as one of the leading authorities for vehicle dynamics and automotive test and development.

Lotus agreed with the Expo organisers to hold a vehicle dynamics workshop. In an attempt to be more interactive, the Lotus workshop was a full participation event where we wanted to showcase the integrated approach Lotus takes to all aspects of driving dynamics, right from the early concept stage. It was also an opportunity to demonstrate the considerable advantages of some the tools we use such as the latest versions of the Lotus developed dynamics analysis software SHARK and RAVEN.

The workshop was conceived as an interactive session using a vehicle-level approach to understanding suspension concepts and design. The idea was to split the audience up into four groups, each supported by a Lotus CAE dynamics engineer. The groups would then be presented with a basic concept for a new vehicle. The participants were encouraged to help define the vehicle using a set of templates that allowed them to select things like engine position, suspension type and tyre size.

Once the fundamental vehicle layout and suspension were established the vehicle would be analysed using the Lotus software to show how user-friendly it was but also how easy it was to check the performance characteristics of the new vehicle. Furthermore, the participants were then asked to modify some of the characteristics and refine the model to improve its performance potential. Again, the revised model would be analysed and the new characteristics displayed.

The output data from the analysis was to be collected by the group and then presented back to the other groups, using a presentation template prepared by Lotus beforehand.

There had been healthy interest before the event, but to keep the event sensible we had decided to limit numbers to nine per group (36 in total plus the four Lotus team leaders.) On the first day of the Expo, we had a steady stream of people approaching our stand



Members of the Lotus workshop team: (seated) James Coleman, Steve Williams, Robin Auckland and Malcolm Burgess; (standing) John Bingham, Daryl Greig and Paul Harvey.

asking if there was still room for extra participants. Unfortunately, we were forced to say no, but started a waiting list should any of the confirmed not be able to attend.

By the morning of the workshop, this message had obviously been passed on as we had around 15 non-registered people turning up all hopeful of joining in. This actually proved to be a good move as we did have nine absentees, so we offered these places and actually allowed the rest in as spectators.

The room was arranged with four separate groups each with a laptop and large screen. Participants were divided into four teams and the workshop began. John Bingham, chief engineer of the Lotus Chassis Design group who had been architect of the workshop from its conception, introduced the session and explained that the aim was to provide the concept of an MPV vehicle. He outlined what was required and then passed over to the Lotus team leaders to kick off their individual sessions. Daryl Greig and Paul Harvey acted as facilitators for the session while the the four teams were led by:

Malcolm Burgess – chief engineer of the CAE group;
Steve Williams – principal engineer, Vehicle Dynamics CAE;
James Coleman – engineer, Vehicle Dynamics CAE;
Robin Auckland – engineer, Vehicle Dynamics CAE.

Which vehicle layout would you select – As a group, make a selection and add comments to explain your selection

	Corr Height	Mass	Mass Dist % front	Roll Inertia	Pitch Inertia	Yaw Inertia	Comment
Front Engine	0.55	2000	55	536	3735	4848	
Mid Engine	0.5	2000	50	536	3539	4652	
Rear Engine	0.55	2000	45	536	3735	4848	

Lotus Engineering 1 13/05/2008

The four groups selected markedly different vehicle layouts and defined quite different required characteristics. The team leaders inputted the selected layouts and set up the suspensions, and the software allowed a rapid solution of the models to show how quickly a range of options can be analysed. In each group the resulting

Selecting the Front Suspension

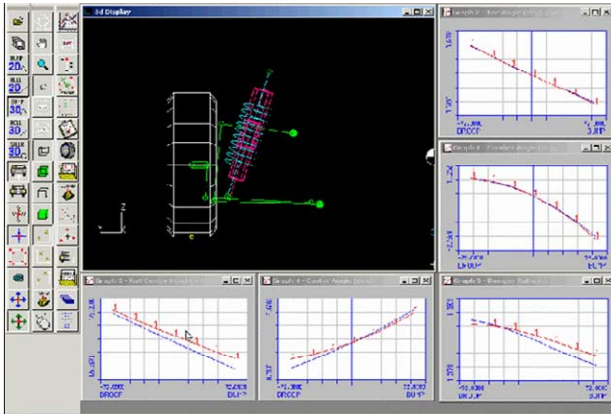
- You have a choice of two front suspension systems, each has its own benefits and compromises
- Select the suspension system that best addresses the needs of the vehicle type
- The two front suspension choices are:
 - Strut Suspension
 - Double Wishbone Suspension

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Extract pages from the workshop handouts showing the front suspension options and a worksheet.

An integrated approach to driving dynamics – A workshop by Lotus Engineering

“ Another participant was very impressed by the speed of solution and the real-time capability of the analysis ”



Typical output from SHARK analysis showing target and actual line converging.

vehicles had quite different characteristics. There was time to look at a few options to see if some of the characteristics could be improved and, this again showed the flexibility of the software (and skill of the users).

Malcolm allowed his group to go off script fairly early, but used the templates to outline the pros and cons of each of the suspension options and used the flexibility of the software to demonstrate how this could be supported. The models allow detailed review of the suspension types and layouts, together with their key characteristics. This group was also the most interactive with lots of input. Malcolm also avoided the prepared template for his presentation, favouring a simple list of choices and reasons behind them. This approach allowed all of the group members to present one or two summary items each and display what they had learnt from the experience.

In the end, all four groups presented their findings on time. The template provided technical data together with a summary page showing the advantages and disadvantages of their selected options.

Of course, in the real world this concept phase would be far more rigorous than that allowed by the timing of this event, but it did offer a tremendous insight into the power and capability of the Lotus SHARK and RAVEN software.

What was even more interesting was that even after two-and-a-half hours of fairly intensive workshop, there was still a reluctance on the part of some of the participants to leave. There were a number of small groups still discussing the workshop 40 minutes after we were scheduled to finish. It just shows how dedicated vehicle dynamics guys really are.

This period also gave us a chance to get some feedback from some of the attendees and it was all extremely positive.

One of the participants, Daniel Helguera Sanchez of Porsche, was very impressed by the speed and capability of the analysis. His particular field was steering but he understood clearly how this approach could help in getting the initial concept designs correct. Another, Richard Hurdwell of RHE, was impressed by the user-friendliness of the Lotus software and also the ability of the Lotus team leaders to manipulate it to achieve the results. Vladislav Drobny and Ondrej Vaculin from the Czech TUV SUD Auto CZ were very pleased to have got wild card entry and had thoroughly enjoyed the whole session.

Another participant was very impressed by the speed of solution and the real-time capability of the analysis.



Malcolm's group in deep discussion during the session.



James' group in attentive mood as they study the results. Everyone seemed to be totally engrossed in the sessions and this was confirmed by the feedback.

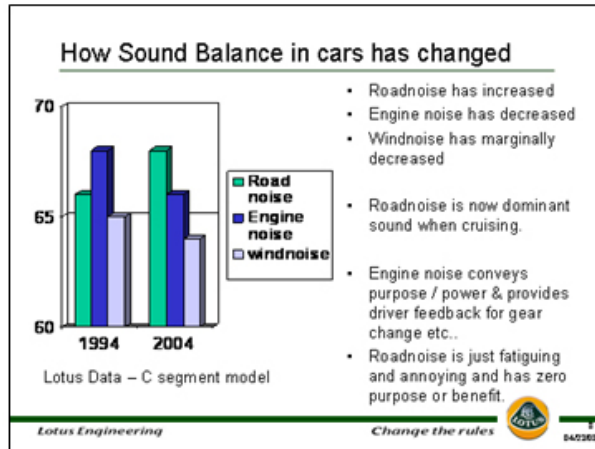
Others in the Lotus team also got very positive feedback. Danny Nowlem of ChassisSim was equally impressed and did not hold back with his satisfaction on the outcome in developing the ideal MPV. This solution provided a car with normally safe characteristics aimed at comfort, but which not that could be pushed quite hard if required. Another member of James' team summed up the session nicely by saying: "It was nice to be able to design from a clean sheet of paper and see the results so quickly"

We then took the Lotus team for a well-deserved if slightly late lunch and discussed how we could tune this workshop to provide training sessions for individual customers. In fact, we have already been approached by one university to run a session for its students but we also believe this would work with vehicle manufacturers' engineering teams too and may even offer the opportunity to study a real life concept.

As for the rest of the Expo, in the main auditorium there were a number of very interesting papers, not least of which was the Lotus paper on active noise. Initially this does not appear to be totally relevant to the subject of the event which was vehicle dynamics. However Colin Peachey, Lotus chief engineer of NVH, quickly showed how the compromises that often constrain vehicle dynamics development can be reduced by use of this technology.

An integrated approach to driving dynamics – A workshop by Lotus Engineering

“ It was nice to be able to design from a clean sheet of paper and see the results so quickly ”



Why is Roadnoise increasing?
Universal trend for wider low profile tyres

Example of VW Golf

Model	Standard Tyre Size
Volkswagen GOLF II	155/80T13
Volkswagen Golf II. GTi	185/60V14
Volkswagen GOLF III	175/70T13
Volkswagen Golf III. 1.8i GT	185/60H14
Volkswagen GOLF IV	175/80T14
Volkswagen Golf IV. 1.8 GTi	195/65V15
Volkswagen GOLF V	195/65H15
Volkswagen Golf V. GTi	225/45W17

Lotus Engineering Change the rules

Pages from the ANC presentation showing how interior noise has changed and why.

Colin showed how vehicles were becoming more and more dominated by road noise due to the push for improved handling forcing stiffer suspension settings. This subjects the body to ever-increasing forces made worse by the trend towards low profile tyres with wider contact patches and stiffer side walls. Until recently, road noise had been lost in the background of other noise; however, with improvements in engine refinement and wind noise, road noise has become the dominant issue. The quandary for the development team is whether to develop the car with a sporty characteristic and accept the higher levels of road noise this inevitably means or develop it for comfort and choose softer settings that prohibit drivers from getting the best handling performance.

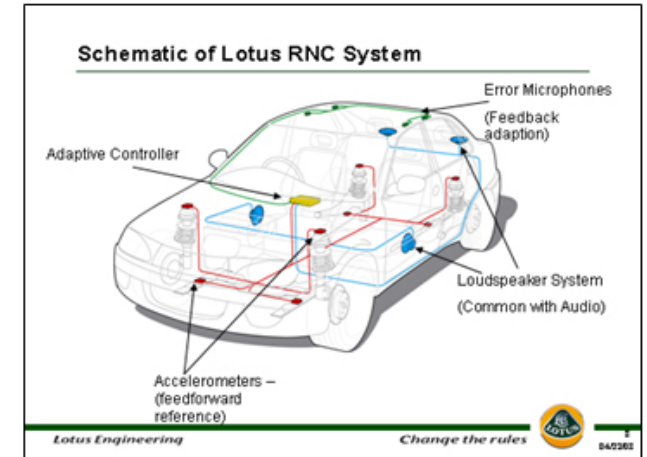
Active road noise cancellation removes much of this compromise. Colin's presentation showed a class-leading luxury saloon which had seen reductions in road noise of around 5dB. More significant, it also showed a class-leading sports saloon which was 5dB louder than the luxury saloon mainly due to its more aggressive suspension settings and ultra low profile tyres. In this case, using the Lotus

Active Noise Technology, the road noise levels were actually brought down below those of the luxury saloon. It is clear that this technology can provide the development team with the freedom to improve the dynamic performance of the vehicle without compromising its refinement. The production version of this technology is in the later stages of development and could be in the market place with one or more of the major car makers within two years.

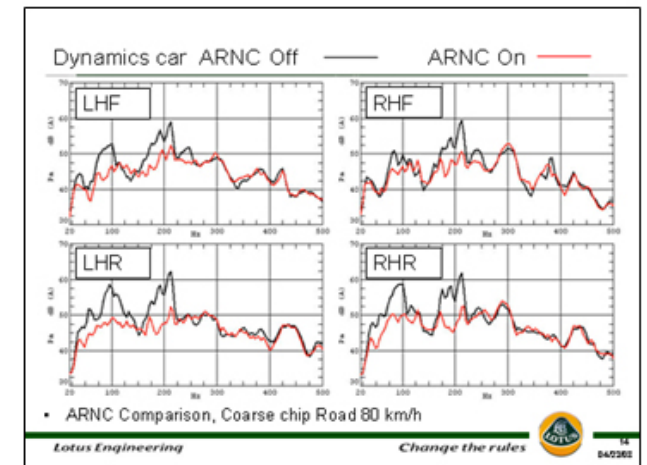
Overall, the Expo was a great success for Lotus, with the workshop the undoubted star. The Active Noise paper was very well received and provoked some interesting follow-up. We also had an excellent cross-section of current and potential customers at the stand.

We are already looking forward to next year and trying to find ideas that might compete with the success of this year's workshop. Hope to see you there.

Source: Paul Harvey, head of Chassis Engineering, Lotus Engineering



Slides showing the layout of an ANC system and then its effect on interior noise where it totally removes the high peaks from road inputs.



“ Overall, the Expo was a great success for Lotus with the workshop the undoubted star ”

Lotus celebrates **60 years** of world-class innovation

14 September 10am-5pm

www.lotus60thanniversary.com



- The Eagle Development Story
- Factory Tours
- Engineering Tours
- Styling Studio Tours
- Live the Lotus Life Competition
- Demo Laps (pre-booked only)
- Lotus Clubs on Display
- Classic Team Lotus on Display
- The Parachute Regiment Freefall Team - The Red Devils
- Lotus Aftersales Auto Jumble
- Lotus and Motorsport Merchandise
- Technical Talks throughout the day
- Lotus 'Best in Show' Cars Competition
- Cars of Interest on Display
- Farmers Market
- Funfair
- Pit Stop Challenge



Q&A with Carbon Motors' Trevor Rudderham

“ One of the big challenges with the state of the US domestic car industry is that they are in a situation in which their resources are at an absolute premium ”

Trevor Rudderham had amassed plenty of experience in product engineering and planning in a large OEM. But a few years ago, he found himself attracted to a much smaller start-up with a very clear mission: to create a viable purpose-built law enforcement patrol car. Carbon Motors is aiming squarely at a sizeable market in North America that is currently dominated by modified retail cars such as Ford's Crown Victoria. As Carbon Motors' VP and chief development officer, Trevor Rudderham is excited by the opportunity ahead in a niche that he believes has been poorly served. *just-auto* editor Dave Leggett interviewed him.

DL: Where did the business idea for a purpose-built police car come from? What's the history?

TR: It was really a confluence of several events. Our chairman and CEO William (Bill) Santana Li is someone I had known and respected at Ford for a number of years. He was being groomed to get to a very high level within Ford Motor, but much to the surprise of a lot of us he quit Ford at the end of 1999 and was lured out to California by a large venture capital group who wanted to do an automotive play – fashionable at the time. Bill was working on a number of business models in the automotive arena.

The idea of a build-to-direct-order automotive company came up, similar to the Dell computer model.

In early 2003 Bill took a phone call from a gentleman called Stacy Stephens who was a law enforcement officer in Dallas. And Stacy raised the issue of doing a purpose-built law enforcement vehicle. Bill's response was 'very interesting and thanks for your call, but Ford's got that market wrapped up and there's not much opportunity there'. But Stacy persisted and went through all the challenges, issues and problems that law enforcement has in the US with what are basically retail passenger cars up-fitted for police usage.

And Bill was intrigued but not really sold on the idea at that point. Stacy is a tenacious character and kept coming back, stressing the size of the opportunity and the need for a purpose-built vehicle for law enforcement officers – which the Detroit Three appeared to have no interest in supplying. Stacy said 'your business model would be suited to this'.



Bill then said he'd do a 30-day feasibility study into it. Those 30 days became 60, became 90 and several years later, here we are.

The crux of it was that every place that Bill looked, in terms of the whole process of designing, engineering, building, selling, servicing, operating and decommissioning law enforcement vehicles in the US, it was evident that it was an incredibly ineffective and inefficient process which doesn't deliver – either for the law enforcement officers using the vehicles or the agencies running the vehicle fleets.

So, Bill decided that there was something in this. He called me up, we looked at the outline of a business plan and I thought it looked great, a really interesting concept. And that was really the genesis of it. Stacy left his job and went to California to join Bill and I left Ford shortly after that and that's when it took off.

DL: Can you summarise the main advantages that your purpose-built E7 patrol car has over the typical retail passenger car modified for police use? And what's the difference in price for the customer?

TR: We're targeting an overall lower cost of ownership.

Let's put some perspective on this. There are 19,000 agencies in the US that buy law enforcement vehicles; it's local police, the sheriff, state patrols, the FBI, the CIA, port authorities and so on – a big list. There's no federal body that provides oversight or coordinates to give advice, recommendations and write specifications or anything like that. All 19,000 agencies are on their own.

The smaller ones in particular have to go to a dealership – be it a Ford, Dodge or Chevrolet dealer – and negotiate a price on what is essentially a retail passenger car. In fairness, there are changes to the vehicles, things the Detroit Three leave off or modifications on springs and dampers and so on, but it's basically a retail passenger car with some minor changes.

And they pay between US\$21,000 and US\$24,000 for that depending on how many they buy and what deal they can do with the dealership.

They then add to that anything between US\$5,000 and US\$55,000 worth of aftermarket equipment – things like radios, sirens, lights, computers and the like.. They are installed via their own service facilities or they use a local garage down the street – who may have

Q&A with Carbon Motors' Trevor Rudderham

“ It will be built in the US. Our customers, not surprisingly, are very patriotic and this has to be an American built car. ”

a relatively inexperienced mechanic who does some disassembly on a vehicle they take delivery of, they'll then install the law enforcement equipment, paint it, put the graphics on the vehicle – police logos – and that whole process takes a lot of time and is inefficient given that it happens after the vehicle has been assembled.

The law enforcement agency then operates the vehicle and gets typically 8–14mpg (US). For example the Crown Vic has a somewhat dated 4.6-litre V8 engine and is at the lower end of that range. We're talking high fuel costs and poor fuel economy.

And at the end of their life, the vehicles then have to be decommissioned, which entails taking all of the police equipment out of the car, removing all graphics and in some cases repainting the vehicle – and then they are sold at auction.

Sometimes that's all done by a law enforcement officer as a sideline and he'd otherwise be out on patrol.

What we're offering is a turnkey solution. We will deliver the vehicle completely ready to go out on patrol, all the law enforcement equipment pre-installed in the vehicle, all the exterior graphics done – all the customer has to do is hit the start button and go out on patrol.

There will be a diesel engine which gives a much lower operating cost on fuel and then at the end of service, rather than decommission we will take the vehicle back and then we will do one of three things:

- 1) “re-certify” the used vehicle and broker the onward sale of that vehicle to a third party – maybe a park security firm or university campus, something like that where they don't have a need for brand new vehicles or;
- 2) dismantle the vehicle and re-use the parts for maintenance and service or;
- 3) recycle the vehicle ourselves.

We are very confident that we will end up with a total life cost for the agencies that is significantly below what they are incur today.

DL: One thing puzzles me – why haven't the existing players in this market gone down this purpose-built police car road? They have the resources don't they?

TR: One of the big challenges with the state of the US domestic car industry is that they are in a situation in which their resources



are at an absolute premium. They are having to cut cost wherever they can; there are legacy issues with UAW deals, dealer distribution agreements, restructuring plans, plants that need to be made more efficient and so on. They are very, very constrained.

There's huge competition in these firms, internally, for resource. Naturally, high-margin product gets the resource and the priority. Or there are products that address CAFÉ (Corporate Average Fuel Economy) and get priority. In these circumstances, the main call on resources is for high volume product that fills existing plants and in areas where they can be profitable. Devoting engineering resource to figuring out how to, say, mount a radar gun on a law enforcement vehicle – which has a relatively low volume and has no relevance to any other company vehicle – is of little interest.

DL: From the point of view of the law enforcement guy at the sharp-end, what are the main benefits in the E7 versus today's patrol cars?

TR: The two big areas from the officer's standpoint are operational effectiveness and safety.

One of the first things you will notice is that because today's patrol cars are up-fitted in the aftermarket, the installation of the equipment – laptop computers, controls for the lights and the sirens, spotlights will be mounted on the A-pillars (a big mechanical handle extending into the car) – it's all very compromised because there's a limit to how much you can change the base vehicle. And that base vehicle has been built for the retail passenger vehicle customer, not for law enforcement.

The consequence of that is that things end up mounted in places that just compromise safety. The handle controlling the spotlight mounted on the A-pillar is a good example. If these vehicles had to meet federal safety standards applying to regular passenger vehicles, they would never pass. In the US, unlike in Germany for example, once you have bought the vehicle, you can do what you like to it. These are extremely compromised vehicles, in terms of ergonomics and human-machine interface. In many cases the way the equipment is mounted can actually constitute a threat to the officer.

Because we are designing specifically for purpose we can integrate all the law enforcement equipment in a manner that is optimising human-machine interfaces with control panels where they should be, docking keyboards mounted on the centre console, a different solution to the lighting and so on. It's a much safer environment for the officer to operate in. It's also much more effective and efficient.

We can display information better – say an officer is following a suspect down a freeway and he wants to check their plates, today he may have to consult a laptop to his side as he drives, but we can bring up the results on a head-up display (HUD) so he doesn't have to take his eyes off the road.

If I can just add one other thing. One of the most challenging things that police officers have to deal with is putting a suspect in the back of a vehicle. Policing in the US is a little bit different to that in Europe in the sense that an officer here on patrol may be 50 or a 100 miles away from his base and cannot simply wait for a dedicated police van to turn up and take the suspect away. Patrol vehicles are used very frequently for suspect transport. Of course, they have a partition between front and rear, plastic seats in the rear and so on, but the actual act of trying to put a suspect in the vehicle is very difficult and very dangerous. The suspect might be a drug addict, or very drunk, or violent... imagine trying to get a 250lb guy who's not happy and is being very aggressive onto the back seat. Not easy.

One of the things we have looked into is the whole ergonomic situation here and we've mimicked the London taxi with a rear-hinged or coach rear door. The biomechanics of inserting a suspect into the rear is very different with a coach door. There's a 90-degree door swing for a very large aperture and that means you can face the suspect and push them back onto the seat, rather than trying to manoeuvre them around the door. It might sound like a small thing, but for an officer – and there are plenty around of who have been injured or spat upon or bitten in such situations – that's a really big advantage.

Q&A with Carbon Motors' Trevor Rudderham

“ Our biggest partner on the vehicle development side is Lotus Engineering and that is our major technology partner ”



Trevor J. Rudderham, vice president and chief development officer

So, operating the vehicle in the front compartment will be much safer and so will safety in the rear.

DL: How big is the police car market you are looking at? And is it just North America?

TR: The market in the US is 75,000 new law enforcement vehicles sold a year. There are approximately 425,000 law enforcement vehicles on the roads. Initially we will target the US and shortly after that we will also target Canada and Mexico – both markets that like the US, use Detroit Three products currently.

We have had a lot of unsolicited interest from around the globe – Russia, China, the Middle East, South Africa, Australia, several police forces in the UK. We're going to look at that as a longer-term opportunity. The vehicle we are doing for the US is large and may be too wide for European roads. There would also have to be some product changes for overseas markets' needs.

DL: So what are your eventual build volume ideas?

TR: Let me just say that today the Crown Victoria achieves an 80% share of this market in the US. If you look back over history at this market niche, whichever vehicle comes closest to meeting the market's needs at a given point in time tends to dominate the market. This is a tool for law enforcement, not a fashion product – it's a functional piece of equipment and the buyers tend to go for the best product that meets their needs.

GM used to have a very large slice of the market with the Chevrolet Caprice – a large vehicle with a high-performance Corvette engine. GM took that off the market and at that point Ford was able to offer a product closest to market needs and its share took off.

Our business plan doesn't jump straight in at that sort of market share but we believe in the long run we should be getting to a pretty significant share. We think we will be the dominant player from a product standpoint.

DL: When might E7 production actually start and where?

TR: It will be built in the US. Our customers, not surprisingly, are very patriotic and this has to be an American-built car. A question we get asked is 'why don't you build this in China or India and get low cost?' Well, our customers want a homegrown, home-built vehicle. We are located in Atlanta, Georgia and are actively looking for a manufacturing facility in the Georgia area.

DL: Definitely in Georgia then?

TR: I wouldn't say definitely, but right now that is the highest probability. As you imagine with a US\$3bn positive economic impact and 10,000 new direct and indirect jobs, a number of the US States are starting to try to change our minds.

DL: And when?

TR: As with any start-up, timing is contingent on raising the necessary finance. We are in the process of building a concept demonstration vehicle and that will be launched in the fourth quarter of this year and we'll transition from that to the main engineering programme. We're targeting 36 months from the start of the main programme to the start of production.

DL: Who are your main technology partners?

TR: Due to confidentiality agreements we have in place, I am a little limited in what I can say. We are sourcing the powertrain from Europe

Carbon Motors philosophy

We have a single, simple and powerful idea: The audacious act of building a new American car company that will produce the world's first purpose-built law enforcement patrol vehicle in support of homeland security. By taking this bold action, we will create 10,000 new direct and indirect American jobs and with the application of new technologies, cut the approximately 1.5bn gallons of gasoline the nation's law enforcement fleet burns through every year by an estimated 40%.

For our vision to become a reality, we knew it would take great minds and strong leaders. World-class automotive companies don't spring up overnight – and Carbon Motors Corporation is no exception. Our core team represents an impressive breadth and depth in every aspect of the automotive and homeland security industries.

From seasoned auto executives, financial leaders, engineers and designers, developers of innovative supply chain approaches and individuals with national, international and start-up experience in the field, to homeland security and law enforcement experts, our company has the business acumen and technical prowess to deliver the Carbon E7.

– the centre of excellence on diesel engine development – and we do have an agreement with a European manufacturer for the supply of engines and transmissions for our vehicle.

Our biggest partner on the vehicle development side is Lotus Engineering and that is our major technology partner.

We are working on agreements with a number of other people. We have received a lot of assistance from BASF.

The structure of the E7 vehicle is aluminium space-frame with plastic exterior panels and that was one of the reasons why we picked Lotus to do the engineering work for us.

BASF has been very helpful on the exterior panels and we have a number of relationships that are developing and anticipate a number of joint announcements in the future.

And a company called Tomar – a supplier of emergency lighting products – is working closely with us. They will be our partner on the emergency lighting for the vehicle and they are a leading innovator in the use of LEDs for emergency vehicle lighting applications.

Q&A with Carbon Motors' Trevor Rudderham

“When you start with a clean sheet of paper you can pretty much be your own architect and chart the course you want to take”

Last, but by no means least, we have a very close relationship with Georgia Institute of Technology who we are working with on a number of research projects on several important areas of the car.

DL: How does the 'Carbon Council' work?

TR: It's open to any active or retired law enforcement officer or anyone else involved in the procurement, servicing or any other aspect of law enforcement vehicles so that they can come to our website, sign up to the Carbon Council and they can raise issues, questions. What we also do is post ideas on the forum so that we can get feedback. For example, we might invite views on where best to locate a laser speed detection device and we can present sketches of options. And a dialogue will follow.

I think we have 1,200 active members of the Carbon Council now, representing something of the order of 700–800 law enforcement agencies across the country. All 50 US states are represented. That tells you a bit about the enthusiasm and demand for the product.

DL: For you personally how has the experience been working in a small start-up development company compared with life in a major OEM?

TR: I guess if I had to sum it up in one word I would use the word 'liberated'. It's very, very different.

We are a very small team, our decision-making is very quick, we're very empowered and obviously that contrasts with a large corporation – any corporation in any industry. In any large corporation decisions tend to be slow and made by committee or at least made by a group of people. That can be a good thing at times, but it can also be a bad thing.

One of the big advantages we have is that we are very nimble.

We will live and die on the decisions we make, and there's no safety net the way there can be in bigger organisations. We make decisions quickly and move on. And our small team is leveraging the expertise of the partners we are working with. It's lean but efficient.

One of the great advantages of doing this as a start-up is that we don't have the set-up the big automotive firms have with legacy plants and commitments to the workforce and things like that. Even if they know what the right thing to do on a project is, it's not always easy to execute because of the constraints.

When you start with a clean sheet of paper, you can pretty much be your own architect and chart the course you want to take.

DL: Just stepping back from Carbon Motors for a second, what do you see as the big challenges ahead for the US auto industry?

TR: I certainly think different global regions face different challenges – some of them shared some of them not.

I think the energy crisis is going to be a very interesting challenge for the US auto industry. Obviously right now there's the emergence of financial problems in the economy and what that is doing to drive down customer demand.

But I think what the industry faces in terms of rapidly rising energy costs presents a bigger, on-going challenge. How do you satisfy the customer in a market that is very accustomed to having large, spacious vehicles and not having to worry unduly about the costs of operating those vehicles? Gas was a dollar a gallon six or seven years ago and nobody cared about miles per gallon.

Now there's a difficult trade for the customer to make. The companies that can continue to deliver the functionality that US customers have become acclimatised to, but in a way that is more affordable and environmentally-conscious – those are the companies who will ultimately be the winners.

There is lots of talk of getting people out of SUVs and trucks and into cars and I think that some of the people who chose SUVs as fashion statements rather than on a need basis will move away from them and that will be a continuing trend. But the nature of the US – the size of the country and the kinds of leisure interests people have – means there are a lot of people out there who need trucks and SUVs.

Tightening CAFÉ restrictions mean that manufacturers are under pressure on their product line-ups to deliver CAFÉ but in many cases the customer doesn't want to get out of the product they have got. Customers will want to keep the product functionality while also driving down fuel costs. That presents a very big challenge to vehicle makers in this market.

Source: David Leggett, *just-auto* editorial



Visible locking nut set to put end to wheel loss

“ For one vehicle the working day could include 300 miles of high speed running ”

Wheel loss is a phenomenon which has challenged the commercial goods and passenger carrying vehicles industry for many years. However, when safety components provider VisiLok approached Lotus Engineering with its nut and stud concept, the resulting collaboration produced a robust solution – the VisiLok nut.

Designed to be a simple yet innovative engineering solution to a global dilemma, VisiLok is a dual-purpose road safety device. In the event that a road-wheel nut loses clamp force and starts to rotate, the VisiLok nut locks to prevent further rotation and displays warning flags to indicate the problem to the operator.

Functioning as a standard nut and stud in all other respects, VisiLok is the culmination of four years of research and development, stringent laboratory testing and operating and durability trials.

Following completion of the initial design, VisiLok Limited turned to Hethel-based Lotus Engineering for the skill and experience to turn the VisiLok concept into a robust product which would survive in the hostile operating environment of a commercial vehicle road wheel and which would provide a reliable safety solution for the operator.

Ron Aspinall, VisiLok operations director (with a background in automotive engineering) explained: “The original VisiLok design was geared towards Formula 1 cars, but we soon realised that the market for this type of product in the racing world was very limited. We subsequently turned our attention to the commercial vehicle industry where loose nuts and road wheel loss were recognised problems and where failure could have far-reaching consequences for the fleet operator and/or owner.

“At this stage we had already secured the patents for the UK, European and US markets, but we needed to demonstrate that the device would function correctly in all operating conditions typically experienced by trucks, buses and coaches.

“We also wanted Lotus Engineering to help us select the component material combinations carefully to prevent corrosion from jamming the mechanism, while keeping the component count to a minimum, and ultimately produce a cost-effective, universally applicable solution which would put an end to the wheel loss problem once and for all.”

Lotus Engineering, which is highly regarded as a provider of world leading transport engineering solutions, became integral to the



VisiLok is the culmination of four years of research and development.

development of the VisiLok system and ensured that the device met all its functional objectives.

Simon Wood, technical director at Lotus Engineering, said: “We are delighted to be working with VisiLok to design and validate a solution to the potentially fatal problem of wheel detachment.

“Using an existing VisiLok design, Lotus modified the locking device to enable manufacturing feasibility for the most effective solution for commercial vehicle operators. Lotus also carried out rigorous testing procedures to validate the performance of the road safety device under the most arduous operating conditions.”

For one vehicle the working day could include 300 miles of high-speed running. Another vehicle could be subjected to operating on uneven road surfaces, road humps and collecting dirt and dust at a quarry face or in a refuse tip. All this at temperatures which can vary from sub-zero to around 140 degrees C.

The result: around 3,000 reportable incidents, 27 injuries and seven fatalities occur each year in the UK alone as a result of wheel loss (*Motor Transport*, 4 June, 1998).

In recognition of the problem, the Department for Transport (DfT) commissioned TRL Ltd in 2005 to try and accurately measure the current frequency of wheel fixing problems. In addition, TRL would examine current practices within the industry in order to assess

whether the previous advice issued by the DfT has had a beneficial effect, and identify new action that could be taken to reduce the scale of the occurrence. Research was carried out in the UK and findings were compared with data collated across the EU and elsewhere.

The 2006 findings showed that the frequency of wheel fixing problems varied, with typical annual frequencies of wheel fixing defects estimated at between 7,500 and 11,000 resulting in between 150 and 400 wheel detachments. Of the wheel detachments, it was estimated that between 50 and 134 would result in damage only accidents, 10 to 27 in injury accidents and three to seven in fatal accidents. What is more, the problem was not unique to the UK and evidence suggested that the levels found elsewhere across the globe were “broadly comparable”.

VisiLok managing director Barry McGowan added: “TRL found that there was a bias toward problems occurring on the nearside of vehicles (i.e. left in the UK). However, this bias appeared small for loose wheel nuts, but large for wheel detachments. This suggested that it may be of small influence in the root cause of nut loosening, but may have a larger influence on the rate of progress between the first nut loosening and wheel fully detaching.”



Partnering for success: by partnering with cold forming specialists Floorm and Lotus Engineering, VisiLok was able to keep the component count to a minimum without compromising the integrity of the design. Pictured here are (l-r): Philip Lawrence, Floorm, Simon Wood, Lotus Engineering and Ron Aspinall, VisiLok.

Visible locking nut set to put end to wheel loss



Wheel nut safety: the new VisiLok device arrests both the movement of wheel nuts and alerts the operator via a yellow flag system. Pictured here during the launch are (clockwise from left) Simon Wood, Lotus technical director, VisiLok management team members Don Reynolds, Ron Aspinall, Graham Watkins, Barry McGowan and Julie Black, Lotus project manager and Andrew Potter, principal engineer, Chassis Systems, Lotus Engineering.

Although this phenomenon remains largely unexplained, it is little consolation for the thousands of fleet operators, etc around the world who have just had to come to terms with nut relaxation and its consequences; however much torque they apply according to Mr. McGowan, who has extensive fleet management experience from his days as director of what was then the GUS White Arrow home-delivery operation.

"Wheel relaxation simply has no bearing on how good an operator you are or how good your fitters are because the nut and stud integrity is based on the elasticity of the thread. Once you take the nut and/or stud off, the risk of loss of clamping force ensues.

"Our view was if you know it is going to happen, how do you stop it?"

With a number of retention devices and movement indicators already on the market ranging from yellow plastic pointers, which indicate if a nut on a wheel has moved, to double locks which prevent the nut

from loosening, VisiLok needed to demonstrate that its device was a holistic and 'true solution' to the problem.

The device had to be applicable anywhere that a fastening is subject to rapid temperature change or vibration, provide an indication of the relaxation problem and arrest the movement as soon as it starts to occur.

What's more, the solution itself had to require no special tools for tightening or removal.

Added McGowan: "The beauty of our relationship with Lotus is twofold. Lotus has an enviable track record on the racing circuit, which is where the idea originated from in the first instance; and we would have the opportunity to bring the product to market with its consultancy division, Lotus Engineering, which is highly regarded for its engineering expertise."

Commenting on the partnership, Wood said: "As a business, Lotus Engineering is all about efficiency and innovation. Subsequently when we were presented with VisiLok's challenge, we wanted to ensure that the clamp load was maintained – i.e. the wheel stays attached to the hub, the device provided a system of indicators illustrating that motion has occurred and the clamp load has been lost; and it was providing retention i.e. the nut is stopped from turning any further.

"The VisiLok device is a simple mechanical solution which needed to be compatible with existing commercial vehicle manufacturers products and suitable for after-market use. We also, amongst other things, looked at the way the flags were situated on the flats of the nut which ensured that when torquing the nut, the entire load is taken into the nut and well away from any deflection which might be caused by the flags.

"Other tests included ensuring the device was completely maintenance free, components within the locking mechanism were well protected, the device could withstand extremes in temperature and would not be eroded by pressure jets and solvents used to clean commercial vehicles.

"This is a fantastic challenge and we, together with our partners at VisiLok, will certainly be looking at other ways and industries such as maritime, rail and defence in which VisiLok could make a difference."

Source: VisiLok

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