# proActive

The official industry newsletter of Lotus Engineering

Issue 6
February 2005

## Lotus Engineering Unleashes Suspension Analysis

## The Chinese are Coming

# Welcome

**Vehicle Dynamics**

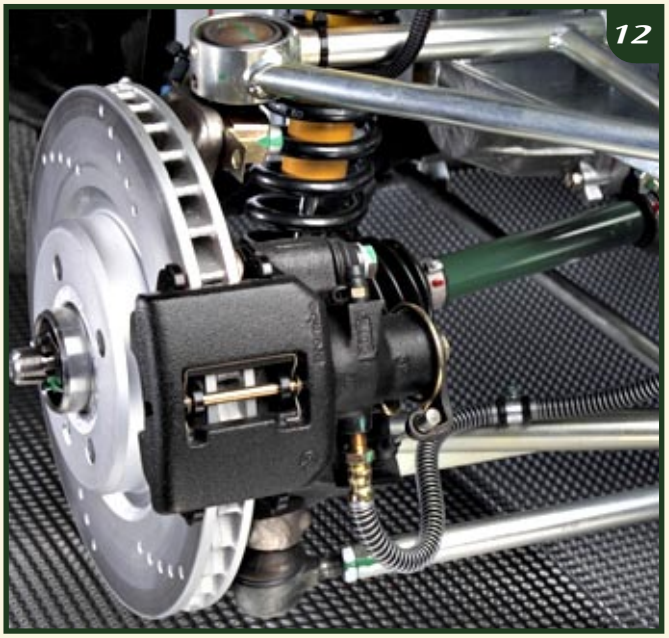
**Analysing and developing the dynamic behaviour of a vehicle is a delicate combination of science and art, where the critical human touch combines with the wealth of data at our disposal, and is a discipline in which Lotus has gained worldwide recognition.**

The ride and handling capabilities of our vehicles is one of the dominant factors behind the success of our cars, and is an area in which many high-profile clients have benefited from our engineering expertise. At Lotus, every single element of the vehicle is afforded enormous importance and our comprehensive knowledge of the symbiotic relationship between the respective chassis systems has enabled us to develop some of the most responsive vehicles on the roads today.

This edition of proActive explores the growing importance of vehicle dynamics at both ends of the automotive spectrum. Whilst exceptional ride and handling was once the exclusive preserve of the luxury car, a shift in customer expectation has meant that it has now become commonplace for less expensive vehicles to perform well in this area. An insight into Lotus' approach to this scenario is provided as we profile our bespoke analysis and development tools, in the form of the hardware and software used in engineering the vehicles of tomorrow.

I hope you enjoy this Vehicle Dynamics-focused issue of proActive and would welcome any thoughts you may have on the topic. If you have any views on this or a related issue please email me at proActive@lotuscars.co.uk.

Martyn Anderson – Chief Engineer, Lotus Vehicle Dynamics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## USA: Hybrids, fuel cells figure at NAIAS 2005

Press days at 2005 NAIAS kicked off as usual with Johnson Controls', shortly followed by the announcements of the 2005 North American Car and Truck of the Year awards.

Although there was stiff competition for 2005 Car of the Year in the shape of General Motors' Chevrolet Corvette and the '05 Ford Mustang, it came as no real surprise to the gathered crowd when Chrysler's 300/300C won with something to spare.

The award caps a resurgent 12 months for Chrysler Group, which posted strong sales on the back of the 300 and Dodge Magnum programs, and seems to have turned the corner. Chrysler also launched the third vehicle off the rear-drive LX platform, the Dodge Charger, a brash muscle car somewhere between the Magnum and 300 in styling and appeal.

Chrysler Group executives had a hunch the 300 was going to be a hit, but "the public's acceptance has been beyond our wildest imagination," said Burke Brown, chief engineer for the LX platform, in an interview with SupplierBusiness.com.

### Electric vehicles march onward

Following on from the F-150's 2004 Truck of the Year, Ford made it two out of two when the Escape petrol/electric hybrid midsize SUV walked away with the award in 2005.

In a possible sign of things to come it is also the second year running that a petrol/electric hybrid vehicle has won one of the North American awards, after the Toyota Prius took Car of the Year 2004. It may be the start of a longer-term consumer trend that large SUVs were much less of a focus in 2005 than vehicles with alternative powertrain technologies.

Both General Motors and Ford had hybrid and fuel cell architectures on display this year. Chrysler is looking to leverage Mercedes' expertise to offer diesels in North America as an alternative.

### Materials one of several key concerns

Rising energy and raw material costs are near the top of many companies' agenda, but most executives questioned feel that suppliers and carmakers will just have to roll with the punches. Indeed, "continuing to [develop] our relationships one-on-one with suppliers" is an even bigger issue for 2005 than rising raw material prices, says Peter Rosenfeld, Chrysler Group executive vice president, procurement and supply.

Most players are at least relieved that this time round they know what's coming, whereas 2004 came as a nasty surprise. But suppliers also say that, with their customers bearing the brunt of steel price rises, there are extremely limited opportunities for passing on costs.

Rising oil prices are more of a concern where they may impact consumer demand. Suppliers and carmakers alike seem agreed that light vehicle sales in North America will be flat this year, with total industry volumes remaining around 16.9 million units.

***Source: SupplierBusiness.com***

## USA: Michelin Tweel combines wheel and tyre in one

Michelin has released new details of its Tweel technology, the fusion of the tyre and the wheel.

Developed in the US at the company's technology centre in Greenville, the non-pneumatic Tweel is said to have the potential to transform the automotive, military, construction and personal mobility industries.

The heart of the Tweel is its simple looking hub and spoke design that replaces the need for air pressure while delivering performance previously only available from pneumatic tyres. The flexible spokes are fused with a flexible wheel that deforms to absorb shock and rebound with ease. Without the air needed by conventional tyres, Tweel is claimed to deliver pneumatic-like performance in weight-carrying capacity, ride comfort, and the ability to "envelope" road hazards.

Michelin has also found that it can tune Tweel performances independently of each other, which is a significant change from conventional tyres. This means that vertical stiffness (which primarily affects ride comfort) and lateral stiffness (which affects handling and cornering) can both be optimised, enabling new performances not possible for current inflated tyres.

The Tweel prototype, demonstrated on the Audi A4, is within 5% of the rolling resistance and mass levels of current pneumatic tyres. That translates to within 1% of the fuel economy of the standard production application. Additionally, Michelin has increased the lateral stiffness by a factor of five, making the prototype unusually responsive in its handling.

***Source: just-auto.com editorial team***

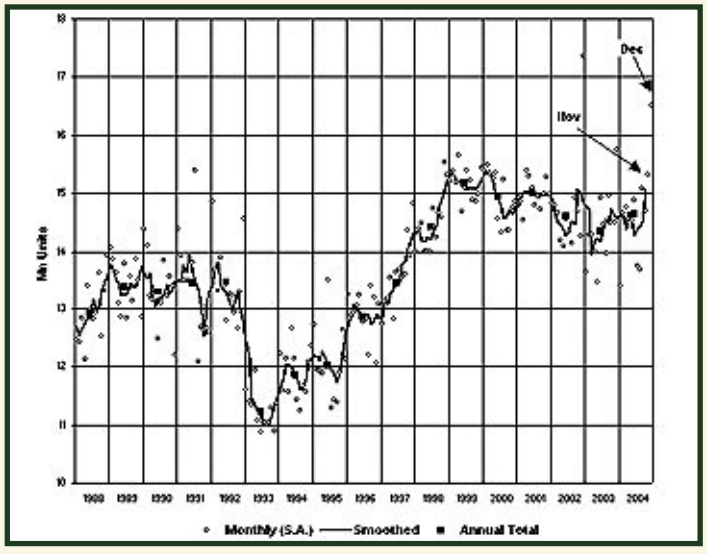
## Strong December boosts Europe's 2004 new car sales total

Early estimates for new car sales in western Europe in December suggest that the market was extremely strong, once again underpinned by the manufacturers' wish to reduce stock and the impact of incentives. Sales in Germany were, for once, particularly vibrant in spite of continuing uncertain signals on the economy - again, a sure sign of incentive activity. But underlying demand conditions are less strong than the December result suggests and some weakening of the market could be in prospect for the early part of 2005. JD Power-LMC reports.

### Summary

- Early estimates for December indicate a stunningly high level of sales following what has been, for many, an uninspiring year.
- Seasonally adjusted annualised sales hit 16.5 mn units/year - and sales were up by almost 7% year on year.
- Gains were prevalent in the large markets, particularly in Germany, Italy and Spain.
- UK sales were down on the previous year, but the selling rate was still very strong at over 2.7 mn units/year.

We had already seen some indication that incentives were ramping up in November - that month was one of the best on record despite the prevailing economic uncertainty. December proved beyond doubt the positive impact of incentives on sales by producing the strongest December yet. The selling rate was far greater than any result earlier in 2004 or, in fact, any other year. We have mentioned before that stock elimination has become a preoccupation of increasing importance for Europe's OEMs and this result is surely a part of that story. Once stock has been reduced to a manageable level, and we must assume that December will have gone some way towards this end, the next phase will be a more diligent alignment of output with demand. Sales in January will likely pay the price for the exuberance of the market in December, as was the case 12 months ago.




The outlook for 2005 should therefore not be changed in any major way by the explosive December result aside, perhaps, from the negative impact of a payback-hit January. A flat or slightly smaller market is therefore expected.

The chart shows total West European sales. The squares represent the total number of cars sold in a year, while the hollow dots represent the selling rate in individual months, and the continuous line represents a five-month moving average of these. We indicate the latest two months. The most recent numbers underlying this chart are appended in the table at the end of this note. There were same number of selling days in December, compared with 2003.

Germany was the most impressive performer in Europe - that is something that has not been said too frequently, if at all, in recent years - accounting for an estimated 60% of the year-on-year gain in Western Europe for December. Few signs from the broader economy indicate that such a positive change in demand should take place but manufacturers have been very keen to support sales with very good deals, forcing the car market to buck economic trends. Germany, like many other markets, has been the beneficiary of the OEMs' need to shift stock and also, perhaps, meet year-end targets. So December was good, but January is likely to be poor as sales have been pulled forward. In fact, this effect may now lead to a year-on-year fall in sales in full-year 2005, albeit a small one.

In the UK one should not be fooled by the year-on-year decline of almost 8%. December 2003 was an exceptionally strong month so almost any comparison was likely to prove unflattering - the selling rate of over 2.7 mn units/year in December 2004 is highly impressive and represents one of the best months in an already strong year. Yet, as with Germany, incentives look certain to have played a role so we should expect January to be hit. We continue to expect a significant downshift in sales in 2005.

The 2.8 mn units/year selling rate in Italy will surely fall to a far lower level in January, as in other countries. There had been little indication in the incoming orders data, which had been trending upwards on only a weakly positive trajectory for the past few months, that such a strong December should be expected - in fact, if anything there were signs of renewed weakness late in 2004. Therefore, we should assume that strong sales in December were at the expense of a much-shortened order book. Sales in 2005 are now expected to decline slightly by around 1%.

The French market was one of the more stable large markets yet it is unlikely that this result was uninfluenced by pricing activity, given the trend on other countries. It is clear, though, that sales in early 2005 will have less to payback and we expect only a

moderation in demand, with the selling rate falling back towards 2 mn units/year before beginning a recovery mid-year. Expectations for growth in 2005 are still relatively modest at just 2%.

The Spanish market continued to shine, as it has done all year - full-year 2004 sales were up by a massive 10% producing a new record of over 1.6 mn units. Sales related to the Prever scrapping incentive were very strong and this was one element which spurred particularly strong sales to consumers, offsetting falls in demand from the much smaller rental sector. It will be difficult to maintain this level of sales in 2005 though economic fundamentals remain relatively sound indicating that a sharp fall is unlikely.

Norway stood out from the crowd of small countries in December - sales doubled year on year as upcoming tax changes produced a flurry of activity (there will be sharp payback in 2005). Sweden also enjoyed a solid month, saving the full-year from decline.

***Source: just-auto.com editorial team***

## Rising electronics content and the outstanding 42v question

The electrical and electronic content of cars continues its upward trajectory. Already estimated at a quarter of the content value of vehicles, it is felt that by 2010 some 40% of a vehicle's cost base will be accounted for by its electrical power and control systems. But just what has happened to the 42v revolution? Dennis Foy reports.

### Replacing mechanical connections

So far as body engineering is concerned, this increase is being driven by a number of different dynamics, which can be broadly split into the two sectors of ecology and safety. The former is geared to providing the optimum fuel efficiency from an engine, allied to the sometimes-incompatible need to minimise harmful or undesirable compound gas emissions. The latter is a broader-still spectrum, which encompasses such elements as suspension and braking stability, speed-distance control systems, and advanced steering systems.

At the same time that electrical and electronic content is being increased, there is a symbiotic demand from auto makers to reduce the kerb weight of vehicles, and one way that this is being achieved is by increasing the amount of electrical/electronic control in place of mechanical connections. Replacing the 'traditional' mechanical-hydraulic power steering pump with an electronically controlled, electrically actuated power assistance unit reduces engine load, but more significantly reduces not just vehicle sprung weight but also reduces complexity of installation on the production line.

### Mandated physical linkages

Were it not for a mandated requirement for the steering wheel to be physically connected to the road wheels, it would be possible to take the technology a stage further, and eliminate the steering column linkage. Similar legal requirements are in place, which constrain the amount of development allowed in braking systems, which at present must retain physical connection between the driver and vehicle hubs.

### Benefits of increased electronic control

Whilst there is much to be said for the weight that can be shed and efficiency which can be increased from the adoption of electronics, there must at the same time be an economic advantage to the carmaker which acts to at least compensate for the additional costs involved. This can be achieved in part by the improved packaging of sub-assemblies by external suppliers - which makes for easier stock control and increased ease of installation - and also by allowing reductions in lead time accorded to designers and engineers.

A further benefit of moving to increased electronic control of the electrical and electronic content of cars continues its upward trajectory. Already estimated at a quarter of the content value of vehicles, it is felt that by 2010 some 40% of a vehicle's cost base will be accounted for by its electrical power and control systems. But just what has happened to the 42v revolution? Dennis Foy reports.

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A further benefit of moving to increased electronic control of functions and systems is that it allows automakers to increase the degree of outsourcing involved in each sub-assembly, which can again reduce the in-house element of new programme development costs. It has been unofficially estimated that each hour saved in the period from Job One to On Sale dates can be broadly equated to one dollar off the showroom sticker price of a mid-range new car model.

Finally, increased electronic control allows model specification differentiations to be made quickly and easily; by simply adjusting the control software the level of functionality in any given system can be adjusted to suit the range position and price point of specific models, providing the bare minimum in entry-level vehicles and full functionality in high-series cars.

## *Role of the sub-contractor*

This increased reliance on supplied-in sub-assemblies places increasing importance on the role of Tier One and Tier Two sub-contractors, and allows those organisations to work both separately and together to provide increasingly sophisticated responses to the demands of the industry as a whole. This means not just the designers and engineers, but also the marketing organisations, the cost control units and the other elements that help make up the whole. Even consumer organisations can be included in the picture, as they, whether as safety campaigners or as bargain hunters, have a role to play in today's auto industry.

As a consequence of this increased reliance on sub-contractors there is scope for organisations that have hitherto had little or no involvement in the auto manufacturing process to become active. This is especially true of microprocessor manufacturers and software houses, which have begun to sniff the scent of business opportunities that exist in the automotive industry.

## *42v - the spectre at the feast*

The increasing demands on vehicle electric architecture led the industry to conclude a decade ago that something major needed to be done; in essence the 14.2 volt system which has been in place since the 1950s is no longer adequate to support the dramatic ramping-up of electrical content. The solution was determined to be a wholesale change over to a 42-volt architecture that would provide several times the capacity of existing systems - sufficient to drive the most complex active suspension, electrically assisted power, electrically powered engine valve-train and automatic stop-start systems.

## *What happened to the 42v dream?*

At the turn of the millennium, proponents stated with some confidence that systems would start to arrive by the 2005 model year. Yet here we are, with 2005MY cars beginning to appear in showrooms, virtually none of which have 42v power systems. What is more, there are no indications that 42v architecture vehicles are imminent. Which begs the question: why not?

The answer seems to be a complex blend of existing electrical manufacturer hegemony and raised games that dramatically reduce the need to hurry from 14.2 to 42 volt systems. That, and the high cost factors involved in their adoption; estimates of 20-30% premiums on electrical content exist.

Norman Traub, director of 42v initiatives at the Society of Automotive Engineers (SAE) when asked: "Will we always need 12 volt power on vehicles?" responded by saying that: "Always is a long time, but I believe it will be a very long time before we eliminate the need for some 12v DC power. Incandescent lighting will stay at 12v because of bulb durability and light focusing issues associated with higher voltage incandescent lighting. Incandescent lighting can be controlled by a 42v pulse width

modulation technique where the 42v DC is modulated to create a 14v rms voltage."

### 12v - not dead, yet

But there is much more to vehicle electrical systems than simply the lighting. The shift over to high voltage is considered essential for in-built - as distinct from external, belt-driven - Integrated Starter-Alternator (ISA) -style devices, and is equally necessary for individual valve operations in place of the conventional camshaft. However Tier One suppliers have thus far been able to supply complete sub-assemblies for complex braking systems, electrically-assisted power steering packages, even reactive suspension, that work to the long-established 12 volt DC power system. Increased sophistication in the handling of such chores, by wider use of microprocessors within digital wiring harnesses, is credited with this situation - but this author suspects that this might simply be a little trumpet blowing by the chip makers. Regardless, and mindful that change is inevitable - eventually - Tier One and Tier Two suppliers are ensuring that when the time for change comes, they will not be left behind.

### Battery systems

Saft is one of a number of battery manufacturers which is ready for any eventual change, having developed two different battery systems - Nickel-Metal Hydride (Ni-MH) and Lithium Ion (Li-ion) - each capable of being incorporated into vehicles. Of the two the Ni-MH is the more useful contender, given its long cycle life in high power applications; Li-ion is suited for power assist applications and alternator-starters, and according to Saft provides "unmatched specific power and power density". Saft also added, "Thanks to Li-ion's modular concept, customer-specific battery packs can be easily customised." - Inferring that there is a ready market. But is there?

### Dual systems

That there is a 42v solution for specific problems hints at a major difficulty facing vehicle manufacturers; there is a need to integrate two completely separate power systems within a single vehicle. This has already been achieved - Toyota managed it as far back as 2001 with the Crown Hybrid, and General Motors has developed two pick-up trucks which have 42 volt integrated starter-alternator-Damper units (ISADs) supplied by Continental - but for the foreseeable future the cost premium of such dual systems is prohibitive to all but the most valuable vehicles. There is a sense of 'who blinks first' about the adoption of 42v systems, and so far it is the world's two biggest manufacturers that have blinked, but they have been cautious in their adoption of higher voltage systems, wisely avoiding direct reference but instead concentrating their marketing strategies on the benefits to drivers.

Toyota promotes the improved economy that automatic stop-start brings, as does the GM campaign, but also adds that: "…there's something Silverado and Sierra Hybrid provide that standard models do not: these trucks are essentially mobile power-generating stations, with four 120-volt/20-amp electrical

"Thanks to Li-ion's modular concept, customer-specific battery packs can be easily customised"

Auxiliary Power Outlets (APOs). The power outlets are located under the rear seat of the cab and in the pickup bed. Customers can conveniently operate power equipment without taking up the bed space typical portable generators would use." Perhaps most interesting of all, both manufacturers market these vehicles as hybrids - despite their being only partial hybrids as we know them from the Toyota Prius, Honda Civic IMA and suchlike. This suggests that even the automakers are unsure of how best to promote the virtues of 42-volt technology.

### The future of 42v technology

The conclusion to be drawn from the protracted birth of this quantum leap in emergent technologies is that the urgency being mooted a decade ago was alarmist, and the imperative for change has receded into the scenery. Perhaps the last word on 42-volt's immediate prospects should go to Denso's R&D Director Masami Manabe, when talking to Automotive Industries, who when asked: "In the electronics area, is 42-volt electrical architecture a development priority?" replied: "We currently supply the 42-volt 'stop-and-go' system for the Toyota Crown hybrid. My feeling is that interest in 42-volt architecture will lessen in the near term due to cost considerations. I expect carmakers to look for cheaper alternatives until around 2008 or 2010 at which time interest will pick up again."

***Source: just-auto.com editorial team***

## The Chinese Are Coming

So far all the news from China has been about the big investments being made there to build cars and trucks to meet the demands of its huge potential market. Carmakers and suppliers from all the major economies are plunging in to make sure they have plants and facilities to build vehicles for China's population of more than one billion. Risks are high, they say, but so are the potential rewards. This story from China is different. It's about the first dedicated effort to create in China a source of cars to compete in the West, writes Karl Ludvigsen.

This has always been seen as a possibility, but only well down the road after domestic demand began to be satisfied. Suddenly, it's not far down the road at all. January 2007 will see the launch in America of a completely new range of cars from a Chinese maker through a network of 250 dealers in stand-alone stores who will each have invested more than a million dollars in their franchises.

> *" 'What I was really looking for" said Bricklin about his quest, "was a factory to build my cars. And I found a factory that was about as impressive as any I'd ever seen"*

And the Chinese products will sell for a stunning 30 percent less than their competitors.

This is the spectacular joint vision of China's Chery Automobile Company and an importer based in New York, aptly named Visionary Vehicles. Although only founded in 1997, Chery is already making waves as one of the 'young tigers' in China's young industry. Know-how came in at the top in the person of Yin Tongyao, formerly a senior engineer at the FAW-Volkswagen joint venture and now Chery's president. Backing is by Anhui Province, which funded the company's founding in an economy and technology development zone at Wuhu, 200 miles inland from Shanghai, through its investment companies.

From its standing start only seven years ago, without the help of a western automotive partner, Chery has raced its production to 100,000 vehicles a year. One-tenth are sold abroad in Egypt, Bangladesh and Cuba among a dozen of its markets, making Chery China's biggest auto exporter. Its comprehensive production facilities include a stamping plant, engine and transmission plant, body and welding plant, a modern paint facility and a spacious assembly operation that one observer has called 'a state-of-the-art two-billion-dollar manufacturing campus'. That Chery cares about quality is shown by its adherence to international standards with ISO/9001 certification in 2001 and ISO/TS16949 certification in 2002.


*The controversial Chery QQ*

Without an international partner to deliver ready-made designs, Chery had to scramble to put a product line together - and this has already landed it in hot water. Chery says that one of its initiatives was to buy the rights to Daewoo's Matiz small-car design when that troubled company was in bankruptcy. Now that GM has taken over Daewoo, and is selling the Matiz as the Chevrolet Spark, it's complaining in court that Chery's QQ is a knock-off of the Matiz design. Chery has won the first round but GM still seems determined to seek redress.

At the heart of the Chery proposition is its complete freedom of action. Where Japanese and Western auto producers have formed partnerships in China, those links include constraints on exports. The foreign partners have learned from bitter experience that they don't want to meet cheap competition in their home markets from the products of their Chinese plants. Chery faces no such constraints. In fact, as a latecomer to its home market, where it's a minnow with a 4-percent share, Chery wants to emphasise expansion abroad. By 2007 it plans to be able to ship a quarter of a million cars to America.

*Chery Oriental Sun - flagship model*

Waiting eagerly to receive the Chery range - which will include two sizes of saloons, a crossover saloon, a sport-utility and a sports-luxury coupe - is one of the most charismatic and controversial entrepreneurs ever to enter the automobile business. Fast-talking Malcolm Bricklin, now 65, heads privately held Visionary Vehicles, the company that will set up Chery's American importation. This is the same Malcolm Bricklin who founded Subaru's American import company, lost $20 million of his own money trying to build his eponymous sports car in Canada, and went from hero to zero when his low-cost Yugo - greeted with wild enthusiasm - imploded on the American market.

Since then, Bricklin has been combing the globe in search of another make to import. 'I thought it would be great to find a car company that could build vehicles that had great style, ride, price and service,' Bricklin said. The Yugo's failure was a direct result of its maker Zastava's refusal to meet the quality standards that export markets demanded, in spite of Bricklin's best efforts to get them to see the light. When one quality-control expert delivered

his scathing report, Zastava's reaction was to bar him from the factory. 'Every business I've been in has been successful, if the factory did its job,' Bricklin reflected. 'This factory can do the job,' he added of Chery.

Malcolm and his VV team scoured the world in search of a new source of imports. They've been to MG Rover in Britain, Tata in India and automakers in Eastern Europe. For a while hopes were high for a revival of Zastava, but this never took wings - fortunately, in my view. 'What I was really looking for,' said Bricklin about his quest, 'was a factory to build my cars. And I found a factory that was about as impressive as any I'd ever seen.'

The first meetings in Wuhu took place in April of last year. Talks followed both with Chery and with officials of Anhui province, the company's owners. By December agreement had been reached and Bricklin travelled to Wuhu on the 11th. On the 16th he and president Yin signed the contract covering their business relationship. 'I have great confidence that they are going to be as innovative and productive as any automobile company in the world,' Bricklin said of Chery. 'They're ambitious like crazy. They want to be a major global player.'

Under the agreement Bricklin's VV team has significant responsibilities, including product planning, engineering of safety and emissions systems for the US market and homologation of the cars - not to mention signing up the 250 dealers with which VV plans to launch Chery's products - under a new brand name - two years from now. To meet his commitments Bricklin has assembled a team that includes some of his colleagues from the Yugo days, such as Paul Lambert in marketing and Tony Ciminera in product development. A newcomer is manufacturing consultant Ron Harbour, whose company - famed in the industry for its studies of factory efficiency - will advise Chery on improving quality and output. The import company will have offices in New York and New Jersey and a technical centre in Detroit.

Malcolm Bricklin has never had difficulty in assembling a blue-ribbon team of backers and advisors. After all, it was international businessman Armand Hammer who raised the Yugo opportunity and Henry Kissinger whose consultancy supported his efforts. Advisors of like calibre have signed on for the Chery adventure, which offers the huge potential of cars of quality sold in America at almost one-third less than the opposition. One such is William vanden Heuvel, senior adviser to investment bankers Allen & Co. and a former director of Time Warner Inc. 'I was taken by his personality and his vision,' he said of Bricklin. 'To be the first importer of Chinese cars will be a huge achievement. I think Malcolm is a master salesman who got everyone to understand the dimensions of his vision.' Vanden Heuvel is chairman of the Visionary Vehicles management board.

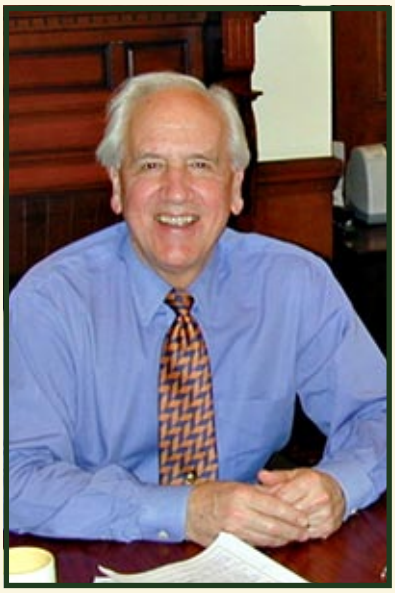
Not everyone is cheering for Bricklin's new initiative. 'I wouldn't trust him as far as I could throw him,' said Ron Tonkin, an Oregon auto dealer who was out of pocket to the tune of six figures after the collapse of a Bricklin venture to sell electric bicycles through auto dealers. In fact this aborted venture saw Bricklin fleeced as well when a master wheeler-dealer, Lee Iacocca, came on board and snaffled up the electric-bike idea to promote it for his own advantage.

Bricklin's team how has until mid-year to raise the $200 million that it needs for its end of the deal with Chery. Seeing the potential of what Malcolm likes to call 'the next Toyota', outside backers are swarming around like bees to the honeypot. Bricklin, on the other hand, may wish to maintain control of what promises to be the best deal he's ever negotiated. The next few months will determine whether he's able to do that.

This is by any standard an awesome initiative, one that has major implications for the industry in all parts of the world. With VV's assistance, Chery plans to offer cars of quality, with a warranty of 10-years/100,000 miles, that will compete with the mainstream offerings of major auto producers at a price 30 percent lower. No spelling out is needed for the implications of such an offer not only for the export markets of the Japanese and Europeans but also for their home-market prospects. In five years from 2007 the partnership expects to be selling a million cars in America. After that, exports elsewhere will be on the agenda.

Thanks to his rocky experiences as an importer, Bricklin is realistic about his prospects. 'If we don't make sure these cars are among the best in the world,' he told the Detroit News, 'we're going to get our ass handed to us. But if we do what we're supposed to do, this could be the deal that changes the industry.' Malcolm is a promoter par excellence, an artist at seizing the deal. If he can back this up with a strong team at VV and maintain good relations with Chery, I think he'll pull off the deal of a lifetime. Not bad for a guy who should by rights be in the pipe-and-slippers category.

*- Karl Ludvigsen*



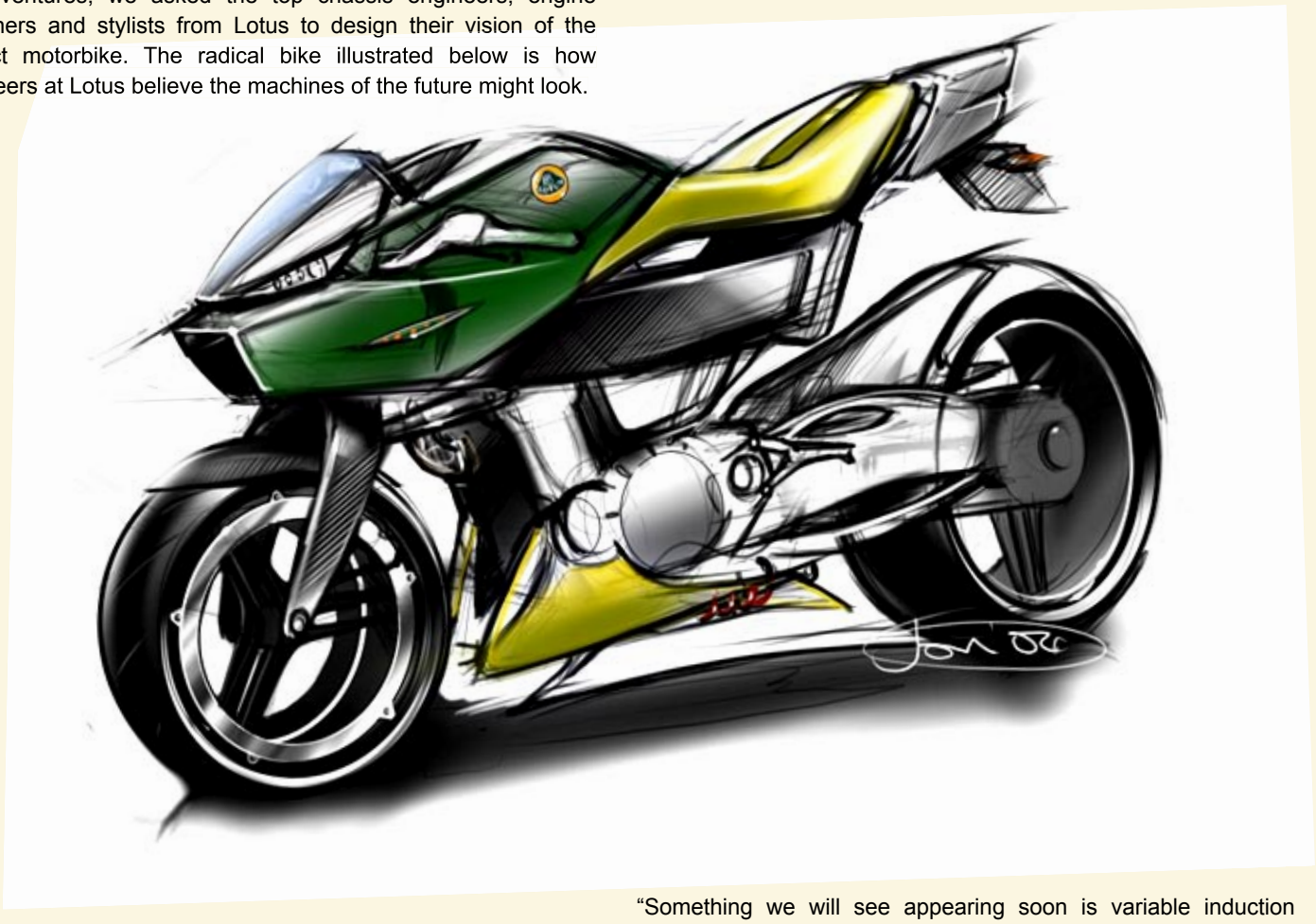
*Karl Ludvigsen is an award-winning author, historian and consultant who has worked in senior positions for GM, Fiat and Ford. In the 1980s and 1990s he ran the London-based motor-industry management consultancy, Ludvigsen Associates. He is currently an independent consultant and the author of more than three dozen books about cars and the motor industry, including Creating the Customer-Driven Car Company.*

***Source: just-auto.com editorial team***

# Lotus Engineers Create Their Ultimate Motorcycle

**Lotus might be best known for its cars, but the scope of the firm's engineering activity stretches way beyond traditional automotive boundaries. The overriding success factor with these non-automotive projects is an ability to apply lateral thinking and problem solving techniques to generate innovative solutions.**

Most of these projects are of a sensitive nature and are therefore strictly confidential. So, to give an idea of the process behind such ventures, we asked the top chassis engineers, engine designers and stylists from Lotus to design their vision of the perfect motorbike. The radical bike illustrated below is how engineers at Lotus believe the machines of the future might look.



The eye-catching result is a single cylinder 600 with variable valve timing, carbon forks combined with a Hossack front suspension, adjustable damping, composite chassis construction and a display screen which can be used to alter engine mapping and suspension settings.

Representing much more than a visual concept, each element of the motorcycle has been given considerable thought by the relevant areas within Lotus Engineering.

## *Engine*

The bike uses a single cylinder engine between 450cc and 600cc. Jamie Turner, leader of Lotus' Powertrain Research Group, said: "Power output has been the key to bike design in recent years, and the main reason manufacturers have been able to make these powerful engines is the advances in engine control systems.

"Bike engines are still relatively simple compared to cars. There is a challenge to engineer variable valve systems to cope with the engine speeds of bikes, but there's very little room for the technology. On bikes there's a goal of making engines smaller, more powerful and lighter – and it's hard to see how manufacturers could incorporate variable valve technology in the space available.

"Something we will see appearing soon is variable induction systems – MV is introducing it on the F4 1000 Tamburini. It's easy to package inside the airbox and doesn't add much weight, but can affect the shape of the torque curve, making, engines more rideable."

## *Chassis*

Lotus' Chief Engineer, Vehicle Dynamics, Martyn Anderson, believes the firm's experience with car suspension, in particular

double wishbone set-ups, means it could engineer a bike without a conventional suspension design.

He said: “Something we discussed is a reluctance from customers to veer away from conventional suspension design. “We’ve chosen a Hossack front end, like the BMW K1200S (right), but with carbon-fibre forks. For the rear suspension, we’ve gone for a single-sided swingarm.

“I like the idea of having adjustable damping, so you can change between road and track settings from a switch on the bars. Lots of cars have systems like this, and the K1200S shows it can be transferred to bikes.

“Electronic steering dampers, as on the new FireBlade, could be adjusted in the same way. All you need to do is add a lightweight stepper motor to the adjusters on a current suspension, and it would be there. “The engine has to be a stressed member – acting as the frame.”

## Styling

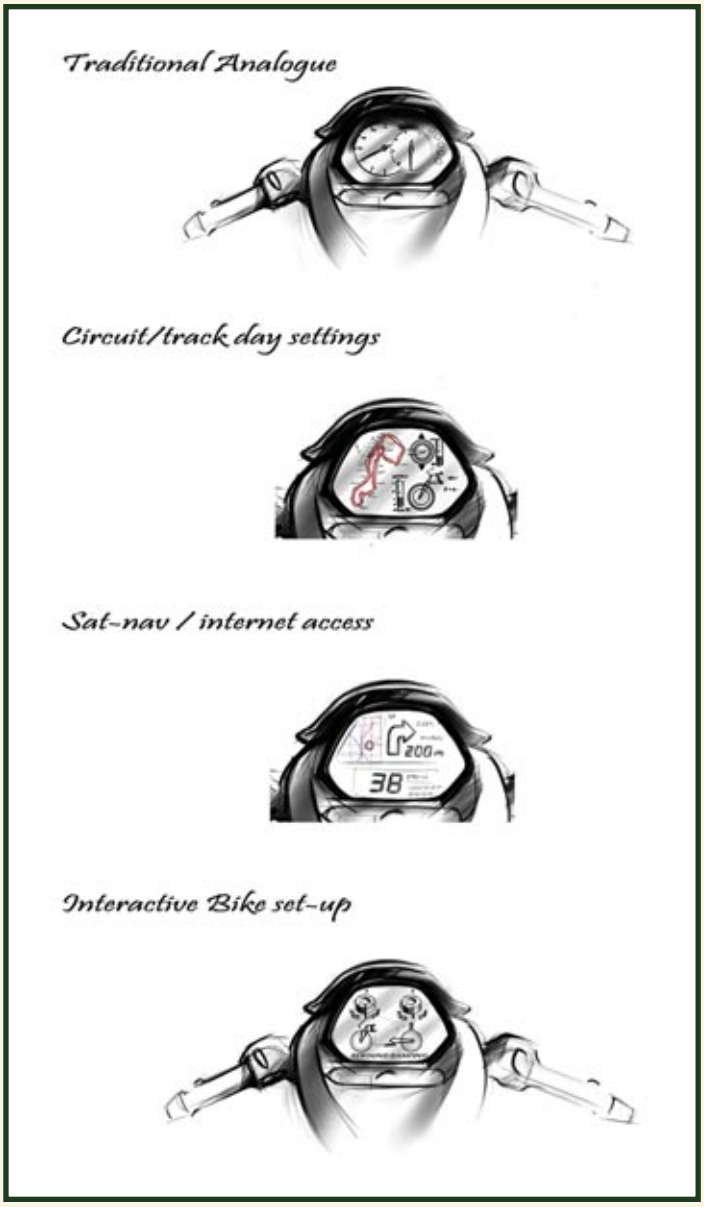
Lotus Design’s Jon Statham said: “If Lotus was to get involved in bikes it would definitely be a sports bike – but there is a trend away from race replicas at the moment.

“For the styling, we’ve gone for an aggressive stance, as I think bike proportions are going to get more extreme. That’s why it’s high at the back, with a lot of the visual weight forward over the front wheel. But there’s practicality here, too. We’ve mounted the fuel tank lower down, which offers dynamic benefits but also gives luggage space under the dummy tank cover.

“For the bodywork, we envisage the tank and seat all as a one-piece composite construction. By using composites, we can hang components like the radiator and exhaust directly from the bodywork without needing subframes. That way of thinking comes from a core idea that the lower the number of parts, the better, and comes from our experience in Formula One.”

## Electronics

Jon Statham also produced the concept of a multi adjustable LCD instrument binnacle, shown below.


He said: “You could show and alter the settings – a similar system has been shown on concept cars, and there’s no reason not to have the system on bikes. The display would be lighter than conventional instruments, too.

“Emissions regulations are increasingly restricting performance, but using satellite navigation you could engineer a system where the bike recognises it is at a circuit, and not on a public road, and change the engine mapping for more power.

“By combining the sat-nav with this, you would satisfy the regulators for road use.”

***Source: Article reproduced with permission of Motor Cycle News magazine.***

# Lotus Engineering unleashes Suspension Analysis (LSA) software

**Lotus Engineering's Suspension Analysis (LSA) software is the latest software product to be released by Lotus Engineering's software group. Originally developed in-house by Lotus for its world-leading ride and handling engineers, this is the first time that LSA has been available to users outside the company.**

The Lotus ride and handling team, responsible for the development of the vehicle dynamics for some of the world's class-leading passenger cars, was integral to the design and development of LSA and continues to use the package for in-house and client development projects.

*Lotus Exige suspension – designed using LSA*

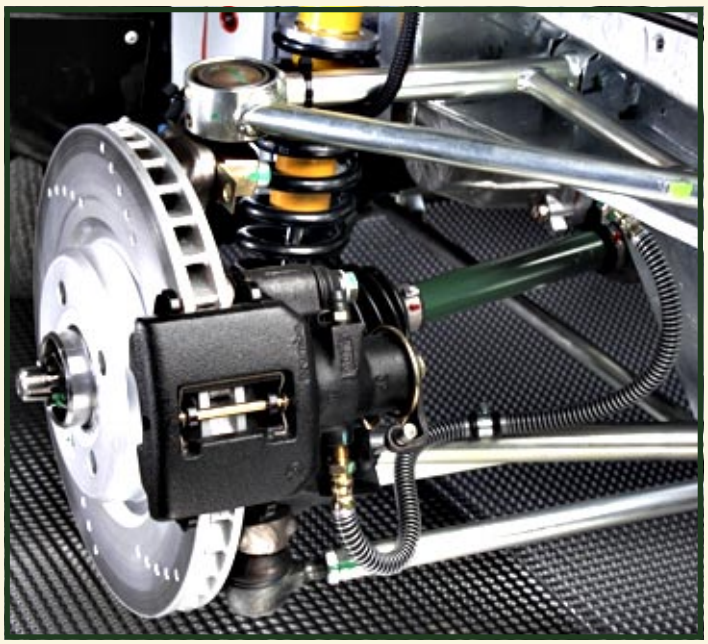
"With the ever-present pressures to reduce development time scales and improve efficiency, LSA offers the vehicle dynamics engineer the most effective solution for suspension design, simulation and analysis," explains Steve Swift, Head of Vehicle Engineering at Lotus Engineering.

The PC-based software has been continually updated and refined to keep abreast with the latest trends in suspension configurations, design techniques and analysis requirements.

The software models the suspension as an equivalent, rigid-body, kinematic system that can be articulated in user defined bump, rebound, roll and steering motions. The kinematic model is extended by the optional inclusion of bush compliance at each connection within the model.

Models are constructed using a template-based approach making model building simple and quick for end users. Each template covers a specific suspension type defining its parts, points, graphics and part connectivity.

*Lotus Elise double wishbone suspension*

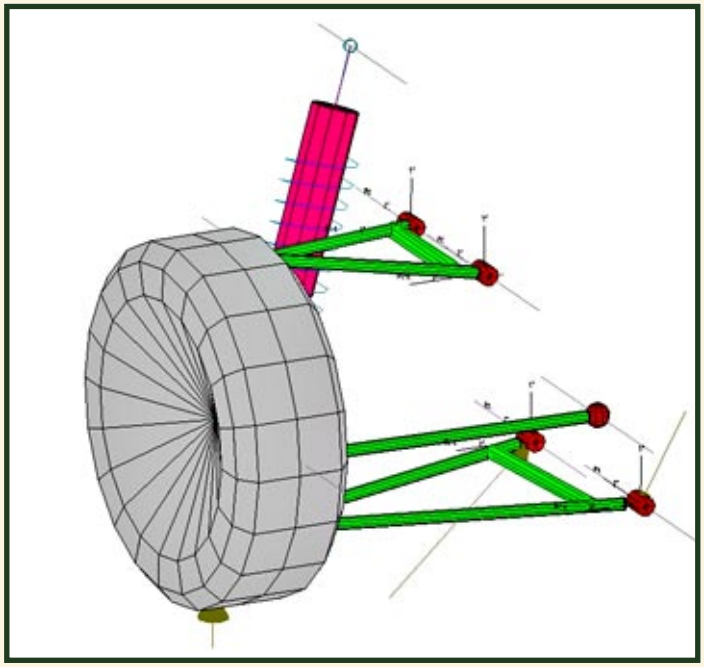


*'LSA' corner model of Elise suspension*

Over twenty 'standard' templates are supplied with the software including double wishbones, MacPherson Struts, Semi-Trailing arms and multi-link independent suspensions. A template editor/builder mode enables users to create and share their own new templates.

*" With the ever-present pressures to reduce development time scales and improve efficiency, LSA offers the vehicle dynamics engineer the most effective solution for suspension design, simulation and analysis "*

The suspension characteristics available include camber, castor, toe, kingpin angles, as well as roll centre positions, swing axle lengths, damper ratios, anti-dive, anti-squat and ackermann. These can be displayed numerically or graphically.



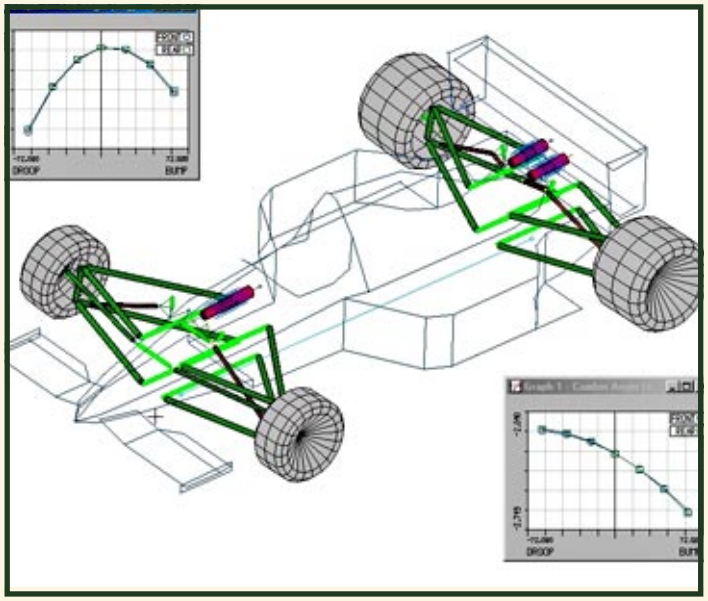
***Camber characteristics displayed for full vehicle***

The simple inclusion of ball joints, external forces, spring forces and 6 d.o.f. linear bushes allows the calculation of forces and deflections to be carried out and hence compliant results, such as lateral force steer, can be easily generated.

A unique feature of LSA is that the displayed results are updated in 'real-time' as the user makes a change to the model. These changes can be made on-screen through the 3D-viewing environment. For example, the position of a suspension hard point can be selected with the mouse and dragged (or 'stepped') along the required axes, the results display is updated as the point is moved.

This 'real-time' analysis capability has been achieved through significant changes to the bespoke LSA solver. The problem has been split into two components; the equations for the kinematic motion of the system are solved first, then the effect of component compliance is 'super-imposed' onto the kinematic solution.

To solve the kinematic system a set of non-linear equations is created to satisfy the fixed lengths of the pin-jointed system as defined in the suspension template. Additional equations are added to cater for strut slider constraints. An iterative simultaneous equation solver is used, based on the Powell's Hybrid method.



***Camber characteristics displayed for full vehicle***

The compliant analysis is treated as a linear finite element analysis, solved by the inversion of the sparse stiffness matrix for the system, this is added at each suspension position and added to the Kinematic results (super position).

LSA has revolutionised the design and development of vehicle suspension systems both for Lotus Cars and for client engineering programmes. Lotus is now making this advanced suspension analysis tool available to the OEM, performance engineering and motor sports communities.

***Source: Lotus Engineering***

**The world-renowned ride and handling specialists, Lotus Engineering are pleased to bring you LSA – Lotus Engineering Suspension Analysis; the latest suspension and analysis software tool to compliment your Vehicle Kinematics Toolkit.**

**Change the rules**

Fully versatile, LSA goes beyond simple kinematic products and facilitates the design and analysis of your suspension specifi cation, providing you with all the tools you need to:

- Manipulate suspension geometry with analysis displayed in graphical and numerical form
- Perform bush property defi nition with 6 d.o.f
- Design a complete suspension system in both a 2D/3D viewing environment
- Create, edit, test and document any suspension system with procedures to get you started

**You will find LSA,**

- Easy to use, cost effective with an intuitive user interface
- Downloadable via the web
- Offers Single, Multi-user and Floating licence options
- Reduces typical design and analysis cycle time

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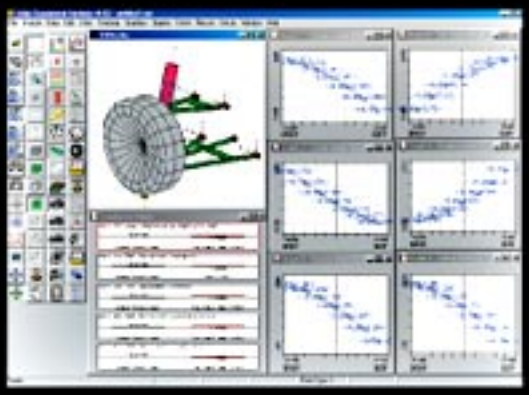
Call us on 01953 608768



# The Future Role of Vehicle Dynamics

**No-one has yet managed to find a suitable replacement for the wheel and in the field of vehicle dynamics, the spring and damper still holds sway. But does the electronic revolution signal the end for conventional chassis design and should ride and handling engineers be searching the situations vacant columns? Jesse Crosse reports.**

One thing the Detroit Auto Show did for us this year was to confirm just how far the automotive industry has lapsed into the grip of a green frenzy as the environmental black dog threatens to bite down hard on its wallet. In the space of just a few years, hybrids have exchanged their nerdy image for a kind of baggy trousers street cred that most rappers would die for. As a result, powertrain development has been hogging the limelight for some time but that doesn't mean to say that other crucial areas of development have ground to a halt and vehicle dynamics is one of them.

Consider vehicle dynamics in the broadest sense and it is actually one of the most important brand differentiators after styling, equipment and interior finish. These days, when data rules, a car's tactile qualities and how it responds dynamically in the hands of its driver, owes far more to the subjective judgement of individual development engineers than perhaps any other mechanical aspect of the car. In some sense, this has become a difficult area. In the future, the prospect of platform sharing beyond a basic structure looms large and if it were to reach a level where chassis components such as adaptive dampers become identical right down to a part number, then what happens to the dynamic distinction between different brands? Will vehicles lose their identity or will individual personalities disappear under the mass of advanced adaptive technologies that have burst upon the vehicle dynamics arena.

And there's no doubt, research departments are awash with new adaptive technologies. Where there was once simply a damper, there are now adaptive dampers. And where there were once differentials, there are adaptive torque control systems. Active anti-roll bars have been joined by active steering systems and electronic stability programs, by electromechanical brakes. Then, of course, there's the holy grail of future chassis systems, the active suspension system.

Active suspension falls into two broad categories, high and low band. High band systems are what might be described as 'fully' active, providing complete control through all frequency ranges, from gentle wallowing over undulating surfaces to high speed pattering over small irregularities. Low band systems, such as Mercedes ABC (CL and SL) use conventional springs to handle the low frequency work and support the car's weight. Just a gimmick? Well yes and no, in the sense that springs, dampers and anti-roll bars are actually hard to beat given the right level of expertise.

Attempts to introduce active suspension into mainstream manufacturing have been going on for almost 30 years but have been frustrated in the past mainly through the unavailability of computer processors capable of reacting fast enough, cost and the energy required to drive them. Since the super fast semi-conductor has come of age only Mercedes has taken the plunge so far but other concepts are emerging. Tyre manufacturer, Michelin, has a working concept for an active suspension unit comprising a spring and hydraulic actuator. At Paris in 2004 it revealed it's Active Wheel concept, which as the name suggests, packages active suspension, disc brake unit, wheel hub and even electric drive motor, inside the envelope of the wheel rim. Are we ever likely to see fully active, spring-free suspension in production? It's unlikely, simply because supporting the vehicle's weight consumes a huge amount of energy, while supporting it with a spring is free.

The real advantages of active suspension components of all types arguably lie in their potential not for enhancing the driving experience, but in providing an added safety margin for the driver. Integration with stability, braking and steering systems already make it possible for the vehicle to respond to a dynamic crisis even if the driver does not. Active front steering systems which

***Bose Suspension System (linear eletromagnetic motors)***

can influence the steering angle independently of driver input, are already in the marketplace and tentatively being integrated with stability and active suspension systems to complement the effect of both if the vehicle becomes unstable.

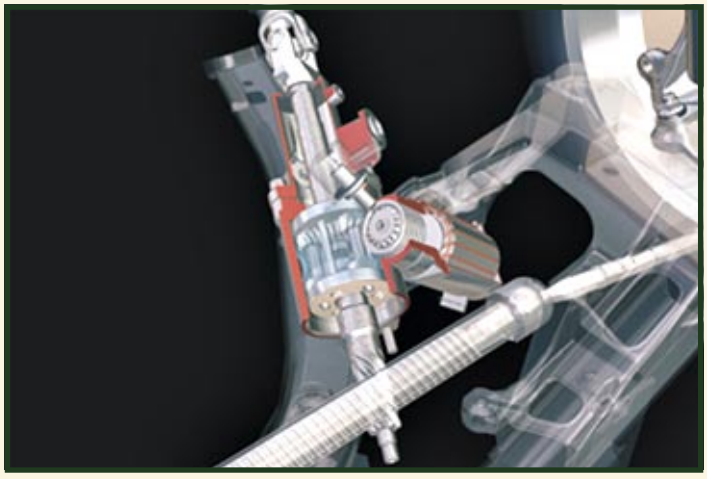
All of that implies a substantial role in the use of electrical chassis components which in itself brings manufacturing benefits. Electro-mechanical brakes already being successfully trialled by Tier 1 suppliers not only promise slick integration with electronic stability systems and active suspension, but in manufacturing,

the prospect of 'dry' assembly lines free of brake fluid is an attractive one. Last year, yet another possibility was revealed by hi-fi manufacturer Bose when it pulled the wraps off the 'Bose Suspension,' a semi-active suspension which swaps an hydraulic actuator for an electromagnetic linear motor.

Each unit resembles a conventional strut, minus coil spring. Instead, vehicle weight is supported by a torsion bar integrated with a two-piece lower control arm. Power amplifiers using switching amplification technology evolved at Bose during the last forty years, feed energy to the motors under the control of algorithms. The algorithms in turn, respond to data from sensors, continually reporting on the dynamic state of the car. Linear motors are proving simple and reliable in other areas of industry and in this instance, provide one benefit that no hydraulic active unit could do; they can regenerate energy.

When the electromagnet of the motor is active, then naturally, it consumes electrical energy. But when it is passive and being moved in bump or rebound by the road surface, then it can generate electricity which could be stored in a battery or better still, an ultra capacitor. This is a crucial aspect of the design and the designers claim the energy consumption is less than 30 percent of a conventional vehicle air conditioning system. However, that's still more than a spring and damper unit and ultimately the benefits of using such a system will be weighed not just against the cost of the components, but against the cost of improving powertrain efficiency by an equivalent amount, if the vehicle's efficiency is to remain in balance.

Assuming everyone's happy on that front, the electromagnetic linear motor could conceivably crop up in other chassis applications too. Steer-by-wire may be in it's infancy but it has



***BMW Active Front Steering System***

many supporters. The problems of doing away with a mechanical link between driver and wheels stood in the way for some time until BMW and ZF devised the Active Front Steering system. An electric motor and epicyclic gearbox spitting the steering column

> *"If the rules on vehicle dynamics are going to be re-written, then it won't be anytime soon"*

meant that steering angle could be changed independently of driver input while retaining a mechanical link.

It's clever stuff, although research engineers are still working on the principal of electric steering racks to provide full steer-by-wire and do away with the packaging and safety constraints of a conventional steering column. In that case, linear motors could have a role to play. The same electromagnetic forces used to apply torque in a conventional electric motor produces linear force. A linear motor can deliver accuracy measured in microns, produce both miniscule and massive forces, are fast and don't wear out.

However, back in the real world it's likely that a more conventional approach will prevail for a long time yet and certainly when it comes to 'proper' sports cars of all types. Despite the appliance of science, most juries composed of committed drivers are still out on the subject of driver intervention (or is that interference?) systems of any kind. And whatever the advantage of the more exotic devices when it comes to manufacturing, packaging and safety, they will have to evolve and awfully long way before they can out perform conventional chassis systems on a fundamental level.

Attention to the basics of vehicle dynamics still count for most and that becomes obvious during simple back to back testing of different products. Body rigidity, thanks to ever improving CAE techniques and availability of more sophisticated materials plays a big part, as do finer manufacturing tolerances and the ability to reduce friction in suspension components without breaking the bank. So too is the endless battle against increasing weight. The use of lightweight materials is crucial here and hybrid bodyshells combining both steel and alloys are already appearing in mainstream production cars. Aluminium construction is consolidating a niche too and for smaller volumes, Lotus's own, revolutionary, bonded aluminium architecture has proved a resounding success, first in the Elise, then in the Vauxhall/ Opel VX220 and Sportser and then the new Aston Martin range comprising the Vanquish, DB9 and soon, the new V8 Vantage.

If the rules on vehicle dynamics are going to be re-written, then it won't be anytime soon. The same laws of physics apply and though technologies improve, many of the basic, established techniques for dealing with them are simply so good, improving upon their elegant simplicity to any substantial degree is going to be a tough call.

***Source: just-auto.com editorial team***

# Lotus Technology Combats Louder Interior of the Modern Car

From both a technological and aesthetic perspective it is clearly evident that vehicles have advanced considerably in the last decade on a number of different levels. The enhanced ride and handling performance of the modern car represents one of the most significant aspects of this trend of continuous improvement, however such developments are not entirely without detriment.

As it launches a new patented system for actively tailoring vehicle acoustics, Lotus Engineering has found that many new cars subject their passengers to higher internal noise levels than their predecessors.

The surprising findings apply particularly to high volume family hatchbacks and superminis. Modern cars are undoubtedly better value for money, better equipped, more reliable, more fun to drive, more fuel efficient, and are safer. But as the issue of increasing interior noise is confounding the automotive industry, Lotus is launching a technology to solve the problem.

The Hethel-based consultancy's 'In-Car Active Acoustic Tailoring' (ICAAT) system allows vehicle manufacturers to create an acoustic ambience that matches consumers' expectations, and which can even be tailored to suit individual driving styles and auditory expectations.

"It's a surprise to most people that while you'd expect every aspect of a car to have improved over the last ten years, noise levels inside the car have actually worsened in the majority of cases," reveals Steve Swift, Head of Vehicle Engineering at Lotus. "As the number of clients requesting our help in this area has increased, we've been working to refine our active noise solution. With the newest version, ICAAT, car manufacturers can discreetly improve and manage interior noise characteristics."

Lotus has observed that over the last decade, while engine noise and wind noise have decreased, the efforts of manufacturers to make cars more attractive, safer, and more fun to drive have resulted in greater in-car noise.

To improve the appearance of today's cars, manufacturers fit larger wheels, alloy not steel, and low profile, wider tyres, more frequently of a run-flat design for increased safety. These welcome improvements may enhance styling and safety, but produce greater levels of road noise and transmit more of that generated noise to the passenger cabin.

The suspension configuration of modern cars compounds the issue. A decade ago, most hatchbacks had standard beam axle suspension, but many modern hatchbacks now feature multi-link suspension as manufacturers pursue superior ride and handling. This setup, however, offers multiple paths for vibration and noise to enter the car.

The noise is not only an annoyance, but according to Swedish researchers the presence of a low frequency monotonous noise can make drivers feel drowsy, which is widely believed to be a factor in some accidents.

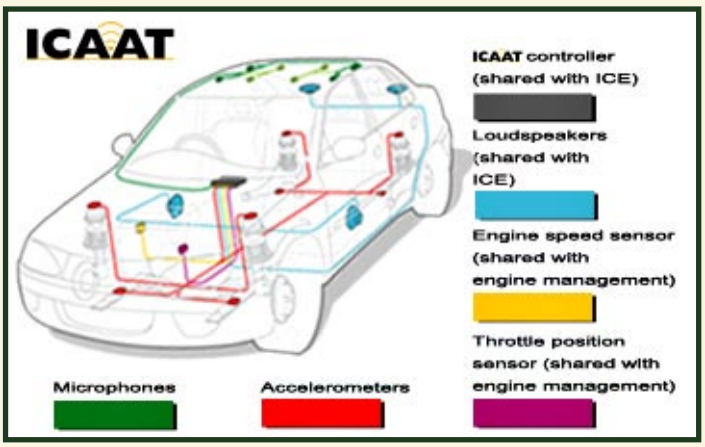
Low frequency road noise cannot be effectively treated with conventional NVH tools without compromising vehicle dynamics performance. Lotus is marketing ICAAT as a viable and cost-effective solution, integrating road noise cancellation and engine order cancellation.

ICAAT works by reducing unwanted noise in the relevant frequency range from both the road and engine. Through complex algorithms, the technology then generates sound of an opposing phase through the car's standard speakers, suppressing the perceived level of noise for passengers.

In addition to eliminating unwanted engine and road noise, ICAAT also features a sound generation mode, as Swift explains. "ICAAT is capable of producing engine sound cues as well as suppressing unwanted noise.

Manufacturers could therefore tune the engine tone characteristics between different models in a product range. Alternatively, there is the option to leave the decision to individual drivers, allowing them to choose the engine tone dependent on their mood or preferred driving experience. It's an extremely versatile and valuable technology."

Lotus' first generation active engine noise suppression system was fitted to Japanese-specification Nissan cars in the early 1990's. ICAAT builds on the performance of Lotus' previous active technology, but is significantly lower cost, and integrates into a single system the functionality of engine order and road noise cancellation, in addition to the sound synthesis feature. Increased performance and lower cost means that active acoustics are now, more than ever, a commercially feasible proposition for high volume vehicle manufacturers. As a result the first version of the new technology is already in demonstrator vehicles, and the Hethel-based consultancy is now in advanced stages of discussions with OEMs and Tier-One ICE suppliers regarding mass-production of ICAAT.




*Source: just-auto.com editorial team*

# Focus on Vehicle Dynamics Suits Lotus Engineering

It is an undeniable fact that Mr Joe Average is becoming ever more savvy. For many years he has been hearing about the virtues of cars that handle well and ride comfortably, but at the start of the 21st century it seems that the message is finally filtering through. It is not just the hot hatch variants that must ride and handle with aplomb, today the family car must also be an engaging and competent drive. So, now that the manufacturers have successfully educated the consumer, they must deliver. And they must do so without compromising safety, which must remain unquestionable.

These vehicle dynamics attributes, dare it be suggested, might be part of the basis of a purchasing decision. Witness the number of small B- and C-segment cars in Europe with multi-link suspension, the preserve of the luxury car only ten years ago. It's expensive, but OEMs believe it is important in the marketplace.

But while OEMs may know what they want to achieve, few possess the capability to complete a full vehicle dynamics programme without specialist support.

Lotus' ride and handling team are past masters at undertaking vehicle dynamics development. The range and breadth of their expertise is staggering. Almost 15 per cent of cars sold each year in Europe have passed through the gates at Hethel for dynamics development. Current work includes mass-volume passenger vehicles from the Far East, commercial vehicles in China, a European SUV, and a high performance luxury four-seater coupe.

The Lotus approach to chassis design and development is to understand both the link between wheel motion and forces at the tyre contact patch, and, importantly, the relationship between these forces and desirable responses of the vehicle as experienced by the driver. While this may not be entirely unique, it is Lotus' unrivalled combination of subjective assessment experience supported by superior in-house objective techniques that sets the Hethel-based consultancy apart.

The personal skills of the individual vehicle development engineers are key to the subjective side of the ride and handling equation. To this end, the range of expertise within the team is phenomenal. The skills are learned programme by programme, year after year, and passed on from experienced senior consultants like Roger Becker. The 8-strong team has over 100 man-years of experience. Team members are involved in a wide variety of activities and across a spectrum of products. The principal engineers have been at Lotus an average of 17 years, starting on apprenticeship schemes at Lotus.

This incredible wealth of knowledge, combined with close working relationships with client engineers, results in specific vehicle ride and handling characteristics perfectly matched to client / market expectations.

The flexible approach employed by Lotus means that where adequate off-the-shelf-tools are not available Lotus will readily develop its own bespoke solutions. This allows Lotus to ensure that its development tools will best fit the needs of its clients and reflect the unique way in which it operates. An example of this is the Lotus SKCMS (Suspension Kinematics and Compliance Measurement System).

Developed and refined over a period of more than 10 years, Lotus' SKCMS has established itself as one of the most advanced and flexible test machines of its type. Its role is to measure suspension characteristics by slowly applying vertical, lateral and longitudinal forces into each tyre contact patch and measuring the suspension response. The suspension measurements, such as 6-axis force/displacement variation and individual wheel steer and camber change characteristics, allows Lotus to build up a picture of how the car will react in various situations. Characterising the suspension in this way allows Lotus engineers to adjust the stiffness or kinematic properties of individual components to achieve the desired vehicle response characteristics.

The SKCMS is used throughout the development process, from competitor benchmarking, mule car setup, prototype development, through to verification of production car specification. As such it has been designed to be flexible, allowing a wide range of vehicles to be measured, and highly time efficient.

Developed in parallel with the SKCMS, Lotus' Suspension Analysis software (LSA) further enhances the value of the suspension characterisation information. LSA can be used as a stand-alone package, but uniquely it can import data directly from the SKCMS allowing vehicle models to be created in a matter of minutes. The main advantage of using the SKCMS to generate models is that it eliminates the need for extensive design data and time consuming model building. As it is based on measured data it allows a more representative simulation model of an actual test vehicle to be generated. This ensures that subjective evaluations and objective simulation measures may be correctly compared and correlated.

LSA allows changes to suspension parameters to be quickly and accurately simulated and optimised before making hardware changes on the vehicle. This interactivity between LSA and the

this issue, Jesse Crosse looks at the various systems that are creeping into the market, but Lotus is looking still one further step ahead. It has developed a single technology concept that integrates the various disparate systems being implemented by OEMs today.

Drawing on Lotus' lengthy history with active systems, a technology called Controlled Vehicle Dynamics (CVD) is being developed by Lotus' Control Systems Group. Its head, Chief Engineer Steve Kenchington argues that independent active systems aren't making full use of their promised safety benefits. "We've seen the introduction of active steering, active suspension, active brake distribution, but these tend to manage the car's stability. What Lotus is developing is a technology that allows the control of the behaviour of the car in all conditions up to the limit of adhesion." Again, this is all about optimising the forces between the tyre and the road. Lotus CVD aims to control both longitudinal and lateral slip. The end goal is an integrated system controlling brakes, suspension, steering and transmission. The system would incorporate active rear steer, active suspension, ABS, traction control, and stability control.

Kenchington claims CVD is likely to feature on cars before the end of the decade. "Essentially, there is the potential to numerically engineer the feel of the car. A CVD-equipped car will have improved body control, better steering feel, and manufacturers will be able to make claims around safety improvements." Electronic aids are inevitable as the technology becomes more accessible and as the market demands parallel improvements in safety and performance. In the past this often dictated a compromise. If electronics can be discreetly and cleverly implemented, that compromise may be eliminated.

With this new power of control over vehicle behaviour, the importance of understanding what actually represents desirable dynamic character in different markets and how best to achieve it will become a key requirement. It is here that Lotus' unique combination of extensive subjective assessment experience, and their understanding of how to match specific vehicle ride and handling characteristics to different market expectations, presents a powerful resource for extracting the best performance from the new technologies.

Now that manufacturers have exposed themselves to competing head-to-head in a new arena, that of vehicle dynamics performance, focussed consultancies that are able to implement exactly the characteristics desired will be shouldering more and more of the development burden. It's becoming an incredibly important attribute in the product offering.

OEMs beware!

***Source: Lotus Engineering***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