Automotive industry issues

Drivers for change

Steelmakers need to work closely with carmakers to develop advanced materials that respond to the issues that drive the automotive industry.

In this section

This section explains how materials suppliers like Corus are changing to help carmakers through the development of new products – helping them to meet the challenges they face in the areas of:

- Safety
- Environment
- Weight and cost reduction
- Quality and service

Dates and targets below are subject to continual revision.

Legislative changes

The diagram below shows the timetable for some of the anticipated global legislation that is driving change in the industry. This legislation covers:

- Occupant safety – making cars safer for their passengers.
- Pedestrian safety – increasing the chances of survival for pedestrians hit by cars.
- Emissions – meeting legislative targets.
- End of Life Vehicle Directive (ELVD) – reducing landfill by recovery and reuse of vehicle mass (85 per cent by 2006, 95 per cent by 2015).

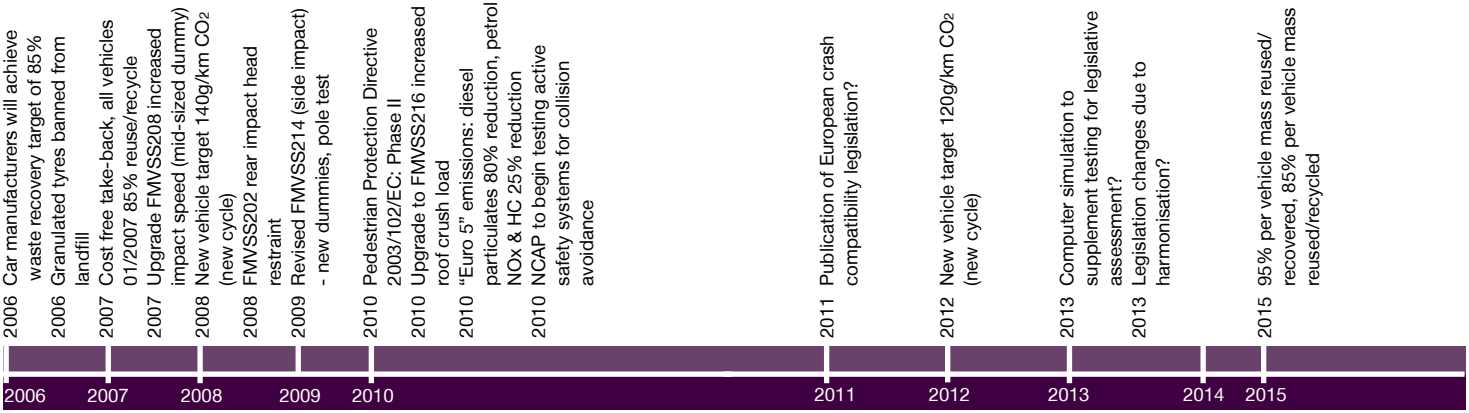
The main drivers of change in the global automotive industry are:

- Marketing & brand management - for product differentiation and image
- Cost reduction - improving development & production processes and introducing new technology.
- Legislation - the need to meet rising safety, emissions and environmental challenges
- Feature content - to satisfy increasing consumer expectations

For steelmakers, satisfying the demands created by these drivers means developing new materials and more efficient processes. It also means building a good working knowledge of the industries that their materials are supplied into. The natural consequence is that steelmakers must maintain constant dialogue with carmakers, and work collaboratively with them.

Carmakers are acutely aware that good and early selection of materials is essential to the integrity of a vehicle's structure and the effectiveness of manufacturing processes. The combination of these demands and the constant pressure to bring cars to market faster, means that steelmakers like Corus are taking an increasingly active role in recommending the optimum steels for particular engineering applications.

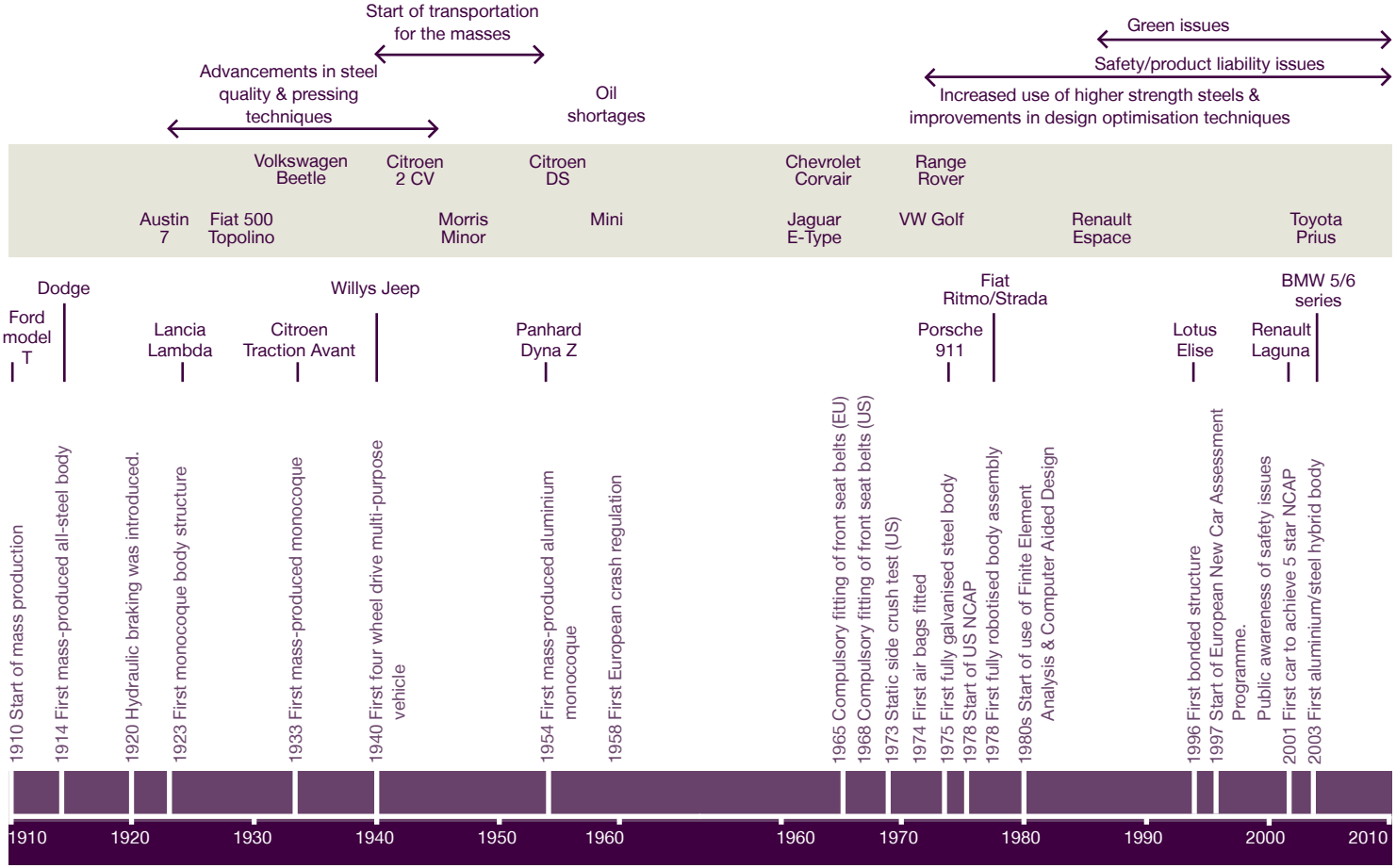
All participants in the vehicle design process now accept that the cost of developing new platforms is mostly committed before designs are fixed and any tooling metal is cut. This increases the reliance on ever more accurate computer simulation methods.



The history of the car

This timeline demonstrates how changes in legislation, technology and the market in the automotive industry have driven material development and application.

Steel became the material of choice as soon as mass production and moving production lines dramatically lowered the cost of vehicle manufacture in the early 20th century. The challenge for steelmakers has been to keep pace with the ever increasing rate of technological change in this dynamic industry.



Safety for vehicle occupants

Most new cars now achieve a five-star rating for Euro-NCAP (European New Car Assessment Programme) performance in protecting vehicle occupants from collisions. In future, further stars may be awarded for other test cases, such as rear impact, roll over or crash compatibility.

The increasing array of crash-test scenarios will require more sophisticated crash structures that take account of a wider range of potential accidents.

To meet the changing requirements placed upon a vehicle to protect its occupants, there have been many innovations in passive safety devices such as air-bags, knee-bolsters and anti-submarining seats. Together these life-saving devices work to protect occupants if they are unfortunate enough to be involved in an accident.

The body structure of modern vehicles has developed from the simple crumple-zone approach of the 1980s to become a sophisticated load and energy management device, providing not only for day-to-day in-service performance, but also for the extreme conditions of a crash event.

As well as contributing to the manufacture of these components, Corus assists vehicle manufacturers and their suppliers in developing materials and application technologies that reduce cost while meeting the increasing demands for safety in ever-shorter development times.

Image courtesy of Essex County Fire & Rescue Service

By using its computer simulation expertise to predict the effects of these changing requirements upon the vehicle structure, Corus is able to define the best materials, manufacturing and assembly methods.

It is anticipated that the increased confidence in virtual testing – as engineering analysis models become more sophisticated – will lead to crash testing of only the worst-case scenarios.

Safety for side impact

Safety in side impact is a key automotive design requirement, covered by extensive legislation and consumer testing in each of the major world markets.

The basic principles of side-impact design require the control of vehicle intrusion, intrusion profile and intrusion rate. This is typically achieved using a strong B-pillar structure which pivots around the connection with the roof and deflects more at the base, while avoiding collapse in the middle.

Manufacturers employ a number of strategies for achieving the desired performance, ranging from using High Strength Steels and fewer parts to using lower strength grades but with more parts and thicker gauges. A good illustration is the extent to which press-hardened boron steel is used in B-pillar structures.

Boron steel parts offer very high strength and are hot-formed, which enables complex shapes to be made, facilitating a reduction in the number of parts required. The disadvantages are high forming costs, slow process times and more complex joining and coating.

High Strength Steel parts offer an alternative to boron steel. These steel grades also provide good performance and are cold pressed, giving faster production times. Forming and joining are more demanding than with conventional steel, and there is little scope for reducing the number of parts.

Lower-strength steel structures can also be used but are more difficult to engineer to achieve the desired performance. Thicker gauges and more parts are required, leading to heavier vehicles with less internal packaging space.

The ideal material for side-impact protection would be a low-cost, high-strength grade that can be formed, joined and coated easily. Corus continues to develop their products towards this goal. In the meantime, vehicle designers are using their expertise to find solutions that still give the desired performance.

Safety for pedestrians

In the European Union, around 8,000 pedestrians and cyclists are killed and around 300,000 are injured each year in road traffic accidents. In October 2005, the European Union enforced Phase I legislation (2003/102/EC) aiming to minimise pedestrian injuries.

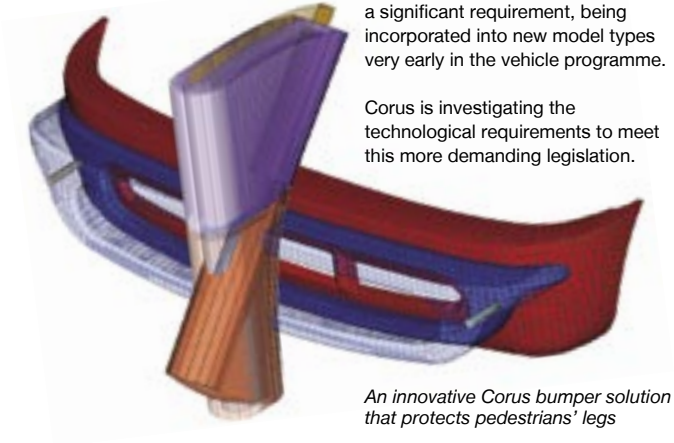
Vehicles now have to be more compliant to pedestrians and meet legislative impact criteria, protecting leg and head in simulated collisions.

Phase I of the legislation is already posing major challenges for vehicle manufacturers. Pedestrian safety has a significant influence on styling, under-bonnet packaging and structure crushability. Vehicle bonnets, fronts and bumpers must now deform at lower loads over longer distances, requiring additional package space and revised components. Achieving this space and stiffness at the same time as making the vehicle aesthetically pleasing and considering all other design requirements, is extremely challenging.

Advanced computer simulation capabilities and detailed materials knowledge have enabled Corus to work with OEMs and their Tier suppliers to develop new concepts for vehicle bonnets, wings and bumpers that satisfy these requirements

Phase II legislation is being discussed at the European Commission and should be confirmed in the near future. Initial texts are suggesting more stringent safety targets with an enforcement date of 2010. It is expected that pedestrian safety design will continue to be a significant requirement, being incorporated into new model types very early in the vehicle programme.

Corus is investigating the technological requirements to meet this more demanding legislation.



An innovative Corus bumper solution that protects pedestrians' legs

Safety at the roadside

In addition to the demands of vehicle safety, Corus is keen to help improve safety on the roadside by developing ever-more advanced vehicle-restraint systems.

The first of a new set of six parts of standard EN1317 was released in 2004 by the European Commission. This consolidated the previously disparate standards for roadside safety fences and bridge parapets, also known as vehicle restraints. The other parts of the standard will come into force by 2010. Corus is a key contributor to the technical debate that will ensure the new standards address the safety issues on our roads.

Corus has been a vehicle-restraint system manufacturer for more than 40 years, testing and producing the safety fences and bridge parapets that have become a familiar sight on our major road networks. Corus applies its computer-simulation technology to solve the complex problems of redirecting errant vehicles from high-energy collisions with roadside obstructions. The fruit of this work is a series of products that are already contributing to safer roads.

The Corus portfolio includes products ranging from motorway safety barriers to high-containment bridge parapets.

Find out more: **www.corusconstruction.com/saferoads**

End of Life Vehicle Directive (ELVD)

The use of steel for an increasing range of components is helping carmakers to improve vehicle recyclability and meet the demands of legislation.

Carmakers have a real challenge on their hands. In an effort to reduce landfill, the End of Life Vehicle Directive (ELVD) legislation states that from early 2007, 85 per cent of the mass of any new car sold in the EU must be recycled or reused. By the end of 2015 this target rises to 95 per cent.

Corus is working to maximise the benefit of recycling steel, using its materials and engineering expertise.

Advances in steel technology over recent years mean that components like fuel tanks, pedals, engine covers, fluid reservoirs and front-end structures can now revert cost-effectively from plastics back to steel to improve recyclability. Research shows that if just 25 components in a modern car were to revert from plastic to steel, it could increase the vehicle's recyclability by five per cent.

When it comes to car components, sustainability involves finding more cost-effective ways of using recyclable steel. A recent vehicle engineering study by Corus on designs for a clutch pedal in aluminium, plastic and steel demonstrates that improving recyclability need not have an adverse effect on cost or performance (see Table 3 opposite). Carmakers will increasingly need this type of support from materials suppliers as the ELVD legislation comes into force.

Find our more: **http://ec.europa.eu/environment/waste/elv_index.htm**

Table 3: Evaluation of a clutch pedal

	Design	Advantages	Disadvantages	Piece cost (euro)	Mass (kg)
	Steel fabrication	Recyclable, low parts cost, stiff, robust	High mass, moderate tooling cost, poor NVH	2.81	0.58
	Plastic injection moulding	Low mass, good for complex shapes, good NVH	Poor recycling, high parts cost, low stiffness, not robust	3.51	0.30
	Steel pressing	Recyclable, low parts cost, robust, stiff	High mass, high tooling cost, not suited to complex shapes	2.20	0.39
	Aluminium alloy	Recyclable, low mass, low tooling cost, robust, good for complex shapes	High parts cost, poor NVH (noise, vibration and harshness)	4.20	0.36

Source of Table 3: Corus

Wonder material

More than 400 million tonnes of steel is recycled globally every year. It is the most widely recycled engineering material in the world. Around 40 per cent of the world's production of 'new' steel is made from steel recyclate. Like water, steel can be recycled over and over again without performance degradation.

Did you know?

Analysis shows that if just 25 key components were converted back to steel from plastics, it would increase vehicle recyclability by five per cent.

Sustainable solutions

ELVD legislation demands that carmakers remove harmful substances from vehicles, including hexavalent chromium, lead, mercury and cadmium.

Hexavalent chromium is commonly used in the production of adhesive-coated metals. Corus has developed a unique hexavalent chromium-free adhesive-coated metal called Envirobond™, for use in a wide range of automotive applications.

Envirobond™ provides an alternative for components where pre-applied reactivatable adhesives are required, such as weather strips for door linings, sunroofs, bonnets, boots, body side mouldings, brake shims and interior trims. Envirobond™ is capable of meeting the stringent quality requirements demanded by the industry, without any loss of corrosion or adhesion performance. It can be used on a full range of metal substrates for bonding to plastics and rubbers in many automotive applications.

Going the extra mile

In recent years, improvements in the selection of raw materials – and better process controls – mean that primary steelmaking by-products now meet strict quality standards. As a result, these by-products are being used as secondary materials in sectors such as cement and chemicals manufacture. This results in non-renewable primary raw materials being conserved.

A good example is blast-furnace slag, a by-product from the production of pig iron in a blast furnace. For years this was considered as waste and ended up in landfill. Corus has optimised its iron-making processes and invested in granulation facilities to generate tightly specified slag products, which are now used as a valuable secondary raw material in the cement industry. This approach helps to conserve non-renewable resources such as limestone, and significantly reduces emissions of CO_2.

Ultra Low CO_2 Steelmaking (ULCOS)

The steel industry accounts for six per cent of all man-made CO_2 emissions and is therefore in the frontline of efforts to combat global warming.

Although typical CO_2 emissions per tonne of steel are now around 50 per cent lower than 40 years ago, more needs to be done. This requires both a short-term effort on incremental reduction and a long-term strategy to find innovative ways to reduce carbon gas emissions.

This effort is being spearheaded by the European steelmakers who have launched the Ultra-Low Carbon Steelmaking programme (ULCOS), which is examining a range of radical technologies to reduce the steel industry's emissions. In addition to the European steel companies, consortium members include other industries, universities and research institutes who bring a fresh perspective to the issues faced by steelmakers.

Corus is a major partner in ULCOS whose short to medium term emphasis is on reducing emissions incrementally, wherever this can be achieved in a cost-effective way.

Although more than 80 per cent of emissions from Corus's integrated steelworks are irreducible process emissions, the combustion-related CO_2 emissions are closely linked with energy use. In recent years, Corus has been successful in significantly reducing the amount of energy used to make each tonne of steel. The restructuring of UK operations, which involved rationalising steelmaking activities from six sites in 2001 to four at the end of 2005, has played a substantial part in this.

Weight and cost reduction

More than 25 per cent of all European emissions of CO_2 result from the use of transport. One of the ways to reduce fuel consumption and CO_2 emissions is to reduce the weight of vehicles.

Corus Automotive has developed a proven approach for reducing cost and weight of both existing and new prototype vehicles, called VA/VE (Value Analysis/ Value Engineering).

The value analysis part of this approach systematically evaluates the gauge, grade and coatings of vehicle body and chassis components, to identify materials-based cost and weight reduction opportunities.

The value engineering part of the process identifies design change opportunities to reduce tooling and other manufacturing costs, while maintaining or enhancing structural performance.

Using this approach, customers are assured of the optimum deployment of materials to achieve required performances at the lowest practical cost. Some examples of the output from previous VA/VE studies are shown in Table 4 below.

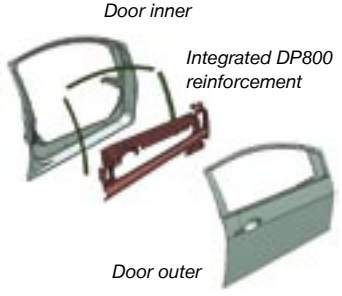
Source of Table 4: Corus

Table 4: Output from previous VA/VE studies

Vehicle	Corus task	Saving potential	Approx saving/year
Light van	VA/VE	£70/vehicle	£14m
4x4 chassis	VA	£30/vehicle	£3.6m
B segment	VA/VE	£20/vehicle	£3m
C segment	VA	£10/vehicle	£2.5m
D segment	VA/VE	£10/vehicle & 10kg	£1.5m
C segment	VA	£30/vehicle & 16kg	£22.5m
MPV	VA	150kg	N/A
C segment	VA	£50/vehicle & 9kg	£7.5m

Fewer parts mean lower cost

By combining their knowledge of Advanced High Strength Steels (AHSS) and automotive engineering, Corus engineers are constantly looking for new applications that will reduce cost and weight for automotive customers.



Did you know?
A Smart Fortwo weighs more than a 1974 Mark I Golf.

Corus recognises the need for cost-effective, lightweight solutions that do not compromise performance. For this reason, the company strives to use its extensive materials knowledge to develop ideas for extracting the maximum benefit out of the steel used.

As part of its efforts, Corus has developed a one-piece AHSS door concept. The design integrates the intrusion beam, waist rail, lock and hinge reinforcements into a one-piece panel manufactured from DP800-grade steel. The reduced gauge gives a weight saving of 0.65kg/door, while maintaining the equivalent side-impact performance of the conventional design.

Corus Automotive engineers working on a VA/VE subframe study

Vehicle weight – in decline at last?

For an average-sized car driven 14,000 miles (22,000 km) in a year, four tonnes of CO_2 are emitted. Lighter vehicles mean lower fuel consumption – and trends finally seem to be moving in the right direction.

Vehicle weight has been increasing steadily over the last 40 years, as typified by the 'average' C segment car (see Fig. 5). Cars in this segment have been getting heavier by five to ten per cent at every model change, mostly driven by safety, stiffness and increased equipment levels. Table 5 shows how this weight increase (of 700kg) breaks down.

The weight increase by segment is compounded by fashion trends – people carriers, 4x4s and performance expectations. The popularity of these larger vehicles has slowed the rate of reduction of CO_2 levels.

Vehicle weight – the good news

- Social and economic pressures are now reversing the trend toward large vehicles.
- Most cars are now achieving 5 stars in the Euro-NCAP tests.
- Larger cars (especially in the luxury 'E' segment) are levelling out on size and weight.
- In the C and D segments the rate of increase of vehicle weight is slowing and looks likely to reverse in the next five to ten years
- The European Commission plan to ensure a new car average of 120g CO_2/km by 2012 will result in strong competition and weight reduction in the high-volume B and C segments.

Fig. 5 **Weight increase year by year C segment car**

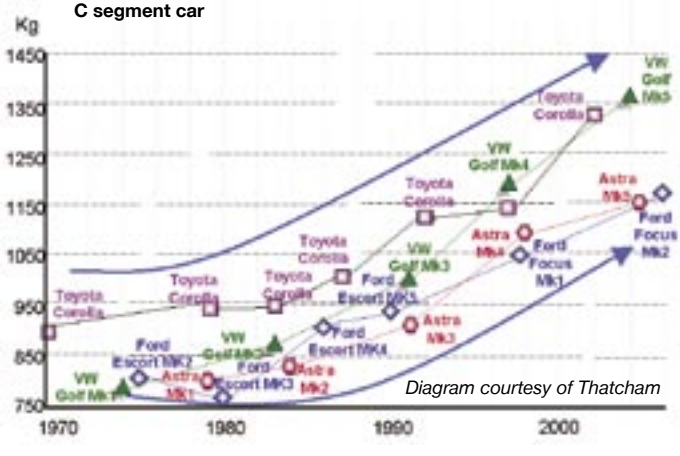


Diagram courtesy of Thatcham

Table 5: Breakdown of 40 years of weight increases (700kg)

	Outcome	Comments	Contribution to weight increase (%)
Vehicle size	Longer, wider and taller	Latest Polo is the same size as the 1974 Golf	30
Vehicle strength	Safer and more durable	EuroNCAP has raised consumer awareness	25
Vehicle stiffness	Improved Noise, Vibration, Harshness (NVH) and handling	Vehicle stiffness contributes to the 'quality' feel	
Comfort/ refinement	Air Conditioning, NVH, seats	The biggest recognisable change in vehicle quality	15
Features/ equipment	In car entertainment, electrical	The average car now contains more than 20 electric motors	13
Occupant safety	Airbags, pre-tensioners	Safety cell improvement is included in vehicle strength	5
Performance	Acceleration, handling and brakes	Includes fuel systems, powertrain and driveline.	17
Emissions	Noxious emissions reduced by two orders of magnitude	Bigger, thicker, exhausts now include catalysts	5
Use of plastics	Plastics and rubber now account for 15% of a vehicle mass	Many materials (aluminium, zinc, wood, steel) have been replaced by plastic	(-) 5
Use of HSS/ AHSS	Rapidly increasing over the past five years	Now accounts for over 50% of BIW and closures	(-)5
Source of Table 5: Corus		**Total**	**100**

Cost effective lightweighting by the use of Advanced High Strength Steels (AHSS) will allow vehicle manufacturers to reverse model on model weight increases without recourse to expensive or environmentally unsound solutions.

The successful introduction of AHSS by European steelmakers, demonstrating material performance and supplier support through Early Vendor Involvement (EVI) and innovation, will ensure steel remains the first choice material for automotive structures for the foreseeable future.

Find out more: **www.acea.be/node**

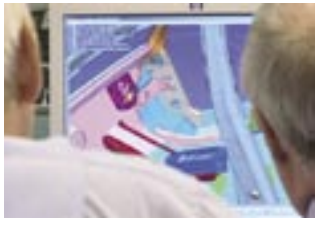
Quality and service

Every automotive component made from steel is designed and built to deliver a reliable and predictable service life. Steel's mechanical properties of strength, cleanness and surface finish must be reliable if carmakers are to create their products cost effectively.

Manufacturing quality
As soon as decisions are made about which steel grades to produce, product quality becomes a priority. Careful selection of raw materials, steelmaking process and refinement and finishing processes all improve the quality of Corus steel products. Corus mills take great care to ensure that the dimensional, surface finish, strength and mechanical properties of every steel product that leaves its plants are within required tolerances.

Distribution quality
Once steel products have been made, it is essential that their hard-won quality is not compromised during the delivery process. One example of the way Corus controls the delivery quality of its steel is in its wire rod mill. Wire rod is used to manufacture an incredible range of automotive components including tyre reinforcement cord, valve springs, headrest supports, air bag and seatbelt wire and windscreen-wiper components. Scratches on the surface of the rod can cause it to break during wire drawing, creating unacceptable production downtimes. As part of a £14m investment in its rod mill, Corus has introduced a state-of-the-art automated warehouse. Here, coils are protected from damage by storage in individual compartments, and manual handling is virtually eliminated. The results have been instant, with incidences of damaged rod dramatically reduced.

Image courtesy of Xtrac



Services to support engineering, design and production quality
Carmakers are increasingly seeking access to in-depth materials knowledge to assist in the selection of cost-effective materials, and to ensure a smooth transition from the design and development stages of carmaking into full production.

That's why the Corus team of design and engineering specialists (mostly recruited from the automotive industry) work with their carmaker customers to select materials and find ways to efficiently manufacture vehicle structures and components at the lowest weight and cost.

High-technology engineering analysis capabilities are used to, for example, review fatigue performance of proposed parts, including advanced methods to assure fatigue performance in critical seam and spot-welded joints. Technical help services like this, when applied early in the concept and design stages of car development, can demonstrate the business case for a wide range of components, including body structures, chassis and suspension parts, hydroformed sub-frame parts and driveline components.

Corus Technical Services also offer press shop support – bringing many years of experience to bear in helping to troubleshoot and ensure that mass-production presses turn out components of acceptable and consistent quality.

Corus Automotive Service Centres offer a range of pre-production services to make 1D and 2D tailor-welded blanks, using CO_2 laser welding cells. Corus also uses specialised lasers which deliver intense light via fibre-optic cables, meaning that complex curved welds are possible.

Find out more: **www.corusautomotive.com/en/products/engineering_services/**