



# *pro* **Active**

The official industry newsletter of Lotus Engineering

Issue 7

March/April 2005

## *Indian light vehicle market review*



## *Rolling Stock*



# Welcome

The strategic importance of an effective supplier network is unquestionable. A fact that is reflected by the prominent role afforded to supply chain management in the modern manufacturing organisation.

Technological advancements and the increased influence of globalisation have presented both challenges and opportunities in equal measure, with the vast array of sourcing opportunities counterbalanced by the potential pitfalls that accompany cross-continental supplier management.

As is clearly illustrated by the candid assessment of Lotus' past supply chain structure and practices in this issue, the need for effective monitoring and control is vital due to the potential for negative impact not only on the bottom line but on all aspects of the business. Such is the all-permeating nature of supply chain activity, mismanagement or oversight to any significant degree can prove crippling – financially and operationally.

The continued evolution and improvement of Lotus' supplier network is recognised as vital within the organisation, with the ultimate goal of forming an optimally efficient, quality and cost-focused process paramount in all our operations.

I hope that Issue 7 of ProActive provides a valuable and interesting insight into supply chain management within the context of Group Lotus plc and our role in the wider commercial setting.

**Selwyn Mould, Head of Supply Chain, Group Lotus plc**



2



5



10

## Contents

news *March/April 2005* features

UK: Rising European demand for diesels spur technical developments 3

UK: Study says purchasing should be a strategic top level function 3

Russia: Government agrees in principle to auto parts duty cut 4

Indian light vehicle market review 5

Globalising the automotive supply chain 8

Rolling Stock 10

BOM Cost down: The Lotus Elise 13

Engineering composite structures 15

## **UK: Rising European demand for diesels spurs technical developments**

**Diesel engine technologies have recorded tremendous growth in recent years, driven by the increasing market share enjoyed by diesel engines in Europe.**

Modern diesel engines are being compelled to comply with various emission regulations and performance requirements that are helping drive the evolution of the technologies from the conventional to the more radical and innovative.

Researcher Frost & Sullivan estimates the total European next-generation diesel engine technologies market to be worth US\$6.34bn in 2004. The market is forecast to increase at a compound annual growth rate of 3.6% to reach around US\$8.26bn in 2012.

Diesel engines are gaining in popularity in Europe, penetrating even vehicle segments that have traditionally been considered gasoline engine strongholds.

With the introduction of sophisticated technologies such as variable geometry turbocharging and common rail direct injection, the penetration of diesel engines is expected to increase from the current 45% to about 53% by 2012.

Among the various technologies, boosting techniques, engine management systems and exhaust gas after-treatment systems are attracting the maximum interest from vehicle manufacturers. Valvetrain technologies are currently in a dormant state but automakers are increasingly evaluating the potential of variable valvetrain applications in reducing pollutants.

Essentially, the growth of individual technologies depends upon the extent to which they enable diesel engines to fulfil certain important requirements. For instance, boosting techniques, engine management and after-treatment systems enable diesel engines to provide reduced fuel consumption and emissions, increased power density and performance and diminished noise, vibration and harshness (NVH) characteristics. These advantages strongly favour such technologies.

Although valvetrain technologies exert little influence on such requirements, they are expected to play an important role in the future with emission regulations becoming progressively more stringent. There have been considerable developments in fuel injection equipment. CRDI is fast becoming a standard feature in the diesel engines of modern passenger vehicles due to the many advantages it offers such as better combustion, improved emission control and reduced fuel consumption.

By 2012, fuel injection technologies are expected to account for the bulk of diesel engine technology revenues. CRDI and unit injector technologies along with multiple injection and variable

nozzle characteristics are expected to remain the focal points of interest in the European market.

Boosting technologies have undergone similar developments, with the simple turbocharger transforming into the modern variable geometry turbocharger and double stage charging. With the specific power output of diesel engines increasing, turbochargers are now a critical part of virtually all engines manufactured today.

Although newer technologies such as homogeneous charge compression ignition (HCCI) and selective catalyst reduction (SCR) are getting a good amount of attention as the technologies likely to drive diesel engines in the future, vehicle manufacturers are still uncertain about when they can actually enter serial production.

Automakers are still struggling to understand the start of combustion in HCCI and its subsequent control. HCCI can be expected to feature in passenger vehicles in the European market only when automakers are able to properly comprehend its functioning.

Among exhaust gas after-treatment systems, diesel particulate filters are projected to significantly grow in the period 2001-2012 with penetration rates likely to reach 35% in 2010.

Automakers are recognising the strong potential of DPFs with regard to particulate matter and oxides of nitrogen reduction.

At the same time, governments are offering generous fiscal incentives for vehicles equipped with DPFs. This, combined with increasingly strict emission norms, has been greatly instrumental in encouraging the adoption of DPFs and boosting their penetration rates as well as revenues in the European market.

*Source: just-auto.com editorial team*

## **UK: Study says purchasing should be a strategic top level function**

**The best purchasers agree targets with their suppliers, according to Markus Knoche, a researcher at the Fraunhofer Institute in Germany.**

His analysis was based on a benchmarking study of successful practices at 70 companies in Germany, focused on automotive suppliers.

The 10 best purchasers in the Fraunhofer evaluation were significantly different from the average in this respect, he said.

Among the top 10, 80% agreed targets with their suppliers, compared with only 45% of the suppliers surveyed as a whole. Almost all (97%) agreed quality targets with their suppliers, 82% agreed targets for the reliability of deliveries and 64% agreed targets for price development.

Knoche said it is very important to achieve transparency with suppliers. A purchaser must “understand the supplier and his processes”, and the shape these processes take with the supplier. “Because potential is not only in the product but also in the processes” he said.

## *“A purchaser must understand the supplier and his processes”*

Long-term co-operation with suppliers makes a complete evaluation of suppliers necessary. The problem is that hard, measurable facts like costs and quality tend to dominate the evaluation but “soft facts” like the long-term nature of the partnership, the long-term prospects for the competitiveness of the supplier location and the supplier development capabilities are becoming more important. Cost and quality are becoming more of a given.

### *Early involvement important*

Knoche said another feature of successful purchasing is the early involvement of suppliers in development. “The biggest lever [for cost reduction] is in the development department of the supplier.”

70% of costs are fixed in the development phase and, with falling levels of vertical integration, that means 50% of total cost is influenced by the development of the supplier product.

Interestingly, he said that early purchasing works better if it is the responsibility of the purchasing department rather than research and development. Among the top 10 purchasers, 10% fully involve suppliers right from the beginning of the project and a further 50% in the concept phase. None of the top 10 purchasers wait until after the development process before involving their suppliers.

Knoche said that another distinctive feature of the top 10 purchasers is that they have made purchasing a high-ranking strategic function – for 30%, purchasing is a board-level function - in general that is true of less than 5% of companies.

It is only possible to overcome traditional interface problems between purchasing and development on a top-down basis.

For European companies Eastern Europe is the most important low labour cost source for purchasers, according to Knoche, and China is of growing importance for international purchasing by European suppliers - it has overtaken South America in importance and now accounts for 3% of the purchasing volume of European suppliers, compared with just 1% for South America.

But NAFTA, other parts of Asia-Pacific and Eastern Europe are all still more important sources. Knoche reported that suppliers say that legal and technological standards are the biggest obstacles to global sourcing, ahead of language and cultural problems.

Knoche said that e-procurement has so far mostly been deployed to improve efficiency through catalogue systems and to some extent e-auctions. Suppliers have found that e-procurement has substantially improved communications along the supply chain, improved the efficiency and quality of the purchasing processes, and added transparency. Contrary to initial expectations, those have been much more significant benefits than direct material cost reduction or the bundling of purchases. E-procurement has had less effect on access to innovations, he added.

The research was undertaken between November 2003 and June 2004 and about 70 firms took part in the survey. Among the participants, Volkswagen, ZF Sachs, Benteler Automotive, Degussa, KBA and Johnson Controls were identified as having successful practices. Knoche presented his insights at a conference organised by the German magazine *Automobil Produktion* on purchasing in Ulm in February 2005.

*SupplierBusiness.com*

## *Russia: Government agrees in principle to auto parts duty cut*

**Russian prime minister Mikhail Fradkov has agreed in principle to cut import duties on auto components to as little as 0%, from 13%, Alexei Kaulbars, the government’s foreign trade regulation and customs department director, told the Prime-Tass news agency on Thursday.**

The move is reportedly designed to encourage foreign auto makers to begin producing in Russia, and follows a bill prepared in late 2004 by the Economic Development and Trade Ministry. According to the *Gazeta* newspaper, that bill envisaged duties on most types of auto components would be reduced to zero, although some would be cut only to between 3% and 5%.

One issue unresolved is the definition of what constitutes “industrial assembly”. Kaulbars told Prime-Tass the term has been defined in general. On Wednesday, another official said its precise definition requires more work to make clear which vehicle parts should be included in the term.

Earlier this week, Prime-Tass noted, *Gazeta* reported the ruling would be made on condition that foreign auto makers operating in Russia localise the production of 50% of the component parts for their vehicles within five years.

*Source: just-auto.com editorial team*

## Indian light vehicle market review

The year 2004 was a healthy one for the Indian passenger car industry. India's booming economy underpinned growth in the market of around 25% with the light passenger vehicle market passing through the one million barrier for the first time. But 2004 in India's light vehicle market was memorable on other levels too. As well as the continuing arrival of significant new models there were signs that India's top selling model – the Suzuki Maruti 800 – is finally, after two decades, about to lose its number one position. Deepesh Rathore and Tilak Swarup report.

2004 was the third straight year of growth for the light vehicle market as the Indian economy continued to record economic growth in the region of 7-8%.

But the year 2004 will be significant in the history of the Indian automobile industry for two important reasons. First, domestic light passenger vehicle sales crossed the one million mark, a landmark breached after a phase of unprecedented market growth that has seen the Indian passenger car and utility vehicle market grow by nearly 50% in the last three years.

*“domestic light passenger vehicle sales crossed the one million mark”*



Maruti Alto

The second significant happening of the year was the Maruti (Suzuki) Alto beating its stablemate and India's best selling car for the last two decades, the Maruti 800 in sales volume for most of the year. The 800 did manage to end the year 2004 as the best selling car in the Indian market but 2004 will probably turn out to be the long-serving 800's last year at the top of the pile.

Indeed, the 800 suffered a 22% fall in sales during 2004 over the previous year – with annual sales for 2004 of 132,706. The Alto posted sales of 112,045 units, a whopping annual growth rate of some 166%. Alto sales are experiencing rapid growth because Maruti Udyog's is strongly pushing the model in India right now.



Maruti Wagon R

The company reduced the price of the Alto, and introduced a base version of the model which was priced only about INR 30,000 (Euro 500) above the Maruti 800's top-end model. At the same time, Maruti discontinued the five-speed transmission version of the 800, pushing customers towards the Alto. The Alto, with its low price and modern styling, has started to find favour with the traditional Maruti 800 customers. In fact, 2004 was the first time that Alto sales crossed the 100,000 units mark in annual sales. Three cars managed to do more than 100,000 units in 2004 (the third being the Hyundai Santro) while another model (the Tata Indica with 98,318 units) came close.

The Alto's stablemate and architectural sister, the Maruti Wagon R, also saw a boost in sales of 69%. The car has received a facelift which has helped it to greater market acceptance in India. Also, the customer's growing familiarity with the Wagon R's boxy shape has helped the car's sales. Meanwhile, Maruti's third model in the B-segment Zen (last generation Alto) stagnated in 2004. The facelift that the car received last year failed to ignite sales, Maruti customers preferring the makes other offerings.

Maruti's major competitor Hyundai Motors India saw an 11.6% jump in Santro (Hyundai Atos/Dodge Atos) sales. This would have been higher but for capacity constraints and high export demand. Hyundai's Indian operations are the global hub for the Santro/Atos.

# Feature



*Hindustan Motors Ambassador*

The Tata Indica was the fourth largest selling car in the country in 2004. At 98,318 units, the Indica saw a jump of 27% in sales over the previous year. About 85% of these were the diesel variants. In apparent opposition to the growing modernisation of the Indian car market, the Hindustan Motors Ambassador (1950s Morris Oxford-based car) saw a healthy 10% growth in sales volumes to 12,758 units, riding on two new variants launched by the company.

The worst performing car in the small car segment was the Fiat Palio which saw a sales decline of some 45%. Palio sales were just 5,514 units in 2004, compared with 9,990 units sold in 2003. This huge decline in sales is indicative of a general loss of faith in Fiat India by the market. With no news models planned, further decline for Fiat is expected.

*“several sub-compact models faced a fall in sales in 2004”*

General Motors India's Corsa Sail has also not been an impressive market performer and the year 2004 saw a further drop of 3% in its sales.

Hyundai India introduced the Getz in 2004 and the car has met with only modest sales success thus far. The Getz has sold some 5,483 units since its launch three months back. The sub-compact

segment has been the fastest growing segment in the passenger car market. The market leader is the Tata Indigo (three-box version of the Indica) which sold 36,257 units in 2004, growth of 41% over the previous year, with the diesel variant once again proving very popular for Tata.

The new Honda City (three box variant of the Fit/Jazz) has been selling well. The year 2004 saw City sales grow by some 115% to reach 30,834 units.

The surprise revival of the year was the Maruti Esteem which registered 65% sales growth thanks mainly to a facelift and price correction. The Esteem is now selling briskly at about 1,500 units per month. Maruti's other offering in this segment, the Baleno, also registered a strong sales growth – sales were up by 268% to end the year at 6,522 units thanks to a low end variant launched by the company.

The Ford Ikon sold 24,536 units in 2004, 32% growth over 2003's sales. The Ikon's sales benefited from several new variants and a price reduction. Ford also introduced the Fusion at the end of the year. Fusion sales have been slow thus far (329 units by end of the year).



*Maruti 800*

Hyundai's Accent sales remained stagnant with a minor 4% drop in 2004 over 2003. The company sold 24,087 Accents in 2004. The Accent did not receive any serious push in 2004 and a facelift is not expected in 2005.

However, several sub-compact models faced a fall in sales in 2004. Hindustan Motors-Mitsubishi Lancer sales dropped 15% over the previous year with 2,494 units sold in 2004. Similarly, the Opel Corsa saw sales slide by about 15% in 2004 with 5,635 units sold in the year.

The sub-executive car segment remains dominated by the Toyota Corolla with strong competition from the Chevrolet Optra. Toyota managed to sell 10,195 Corollas in the calendar year, growth of 24.3% over the last year. The rival Chevrolet Optra continued a

# Feature

strong sales trend throughout the year and ended the year with sales of 9,191 units. It is interesting to note that neither model has a diesel option.

Skoda sold 6,963 Octavias in 2004, growth of 26% over the previous year's volume. Skoda is now offering six variants of the Octavia.

Hyundai sold some 3,962 units of the Elantra in its inaugural year and a high percentage of these sales came from the CRDi version of the car with few takers for the petrol variant.

Generally more attractive offerings in the sub-executive and SUV segments had an adverse impact on the executive segment as nearly every model, except for the Honda Accord, faced a decline in sales. The Honda Accord continued in its dominant leadership position. Honda sells the US market version in India and the company sold 2,977 Accords in 2004, 73% up on the previous year.

Both the Hyundai Sonata and the Toyota Camry failed to pose a major challenge to Honda's leadership position in the segment. The Camry sold 942 units, a 7% drop over the previous year while Hyundai sold just 1,001 units of the Sonata, some 24% off 2003's pace. Clearly, the ageing Sonata is now late in its model cycle and Hyundai will replace the current model with the newly introduced NF Sonata this year.

Skoda also sells the Superb in India, but in the absence of a strong push, the company sold only 243 units in 2004.



*Toyota Qualis*

Mercedes had a remarkable year in 2004 as a buoyant economy pushed more well heeled customers towards Mercedes showrooms. The E-Class continued to be the best-selling Mercedes model, selling 816 units, 22% up on the previous year. The C-Class accounted for 785 units while S-Class sales stood at 126 units, 50% up on the previous year.



*Maruti Omni Minivan*

In the utility vehicle (UV) segment, the Mahindra Scorpio continued its strong run with 27,737 units sold in the calendar year, a 14% gain over the previous year. Significantly, Mahindra's other UVs accounted for 73,673 units in 2004, a big growth of 29% over last year.

The Toyota Qualis remained the best selling UV in the Indian market with 36,699 units sold in calendar year 2004. Ironically, Toyota has now withdrawn the Qualis from the Indian market with the recent introduction of the Innova. This in a year when Qualis sales grew by 19%. Tata presented a facelift on the Sumo and renamed it as the Sumo Victa. Sales grew by 16% to reach 30,006 units in 2004.

GM India had a good start with the Tavera and managed to sell 8,417 units. Sales were undoubtedly hurt by long waiting lists for the Tavera as GM India failed to hike up production in time. Now, with the introduction of the Innova, the Chevrolet Tavera will be under fire from Toyota.

The Maruti Omni minivan sold 59,524 units, growth of 11% over the previous year, as the company introduced a LPG powered cargo version. The Versa people carrier also registered a growth thanks to a low-end version being introduced by the company. However, volumes were still low at 4,955 units. In the imported SUV segment, Ford has been doing brisk business with the Endeavour (Everest in S-E Asian markets). Its huge size and diesel power have made the Endeavour a popular choice.

Honda replaced the CR-V with the European facelifted version and the model continued on its popularity graph, ending the year with 1,600 units sold.

*Source: Lotus Engineering*

## Globalising the automotive supply chain

**Demands on automotive suppliers are unceasing and escalating. Although a simple reflection of the same pressures and demands being felt by their major customers, the impact on supplier strategies is immense. No self-respecting tier one automotive supplier today can be without a full array of corporate policies and tactics designed to address these challenges. Amongst these, the pressure to globalise operations ranks among the most demanding.**

All OEMs face unremitting competitive pressures to improve operational performance in areas such as quality, functionality (at lower cost), time to market and capital utilisation. They also face similar pressures to seek out real growth prospects outside traditional mature geographic and product markets. At the geographic market level, the pressure is on to seek out, and capitalise on, areas of new and growing demand, with China clearly at the top of the list for most, and other countries in Asia not far adrift.

For some OEMs, most notably the Japanese and Koreans, China represents one more avenue for growth, complementing a still-increasing presence in mature regions such as North America and Europe. For others, including GM and Ford, growth in new markets is seen as compensating for continuing market share losses in own backyards. Whatever the motives, going global, especially with regard to expansion in Asia, represents a significant challenge for supplier bases.

For automotive suppliers, at varying levels in the food chain, the need to establish a worldwide presence is added to a formidable array of other selection criteria imposed by customers. These criteria incorporate cost competitiveness, quality, technology, delivery, service and other capabilities associated with being a full-service supplier such as R&D/product development/engineering resources.

For tier one suppliers, being the supplier partner of choice for a particular component, system/module is a key competitive position. While this may be founded on identification of business opportunities and anticipation of customer needs at very early stages of vehicle design, it also increasingly requires suppliers to have global engineering and R&D capabilities and a global manufacturing/delivery footprint.

Such pressures are hard for suppliers to ignore. Through the growth of overseas purchasing offices, even OEMs with limited direct investment in regions of new growth increasingly have intelligence on global procurement and pricing. With this knowledge, they can pressure suppliers to meet these prices, or move offshore.

For suppliers, globalisation can be approached from many directions. In the simplest cases, overseas production facilities can be established to support local production of the global platforms of major customers, at the behest of those customers. This may require modest greenfield investment in program-specific assets, manufacturing/delivering a limited range of components/systems for local assembly. This customer-led investment may have scale and cost disadvantages that have to be factored into the economics of the overall supplier/customer relationship. Beyond this simple form, complexity can increase significantly and suppliers should have clear objectives in mind when initiating an expansion of offshore investment. A number of examples help to underline this complexity.

As one of the top two tier one integrators of automotive interior systems, Lear Corporation is at the leading edge of many of these developments and acknowledges it has been required for some years to manufacture and supply these systems and components in multiple geographic markets. In the last few years, the US\$17bn supplier has followed customers and expanded operations significantly outside its North American base, most notably in Europe, central America, South Africa and Asia. This has lifted net sales outside of North America from US\$4.3bn to US\$7.7bn in the 1999-2004 period.

Beyond this network, much of which supports its traditional North American and European customer base, Lear has also initiated another key part of its globalisation objective, its Asian strategy. This is a two-pronged plan to expand business in Asian markets and with Asian OEMs worldwide.

Like many other leading tier one suppliers, Lear acknowledges that the Asian market presents unique growth opportunities, as all leading major global OEMs expand production in the region, most notably China, to satisfy growing demand. Lear's chosen strategy





# Feature

has been to implement a series of joint-ventures in China, 12 in total with local partners (out of a total of 33 spread across 12 countries, 19 of which operate in Asia). Output from these goes principally, but not exclusively to local assemblers, with some being exported to Japan and North America. Lear also has similar ventures in Korea, a manufacturing presence in Thailand, manufacturing and engineering operations in India and the Philippines and strategic sales and engineering offices in Japan.

This hints at another growing requirement in the globalisation process – the need for “local” engineering and product development assets to service global customers locally. In Asia, Lear has administrative/technical operations in China (2), India, Japan (4) and South Korea.

Magna International, the diversified Canadian supplier with capabilities in the areas of exteriors, interiors, powertrain, metalforming, mirrors, vehicle assembly and drivetrain has similar strategies to leverage its global presence. Correction of current major imbalances to create a broader customer base and more diversified geographical sales mix is a priority. Magna has significantly strengthened its local presence in the Asia Pacific Basin in the last 18 months, most notably through increasing the size of its engineering, program management and sales staff in Japan. This is to facilitate the growth of business with the Japanese OEMs in both Japan and overseas.

Similar investment has been made in Korea where Magna has two facilities and a sales/engineering office, a commitment that has already led to contract awards and given Magna valuable experience of interfacing with the Korean OEMs. Magna has also adopted a partnership strategy, which is focused on identifying partners that serve Asian automakers. These partnerships are based on Magna’s provision of new technologies to supplement the partner’s business relationship and manufacturing capabilities with automakers in Japan. This allows both partners to support Asian automakers on a global basis. Additional initiatives are also being taken, especially with regard to China, where Magna now has six facilities, two of which were established in 2004, as well as a sales and engineering office in Shanghai.

The focus on broadening the customer base to some extent mirrors the strategy of developing new markets. Magna’s basic stance is that global vehicle production will increase from 58.7m in 2003 to 75.1m in 2009, an increase of 28% or 16.4m units. However, this growth will be heavily focused in certain regions that Magna sees as its key targets. China, South east Asia and central/eastern European markets are expected to contribute 6.8m, 2.5m and 2.2m units respectively to this 16.4m total unit growth, or 70%. This implies growth rates of 175%, 71% and 49% respectively in the three regions.

These globalisation trends are not just confined to the largest tier one North American suppliers. LEONI, the German-based supplier of wiring systems has also invested outside Europe, most notably China, where a joint venture was signed in December 2004 with Chinese wiring and component manufacturer THB.

**Forecast vehicle production growth by major region, 2003-09**

Region	Units increase (m)	% change
China	6.8	175
SE Asia	2.5	71
Central/Eastern Europe	2.2	49
North America	1.6	10
Western Europe	1.2	8
South America	1.1	58
India	0.4	42
Japan	0.1	1
Other	0.5	27
Total	16.4	28

LEONI is acquiring a majority stake in THB’s largest automotive cable harness facility in Liuzhou, southern China and this will operate as LEONI Wiring Systems Liuzhou, generating an estimated €10m of sales in 2005. The investment will extend Leoni’s Wiring System Division’s supply footprint to all of China’s principal car manufacturing regions. The collaboration is also seen as facilitating local procurement of components.

Inergy the French-based supplier of fuel systems believes its current two-legged (Europe and North America) sales base is too narrow, and that a mix of organic and inorganic growth should establish Asia as a third support. Some key pieces of this new globalisation strategy are already in place, most notably the establishment of the new R&D centre in South Korea, an essential pre-requisite for gaining new contracts with new customers throughout Asia. The new Won4bn R&D facility in South Korea, built adjacent to an existing production plant, optimises validation testing for all development programs in Korea, Japan, Thailand and China and has become the company’s Asian R&D centre and a key part of its overall Asian strategy.

In summary, many forces are driving the increased globalisation of the automotive supply chain. Many of these forces come directly or indirectly from the OEMs and their own global expansion, but some result from the initiatives of suppliers alone. All are seeking one thing, growth outside traditional, mature markets. This globalisation is not confined just to the upper echelons of the tier one supply base but percolates down to lower levels. Nor is it confined just to certain, high-visibility component sectors. The need for independent engineering services such as those supplied by Lotus Engineering in, for example China, is as real as the demand for finished components and systems, especially among the indigenous vehicle manufacturers. The potential for growth is undoubtedly real, realising that potential may be exigent.

Colin Whitbread



## Rolling Stock

Exact quality standards are identified for every component chosen for a Lotus, and the specification of alloy wheels is no exception. Nick Swallow visits Rimstock, one of Lotus' main suppliers to discover more about this process.

Barrelling into Paddock Hill bend in the middle of a snarling pack of doorbanging British Touring Car Championship contenders is neither the time nor the place to worry if your car's alloy wheels are up to the task. Matt Neal, a former European Touring Car Champion who took fifth place overall in the '04 British Touring Car championship at the wheel of a Honda Civic Type-R, has no such qualms.

And with good reason; as Marketing Director of Rimstock, Britain's largest manufacturer of alloy wheels, he gets a first-hand view of every aspect of production, from aluminium alloy billet to final polish, every day of his working life. His faith in his company's products is absolute, which is handy when you're pulling big lateral g-forces with nothing but Armco between you and a major accident.

Rimstock may not be a familiar name, even to the enthusiast. Its alloy wheels for the aftermarket are marketed under the 100+ and Team Dynamics brand names, and are sold in 48 countries around the world.

Over the past seven years, however, the focus of the company has changed. The manufacture of wheels for original equipment has grown in that time from around 30% of the company's turnover to some 70%. It's an achievement of which Matt Neal and his colleagues are justifiably proud, especially as labour costs in the UK compare unfavourably with those of China, India or the former Soviet Union, where many rival manufacturers are based.



*“ We'll never  
compete on price  
alone, so if we can't  
make a cheaper  
product we have to  
find ways of making  
a better one.”*

Today, Rimstock can claim a roll-call of prestigious automotive manufacturers among their clients, including Lotus. Matt Neal, whose 6'6" (2m) frame must be tough to accommodate in the cockpit of a racing car, has no doubts about Rimstock's competitive advantage. "We invest a big proportion of our profits back into the company, and in particular into developing new technologies. We'll never compete on price alone, so if we can't make a cheaper product we have to find ways of making a better one." The making of a better aluminium alloy wheel starts with the raw material itself, and Rimstock works with the metallurgy department of nearby Birmingham University, sometimes even developing unique alloys for specific wheel designs. Rimstock's typical daily production consumes a massive 20 - 25 tonnes of aluminium, and one of the challenges of the business is deciding where and when to pre-order aluminium on the world's commodity

# Feature

markets. Get the timing wrong with the exchange rate and the profit margin on each wheel can be squeezed alarmingly.

Inside the oldest part of Rimstock's factory, the heat from the furnaces where billets of solid aluminium are transformed into crucibles of molten metal turns a chilly January day into something more like midday in Death Valley. The vats of molten aluminium are kept busy constantly replenishing each die casting machine in turn, and it's hard not to flinch as hundreds of gallons of 800°C (1,400°F) liquid metal are swiftly poured into the open hatch of the machine. One slip and things could get nasty. Fortunately, the furnace men handle the task with practiced – even nonchalant – ease. Above the crash of the cooling wheels dropping out of the moulds, Matt explains that after buying proprietary low-pressure die-casting machines for some years, Rimstock eventually decided to make its own. This means that the company can take the creation of a wheel from the initial sketch to the finished component entirely in-house. Rimstock's design and engineering teams can now design not just the wheels but also make the resin models, the tools, moulds and the die-casting machines to manufacture them. Before we leave the foundry Matt also points out that a slug of molten aluminium is taken out of each crucible load, so that in the event of any problems with a finished wheel, the exact batch of metal is traceable and its composition can be closely examined.



Problems, though, are more than unlikely. Each wheel casting is individually x-rayed and pressure-tested underwater for porosity. Rimstock's in-house testing department, Rim Technologies, is the UK's only recognised independent wheel testing facility, checking not just Rimstock's own production but also that of other manufacturers from all over the world. With facilities like this to hand, and what Matt describes as an 'intense' process control system, it's not surprising that Rimstock is among the few wheel manufacturers in the world to be approved to the industry standard QS9000.

*“Your typical four Elise wheels, therefore, will probably take about half an hour simply to cast, and that's before each wheel is individually machined”*

There are typically around eight die-casting machines in operation, each producing a different design, size and type of wheel, one at a time. It takes around three minutes for the die to fill with the molten alloy and then another three for the metal to harden enough for it to be extracted –still blisteringly hot –from the mould. Your typical four Elise wheels, therefore, will probably take about half an hour simply to cast, and that's before each wheel is individually machined to tidy up the casting and remove loose sprues of aluminium, then x-rayed, pressure-tested, powder-coat primed, part cured, wet coated, cured again, clear coated and given its final bake.

We followed the route taken by the freshly-cast wheels and found ourselves inside the company's latest investment, a brand new £2m paint plant where robotics have replaced humans in the repetitive task of transferring wheels from one process line to the next. Different wheel diameters don't faze the robots either – each wheel is scanned in turn and then the robotic arms delicately pick the wheel up and onto the next line, from powder-coat primer to oven and from thence to the wet coat, from where it receives another flash cure before being transferred once more to the final clear powder-coat and oven bake.

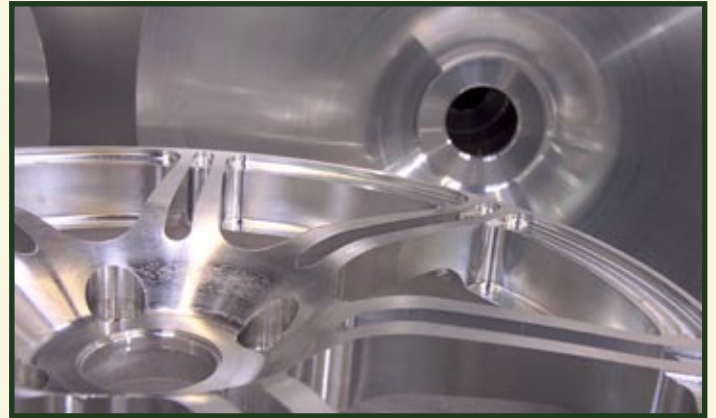
# Feature

Matt points out one of the subtleties of the process, which is that the powder-coat primer and wet colour coats are 'undercured'; that is, they are given just enough heat to set the surface of the finish but not given a full cure in the oven until the final clear acrylic powder-coat has been applied. This helps the three coats to adhere to each other all the better. When you consider the extremes of temperature, the corrosive road salt and the constant blasting from grit and stones that a wheel is subjected to during its lifetime, the care Rimstock takes in applying the finish is repaid in longer life and a tougher, more corrosion-resistant finish.

***“Forged aluminium wheels are another area of speciality for Rimstock”***

Naturally, all Rimstock's finish processes are water-based, and comply with the latest environmental legislation. Once the wheels are out of the final oven bake and are cool enough to handle, they're transferred to the warehouse, where 50,000 wheels are contained, stretching on pallets up to the roof. These wheels are destined for every conceivable machine, from massive American SUVs to the more weight-conscious Lotus.

Forged aluminium wheels are another area of speciality for Rimstock. Forging, unlike casting, involves beating or pressing the metal under huge force into shape. As Matt explains, this not only makes the alloy denser, it also helps to align its molecular structure for maximum strength. Unlike casting, however, you can't create complex spoke shapes and round sections directly from a forging. Instead, Rimstock takes a solid disc of forged alloy and then machines it to the designer's chosen form.



Lotus designer Steve Crijns nods in agreement. “With forgings, you can't create the tapering or rounded spoke shapes of a casting, because you're limited by the axes that the Computer Numerical Control (CNC) router can operate in. That's why the Lotus forged aluminium wheels in particular have this very square-cut look. And yet... this is a very 'technical' look, too, and emphasises the pared-down, track-bred heritage of a Lotus. It's beautiful but in a function-driven way. If it was up to me, I'd have the wheels just as they come out of the machining process, with the circular marks from the cutting head still visible on them... but in reality you can't do that, you need to protect the surface.”

***“Rimstock takes a solid disc of forged alloy and then machines it to the designer's chosen form”***

Within a perspex-shielded booth, the solid disc of forged alloy slowly takes shape, with the CNC lathe performing its complex choreography of movements and carving out the spokes, rim and wheel stud centres in a monsoon of cutting oil. The amount of material that's machined away during this process is quite amazing; try to pick up the original solid billet and you'll struggle to lift it two-handed. Lifting the finished wheel, in contrast, is an easy one-handed task. It's a time-consuming process; each wheel is in the machining booth for 42 minutes and 56 seconds, as I noted from the CNC process readout panel on the booth. Not surprisingly, the expense of the original material and the amount of machining time it takes means that a forged alloy wheel costs considerably more to make than the standard low-pressure die-cast design. But if you're looking for wheels with the lowest possible unsprung weight, impeccable strength and an eye-catching design too, then it's a price well worth paying. As many Elise and Exige owners seem to agree...



## BOM Cost down: The Lotus Elise

**In 2001 Lotus Cars was losing money. Two new products - Elise 'Mark 2' and Opel Speedster/Vauxhall VX220 - had been launched, but they were proving too costly to manufacture. In the rush to bring the products to market, rigorous cost management had been a secondary priority. Furthermore, in comparison with the 'Mark 1' Elise, improvements in performance and additional feature content had led to an increase in the bill of material (BOM) cost for the 'Mark 2' Elise. This increase in cost could not unfortunately be matched by an increase in the selling price - although market demand for the cars was high, the market could not take a selling price increase without a significant drop in sales volumes. For the business to survive and prosper, costs had to be reduced. The BOM represented by far the biggest cost-cutting opportunity.**

The business faced a serious challenge to restore Lotus Cars to profitability quickly. The base Elise BOM cost had to be reduced by 10% within 12 months. As a further constraint, to meet the company's cash targets, payback on the investment made was required within 12 months. A BOM cost down programme was proposed, with the target of making the project cash neutral within the 2001-02 financial year. The targets were extremely aggressive, but nobody was in any doubt as to the seriousness of the situation.

The targets were quickly agreed upon (not without some trepidation from the programme leaders). Selwyn Mould, Head of Supply Chain, was asked to lead the team, while Clive Dopson, (at the time) Manufacturing Director, was appointed Programme Champion. A budget was fixed for all the key parts of the programme, such as: labour, tooling, engineering support, travel, and test & development. A dedicated team was recruited with a mix of skills: sourcing specialists to find new lower cost suppliers, buyers to set up contracts and place orders, cost engineers, designers, supplier quality engineers, database



administrators and a project manager. An initial brainstorming session produced a list of cost saving opportunities, which was quickly supplemented by the findings of a comparative teardown (disassembly) of the Elise and Speedster/VX220 vehicles. At this stage over 50 opportunities were identified.

Once the opportunities were identified, they were categorised as follows:

- Negotiation with current supplier
- Re-source possibilities locally (Western Europe)
- Re-source possibilities globally
- Cost and value analysis to determine optimum manufacturing process and target pricing
- Re-engineering for new design, manufacturing process or material
- Deletion of part or feature

[Some opportunities fitted into more than one box but, for simplicity, each opportunity was filed under a single category.]

The opportunities were then prioritised based on: cost saving, time to fully implement, required cost of investment, and risk/expectation of success. Ten opportunities were selected for immediate action (although this list was added to) and an individual was appointed to own (manage) each opportunity. A savings target and a "time to implement" target was set for each opportunity and a weekly Boardwalk (project meeting) was convened to review progress, set continuing programme direction and remove roadblocks.

Initially progress was slow. Suppliers were reluctant to volunteer price downs. Many of the other opportunities required time to find new suppliers or to engineer cheaper solutions, let alone work through the rigorous 'APQP' (Advanced Product Quality Planning) process that Lotus uses to validate new components. It was quickly realised that early success would only come from negotiation with current suppliers, supported by detailed cost analysis of the components supplied. A target list of suppliers was drawn up and negotiations were begun.

Whilst attempting to be fair and constructive, the Lotus negotiators left the suppliers in no doubt that the survival of the business was at stake and that the price down was an imperative necessity. Most suppliers responded positively. Many recommended changes to designs or processes, or asked why some materials were used when cheaper materials were available. In addition, treatments or finishes were deleted or downgraded to an appropriate level. In some cases Lotus cost engineers worked closely with suppliers to understand the true build up of costs in their processes and agree realistic target costs for the components supplied. Production engineers suggested improvements to shop floor layouts and manufacturing processes that would also deliver cost savings.

# Feature

Relationships with some suppliers were not always entirely harmonious. One small supplier company, for whom Lotus was a major customer, was asked in negotiations for a 30% cost down across the range of parts it supplied. The target saving was based on a detailed analysis of what should be possible, backed up by a quick benchmarking exercise on a few parts. However the supplier did not believe he could afford the cost down, and did not have the necessary skills or resources to make the improvements required. Lotus promised to support this supplier with a dedicated production engineer whilst the improvements were implemented, however insisted on the full 30% cost down immediately. The supplier agreed after negotiations. Four years later that supplier now supplies Lotus with parts representing a bigger value per car, has benefited competitively from spreading its new manufacturing efficiency practice to the rest of its business, grown its business and has reduced its reliance upon Lotus.

The early savings obtained from negotiations with suppliers served to bankroll the project and ensure that it would meet its target of being cash neutral in the financial year. As the year progressed savings from other categories began to be delivered. Components from South Africa were introduced, in some cases offering savings of 50% over those replaced. A rule of thumb began to take shape and experience showed that the return on investment available differed quite markedly from savings category to category. Negotiation was a low investment activity, only requiring a negotiator. It provided fast results and the team could deal with many opportunities at once. Re-sourcing on the other hand often required investment in new tools, required support from SQA (Supplier Quality Assurance), took far longer to implement (3 to 6 months) and meant that the team could only handle a few opportunities at one time. Savings from cost analysis required limited investment, but did take time (3 to 6 months) to gather and analyse all the data. Re-design and re-engineering was the most expensive activity by far, needing expensive engineers and, most often, new tools. It often took up to 12 months to deliver a saving, but these savings could be large. Component & feature deletion was another category where investment was often low and implementation could be quick, depending on the provision of good component obsolescence control and pro-active marketing.

**Savings Table by Category**

	Time to implement	Size of investment
Negotiator	Fast	Low
Re-source	Medium	Medium
Cost Analysis	Medium	Low
Re-Engineer	Slow	High
Deletion	Fast	Low

As the programme progressed the team developed a toolbox of techniques to identify and deliver cost savings. The vehicle/system teardown was often the starting point for opportunity identification. Benchmarking, designs being sent out to a range of suppliers for quotation, was another tool put to good use by the team. These quotes identified the market competitiveness of current suppliers and helped to determine the size of the opportunity. Benchmarking can, however, be overused and unless suppliers believe that there is definite potential to win business, they will not always provide a properly prepared, practical offer. The team's cost engineers spent many hours developing realistic cost models of components in their value engineering activity. This process found opportunities for savings by identifying those costs that were out of line with industry norms. To realise cost savings through negotiation, the team often sought to give more business to successful suppliers and so use the volume benefits gained to allow a price down. This also led to a rationalisation of the supply base, reducing transaction costs to Lotus and making supplier development easier.

The teardown process referenced above also highlighted opportunities for component commonisation/rationalisation across the Elise and Speedster/VX220 ranges. The extra component volume generated allowed further price reductions. There were also clear opportunities to optimise component manufacturing processes and to choose more suitable and cost effective materials for some components. The original 'Mark 1' Elise had been designed for a target annual volume of 700 - the combined annual volume of Elise and Speedster/VX220 was now approaching 6000. Many components in the new cars had been carried over from the earlier car. This represented a major opportunity. In a further intervention, Lotus cost and production engineers worked closely with suppliers to optimise factory layouts and help them incorporate a system based on lean manufacturing philosophy. Design and re-engineering also played a part, and design for manufacturing (DFM) techniques were used to improve quality and reduce cost.

Not least of all the tools employed was Lotus' global sourcing knowledge. Focussing initially on re-sourcing from South Africa, Malaysia and, later on, India, substantial savings were made. The risks of lengthening its Supply Chain and dealing with new suppliers were considerable, but by carefully managing quality and choosing capable partners for logistics, savings were delivered with minimal disruptions to production. (Note: A further article will deal in depth with Lotus Global Sourcing experience).

When the first year of the programme drew to an end, the team had more than achieved its 10% BOM reduction target. In addition, the programme had not just been cash neutral but had delivered savings worth more than two and half times the programme investment within the financial year. As a result the programme was extended into year 2 and later on into year 3. Overall Lotus has now made savings worth more than 20% of the base BOM, with further savings on options equivalent in value to another 10% of the base BOM.



## Engineering composite structures

Today's passenger car industry is increasingly facing complex challenges. For example, legislation is forcing producers to concentrate on fuel efficiency and recyclability. Meanwhile, drivers are demanding more comfort, speed and performance, refinement, and safety features. The desire for greater choice and individuality by car buyers is equally having an impact, forcing down model lifecycle volumes. These pressures threaten the profitability of traditionally-built steel cars which rely on high volumes to be cost-effective.

Furthermore, historically, composite parts for structural applications have typically suffered from slow cycle times and high unit costs which have therefore confined their use to premium ultra-low volume products.

In response to these issues, British consultancy Lotus Engineering and Germany's Jacob Composite GmbH have formed a collaborative partnership to develop 'ECOLITE' (Efficient Composites Lightweight and Thermoformed) which utilises an innovative fibre reinforced composite material. The ultimate aim the development of a typical medium volume passenger car with a chassis structure and body panels produced predominantly using this new technology.

The fibre reinforced thermoplastic composite structures under development will offer a number of advantages over metallic solutions. New thermoforming and joining techniques will require much less investment than metal stamping tools and also offer faster cycle times than current methods of manufacturing structural composite materials. The use of bespoke thermoforming simulation software will generate early feasibility data leading to shortened lead times, reduced risk, and fewer expensive tool modifications. Thermoplastic polymers will provide recyclability which is highly significant given the EU's End of Life Vehicle legislation. Finally, as OEM's struggle to reduce vehicle mass due to ever increasing feature content, the new composite materials will offer significant potential for weight saving.

The first phase of the joint research programme will seek to develop the ECOLITE FRONT END STRUCTURE. This will be a medium volume front-end crash structure produced entirely from thermoplastic composite materials. This phase of the project is scheduled for completion in October 2005.

The second phase of the ECOLITE programme will extend the development to include the remainder of the vehicle structure and body. Using experience gained from the first phase and developing the concept further, Lotus Engineering and Jacob Composite hope to present a "Composite Car", a vehicle manufactured from a complete composite body structure.

### The history of Composite Crash Structures

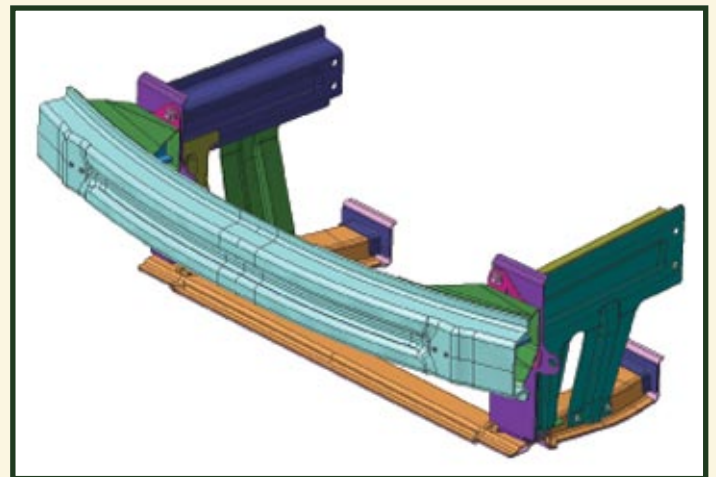
Lotus Engineering has developed a range of Composite Crash Structures for both Lotus product and client vehicles. These are based on polyester RTM systems and glass and/or carbon fibre reinforcement.

The RTM process has been extremely successful in the past in terms of producing crash elements as it allows the design to be tuned. The fibre reinforcement can be tailored to suit the particular static or dynamic properties required both in terms of material type, amount, and orientation. Similarly, the manufacturing process can accommodate changes to part thickness and geometry.

Assembly	Process	SEA (j/g)	Weight (kg)	Residual Length
Steel	Stamped	4	22.5	25 – 30%
Aluminium	Extruded	7	11.5	25 – 30%
Glass / Polyester	RTM	7 - 9	7.5	< 5%
Carbon / Epoxy	RTM	13	6.5	< 5%

### Real-world crash performance for a complete front end assembly

The off-axis stability of composite crash elements is a proven benefit of these materials. RTM crash structures have also been shown to exhibit superior real-world specific energy absorption (SEA) compared to metallic solutions and offer virtually no residual length allowing the full use of available packaging space.



ECOLITE Front End Structure

# Feature

The disadvantage of the RTM crash structures is that they are restricted to economic volumes of typically 10,000 units per annum due to their long cycle times. To address this point Lotus has entered into a collaborative research programme with Jacob Composite GmbH to develop crash elements in thermoplastic materials for volumes over 30,000 units per year. These materials offer extremely short cycle times and based on laboratory tests exhibit excellent SEA properties.

Component	Section	SEA (j/g)
Aluminium 6063 T7	Tube	17
Glass / Polyester (RTM)	Rail (open section)	25 – 35
Carbon / Epoxy (RTM)	Rail (open section)	35 – 80
Glass/PA6 (Thermoformed)	Tube	25 – 45

## *Impact performance in laboratory conditions*

The project aims to deliver a range of composite technologies based on polyamide, PBT, and polystyrene resin systems. The success of these composite materials will depend on compatible chemistry between fibre and matrix, together with the development of fibre impregnation and consolidation phases of the production process.

The ECOLITE Structure being developed has taken a current 5 star NCAP steel front end as a benchmark and aims to offer similar crash performance. The additional benefits of using the thermoplastic composite materials in this scenario are anticipated to be:

- An 80% improvement in residual crush length offering major packaging benefits especially with Pedestrian Impact legislation in mind;
- A 30% saving in weight versus the steel equivalent structure;
- A 50% improvement in tooling investment versus the steel equivalent structure;
- Fewer parts realising a simplified assembly process and lower manufacturing cost;
- Competitive piece cost allowing realistic business cases at 30,000 units per year; and
- Full recyclability.

In conclusion, the diversification away from metallic structures will provide an additional solution to automotive manufacturers in their constant drive for lower production costs and greater efficiency in an international marketplace which is becoming ever more demanding and competitive.



## *Group Lotus plc*

*Head office:  
Lotus Cars Ltd  
Hethel  
Norwich  
Norfolk  
NR14 8EZ  
United Kingdom*

*Editor: Robert Tickner  
E: [proactive@lotuscars.co.uk](mailto:proactive@lotuscars.co.uk)*

## *just-auto.com*

*Head office:  
C/o Aroq Ltd  
Seneca House  
Buntsford Park Road  
Bromsgrove  
B60 3DX  
United Kingdom*

*Contact: Mike Gove  
E: [mike.gove@aroq.com](mailto:mike.gove@aroq.com)*

*This newsletter was produced for Lotus Engineering by Aroq Ltd. © 2005 All content copyright Group Lotus plc and Aroq Ltd.*

