Global market review of vehicle body material trends – forecasts to 2016

2009 edition

Just-auto

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Table of contents

List of tables

Preface

Research methodology

This report is intended to provide an overview of vehicle body panels and materials. Our forecasts are not extrapolative but dependent on the underlying drivers of supply and demand. Our forecasts are largely based on interviews with the author's extensive international network of industry contacts. This allows us to consider and explain the meaning and implications of industry events, rather than offer simple description based on incomplete data.

Our approach is divided into two distinct methodologies:

- qualitative interviews – these are generally opinion-based, which aim to build knowledge about future vehicle body panel and certain material market trends and company strategies;
- quantitative interviews – typically fact-based, focused on establishing market values and volumes.

Our research typically concentrates on applications for light vehicles which include all cars, light trucks and the various cross-over vehicle styles such as sports utility vehicles and people carriers. These vehicles collectively account for about 96% of the global vehicle build.

Report coverage

In this, the first edition of this report, *just-auto* reviews the key market drivers for vehicle panels. The motives behind most advances in process or product technology in exterior trim and body components are to improve the car's overall appearance, save weight, improve fuel efficiency, simplify installation and above all reduce cost. Chapter 2 examines certain trends in the vehicle's body panels and the use of certain materials. There are basically three main materials used in a vehicle body: steel, aluminium and plastics. This report therefore examines the use of each material in turn, reviewing some recent technical advances. It includes exclusive Q&As with Corus, Stadco, JSP and 3M. Chapter 3 sets out *just-auto's* estimates and forecasts of aluminium and plastics in a medium-sized passenger car in Western Europe, North America and Japan as a percentage of total vehicle kerb weight from 2005 through 2016.

The author

Matthew Beecham has more than 15 years' experience of researching, writing and analysing market and technical trends in the global automotive components industry. Since 2000, he has served as an associate editor for *just-auto.* In addition to vehicle body panels and material trends, he authors a range of global auto components' market research reviews, including batteries, braking systems, clutches, coatings, cockpits, driver assistance systems, door modules, electric motors, engine cooling systems, exhaust systems, front-end modules, fuel injection, fuel tanks, glazing systems, ignitions, interiors, lighting, mirrors, roof systems, shock absorbers, spark plugs, rotating electrics, tyre pressure monitoring systems, tyres, wheels and wipers. Matthew's freelance assignments have included working for AT Kearney, McKinsey, Kuwait Institute for Scientific Research, Motorsport Industry Association, Motor Industry Research Association and the Economist Intelligence Unit. He has also written for magazines including *Car Graphic* (Japan), *JAMA* (Japan) and *Automotive Engineer* (UK). He was awarded a PhD in automotive technology transfer from Cranfield University.

Chapter 1 Introduction

For some time, the automotive industry has been under pressure to change the way it designs and builds vehicles, due to factors such as the increasing impact of passenger and pedestrian safety requirements and the competitive intensity caused by globalisation and manufacturing in low cost economies. Furthermore, governmental pressure in Europe and North America to reduce CO_2 emissions has prompted vehiclemakers and their supply base to develop automotive technology to meet those strict emission limits. Consequently, more and more vehicles are incorporating components aimed at mass reduction, parts consolidation to reduce assembly costs and more efficient recycling. The vehiclemakers' need to improve overall fuel economy in vehicles has led to the trend toward minimising vehicle weight. The use of performance materials such as high-strength steel and aluminium is on the rise and heavier traditional materials, such as steel and iron, are being replaced whenever possible.

Chapter 2 Body structure and materials

Overview

Although the car is built from many different materials, its main structure – known as the body in white (BIW) – is usually made of steel pressings welded together to form a strong and stiff frame. According to Corus, this method of construction accounts for 99.9% of all cars produced in the world. The remaining 0.1% are mostly constructed with an aluminium BIW, while a very small number (fewer than 0.01%) are constructed from carbon fibre composite. The BIW of a vehicle accounts for 20% of the vehicle mass, says Corus. The weight of the closures (doors, bonnet and boot/rear hatch), chassis (suspension parts) and driveline bring the total amount of steel and other ferrous metals to more than 60%.

Corus reports that, in recent years, the amount of ferrous metal has declined, mostly driven by manufacturers replacing iron with aluminium for engine castings. The percentage of sheet steel per car has also dropped, mainly due to:

- higher levels of equipment, trim and sound-proofing;
- more aluminium used in wheels and suspension parts;
- more moulded plastics, especially under the bonnet.

The environmental and economic requirements for reduced fuel consumption have also led to an increase in the use of lightweight materials for components that bolt on to a conventional steel vehicle, but at a cost. The following table indicates the potential weight savings of using alternative materials to steel and the additional cost involved.

Table 1: Alternative materials: potential weight saving versus cost

	Steel (kg)	Aluminium (kg)	Magnesium (kg)	% weight reduction (part)	% weight reduction (vehicle)	% cost increase (part)
Body in white	285	218	n/a	23.5	3.90[1]	250
Bonnet (assembly)	14.8	8.3	n/a	44	0.48[2]	300
Door (assembly)	15.7	9.5	n/a	39	0.40[3]	275
Instrument panel support beam	11.4	n/a	6.3	45	0.33[4]	350

1. Example vehicle mass of 17,00kg
2. Example vehicle mass of 1,360kg
3. Example vehicle mass of 1,550kg
4. Example vehicle mass of 1,550kg

Source: Corus Automotive Book of Steel

According to Bosch, a vehicle’s unitised body consists of sheet-metal panels, hollow tubular member and body panels that are joined together by multi-spot welding machines or welding robots. Individual components may also be bonded, riveted or laser-welded. Depending on the vehicle type, says Bosch, roughly 5,000 spot welds must be made along a total flange length of 1.2-2.0 metres. The flange widths are 10-18mm. Other parts, such as front bumpers, doors, bonnet and boot lid, are bolted to the body supporting structure. Other types of body construction include frame and sandwich designs.

Steel

According to Bosch, steel thicknesses range from 0.6mm to 3.0mm, and most parts range from 0.75mm to 1.0mm thick. Due to the mechanical properties of steel with regard to rigidity, strength, economy and ductility, alternative materials for the vehicle body structure are not yet available. Bosch points out that HSLA (high strength low alloy) steel is used for high-stress structural components. The resulting high strength of these components allows their thickness to be reduced.

Following trials, Corus said in late 2008 that it can now offer production-ready coils of Dual-Phase 600 Hot Rolled Steel (DP600HR) that it says can help vehiclemakers reduce weight. The new hot-rolled product will allow customers to benefit from the material’s enhanced properties for a larger number of automotive applications, Corus says. Existing dual-phase cold rolled steels offer carmakers weight reduction benefits via the ability to down-gauge, or reducing the thicknesses of the steel sheet used, for certain applications. However, cold rolled products can only be used for vehicle applications with a gauge range of between 0.6mm and 2mm. Importantly, Corus says its new hot rolled product now allows automotive customers to benefit from dual-phase steel properties for applications that require a thicker gauge above 2mm. The company says early trials of Corus hot-rolled dual-phase steel have already proven that it can help reduce weight in sub-frame applications, including lower and upper control arms and wheel centres, where these applications require improved durability and strength, and therefore thicker material gauge. Significantly improved material properties of dual-phase steels, such as better fatigue durability and tensile strength, allow automotive designers to use less material but at equivalent performance. This results in typical weight savings of between 10-20%, dependent on application use.

Q&A with Corus

In April 2009, Matthew Beecham talked with Professor Jon King, director, Corus Automotive, about the use of steel and aluminium in vehicle manufacture.

***just-auto*:** The aluminium industry claims that usage of its material has grown to an average of 130kg per car. I guess most of it consists of aluminium blocks and heads displacing iron. Yet on body surfaces, is aluminium making progress?

Jon King: We also believe this assertion is mainly based upon cast aluminium in engine blocks and not increased use of aluminium in body structure and panels. However, there are a few panels on a vehicle where conversion to aluminium makes sense in higher cost vehicles – for example, in Europe 20% of new vehicles now have an aluminium bonnet. In the future, we believe that cars will be more multi-material in content than today, but that the economics of steel use (its comparative cost with reference to other metals, the fact that steel is well-understood by the world's automotive engineers, the fact that there is a massive existing installed equipment base used to shape it, and its ease of recycleability), mean that steel will remain the material of choice amongst car-makers for many years to come.

***j-a*:** In terms of fuel and CO_2 savings, is there much to be had from switching to a lightweight material?

JK: All weight savings add up to fuel savings, but not as big as suggested in the press. Our own research to predict steel demand shows that roughly every 100kg saved in vehicle weight offers 4% in fuel economy and the potential to save around 1 tonne of CO_2 over the life of the car. It is true that cars have been getting heavier over the last few decades but, perhaps surprisingly, this is due largely to the increase in general vehicle dimensions, large increases in strength and stiffness and the wider addition of features and devices such as air conditioning. More recently, new car introductions are beginning to show that this increase is peaking, with many launches demonstrating weight savings, in many cases due to successful deployment of advanced high strength steels (Mazda 2, Mercedes C-Class and Renault Laguna). Most vehicle manufacturers will be able to get very close to the 2012 legislative target of 130g/km of CO_2 without big changes to their material strategies, as their current focus on engine and transmission technologies provide major gains.

***j-a*:** I guess that there is not much room for the use of premium-priced structural materials in small- and mid-segment cars. So that just leaves scope for adding new materials on executive and luxury vehicles?

JK: Whilst true that the more exotic ideas are more easily cost-justified on larger cars, we believe there is a limited opportunity for deployment of materials and better manipulation of designs to exploit those materials in small cars. Carmakers are prepared to pay somewhere between US$2 and US$10 per kilogram of weight saved, depending on the particular model business case.

j-a: Are you seeing more use of high tensile steels? Consequently, could we see more vehicles coming which are lighter but use only steel?

JK: The trend in the increased use of higher strength steels such as 600 and 800MPa material and ultra-high strength steels such as boron steel is clear, as are the weight-saving benefits. The challenge for industry is for better collaboration of OEMs and their supply chain to exploit these materials. We will certainly see lighter all-steel vehicles – especially in the highly cost-driven A, B and C segments.

***j-a*:** As we understand it, an increasing proportion of both structural and non-structural components are being made from plastics rather than steel. Some of the structural components include grille opening retainers, floor panels, bumpers and support beams. Non-structural components include exterior trim panels, grilles, duct systems, tail lights, fluid reservoirs, intake manifolds, valve covers and drive train components. Would you agree? How do you see that trend developing?

JK: Despite some innovation in the plastics industry and the functional integration achievable – such as injection moulded parts -- recyclability remains an issue in cars where the use of plastics is concerned. Structural (i.e. composite) plastics are in decline – none are being used in stiffness-critical areas such as floor panels. Bumper facias have been plastic for 20 years and are not considered structural.

***j-a*:** Although the manufacture of body panels and various assemblies have historically formed part of the vehiclemaker's in-house activities, these parts are increasingly being outsourced. In these difficult economic times, do you see that continuing?

JK: We see a range of strategies in this field and it is difficult to see any clear trend emerging in the outsourcing of sheet metal forming. Whilst it is true that Western Europe faces a particular challenge from Eastern Europe and even further afield, rigour in quality has yet to catch up with the enthusiasm for cost reduction in many cases. However there are now increasing opportunities for Tier 1/2 suppliers to develop modular assemblies such as doors and walk-in-front-ends. The rapid growth of die quenched (boron steel) pressings has been mainly due to Tier 1 supply. Carmakers prefer to press the full-finish exterior body panels in-house to reduce the potential for transport damage and control quality.

***j-a*:** In December 2007, the US federal government passed a new energy law raising corporate average fuel economy standards substantially. The new tougher standards swing into force on 1 October 2010. To what extent do you envisage new body panel and material innovations emerging to meet the new rules or can existing technologies already meet the new standards?

JK: The more stringent CAFE standards will drive the US manufacturers to introduce European-sized cars with highly efficient powertrains. There will also be a (lesser) drive towards cost effective light-weighting.

***j-a*:** The first phase of the European Union's stringent pedestrian protection rules took effect in October 2005. Do you see more use of plastic/metal (or hybrid solutions) for structural applications to help meet these EU rules?

JK: Pedestrian safety, like end-of-life recycling legislation, has yet to gain a strong public recognition. The effective use of steel in those solutions (perhaps in combination with other materials such as plastics), will certainly help.

In general, more plastics will be used for the lower level leg and upper leg impact. Both steel and aluminium perform better than plastics in the critical head impact (bonnet and wing) zones, in most cases steel works better than aluminium when there is reduced packaging space.

About Corus

Corus is Europe's second-largest steel producer with annual revenues of some GBP12bn and crude steel capacity of about 20m tonnes. With main steelmaking operations mainly in the UK and the Netherlands, Corus supplies steel and related services to the construction, automotive, packaging, mechanical engineering and other markets worldwide. Corus is a subsidiary of Tata Steel, one of the world's top ten steel producers. Following the acquisition of Corus in 2007, the combined enterprise has an aggregate crude steel capacity of more than 28m tonnes and approximately 82,700 employees across four continents.

As noted in the above Q&A, in October 2005, the European Union enforced Phase 1 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.

Although finding ways in which to protect the pedestrian remains a priority for manufacturers, there are a number of solutions already launched that meet the legislative requirements. An auto executive told us: *"I would say that pedestrian safety is slightly less of an issue nowadays. It is still, of course, of interest at some OEMs and we are active in that area. But I think that one of the interesting aspects is the way that the front of the vehicle will be designed. What we are trying to do is to provide more variance in style in the basic architecture of a given platform. So the style of the vehicle, particularly at the front, is a key provider of consumer segmentation. Customers are therefore* *looking for more specific segmentation. At the same time, the more variance you make then the more cost you add to the product.*

"So automakers are also looking at ways in which to commonise components across the platforms. For instance, Peugeot shares the front-end carrier across the small-car size platform or the mid-car platform. But it is not only the front-end carrier but it could be addressing the headlamps and the parts behind the actual headlamp and even the style of the vehicle through the bumper fascia. So I would say that, in summary, there is an aspect on the variance management, style etc that can be used to differentiate at a lower cost. In order to do that, you can work on the architecture. You can also work on achieving scale on common designs under the hood which the consumer doesn't see, for example, the front-end carrier and cooling components, etc. We see that more and more.

"Another aspect, of course, is weight saving in front of the vehicle. That is because of the overall pressure on fuel economy. At the front of the vehicle, the OEMs are looking for space and weight and, therefore, this is where functional integration comes into the loop as well as plastics integration. It is more than just packaging constraints. We are really focusing on weight saving innovations at the front of the vehicle. That could mean more plastic parts but it could also mean replacing a metal part with an aluminium part. However, replacing metal parts with plastic and aluminium parts increases the cost of the front-end carrier. A balance needs to be struck.

"So although pedestrian safety remains an important issue, a lot of innovation has emerged since the regulation swung into force. Consequently, the urgency to find a solution is no longer present. Another aspect is the electrical and electronic integration which contributes to the weight saving and segmentation."

For its part, Federal Mogul has developed a novel product that helps General Motors eliminate noise in a vehicle's cabin using recycled waste packaging and other by-products normally discarded at a vehicle manufacturing plant. Federal Mogul's so-called QuietShield GRN's (Green Non-woven) first application will be in the 2010 Buick LaCrosse luxury sedan. Cardboard packaging used by manufacturers is then recycled into QuietShield GRN and, in this case, used as acoustical padding in the LaCrosse's headliner. The recyclable by-products collected at the vehicle manufacturing plant are shredded, combined with other recycled materials, formed into a web and bonded in a manufacturing process developed by the supplier. Federal Moguls claims the padding can be used by vehiclemakers and other industries to fabricate linings and sound deadening padding in headrests, door and kick panels and boot liners to abate noise entering the vehicle cabin.

Finally, the use of steel for an increasing range of components is helping vehiclemakers to improve vehicle recyclability and meet the demands of legislation. The End of Life Vehicle Directive states that 85% of the mass of any new car sold in the EU must be recycled or reused. A 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. The following table sets out a comparison of the clutch pedal using different materials.

Table 2: Evaluation of a clutch pedal

Design	Advantages	Disadvantages	Piece cost (EUR)	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 Noise, Vibration and Harshness (NVH)	4.20	0.36

Source: Corus

The following table sets out the amount of CO_2 emissions saved by modifying certain automotive technologies.

Table 3: Cost of CO_2 saving

Modification	% CO_2 saving	Cost/car (EUR)	Cost/% gain (EUR)
Gearing/ECU tune	6.00	10	1.6
Low rolling resistance tyres	5.00	40	8.0
Aero tweaks	2.00	50	25.0
Low friction lubricants	0.70	30	40.0
Dual circuit cooling	0.50	25	50.0
Microhybrid (stop/start)	3.00	200	66.0
Efficient alternator	0.50	35	70.0
Heat storage system	0.50	60	120.0
Aero design (10% lower Cd)	4.00	600	150.0
Electric water pump	0.50	80	160.0
Mild hybrid (diesel)	10.00	2,000	200.0
Automated 6-speed manual	4.00	1,000	250.0
Full hybrid (e.g. Prius)	22.00	6,000	270.0
Aluminium bonnet	0.25	75	300.0
Aluminium BIW/closures	2.00	2,000	1,000.0
Super lightweight vehicle	4.00	5,000	1,250.0

Sources: VAG, IEA 2005, TNO/Ricardo, PSA, Ford, Corus Research

Aluminium

Aluminium competes with other materials, such as steel, plastics, composites, and glass, amongst others, for various applications in certain automotive markets. The automotive market is one of the largest and fastest-growing market sectors for aluminium producers.

Where aluminium products compete with other materials – such as steel and plastics for automotive and building applications; magnesium, titanium, composites and plastics for aerospace and defence applications; steel, plastics and glass for packaging applications – aluminium's diverse characteristics, particularly its light weight, recyclability and flexibility are also significant factors.

Toyota used the 2009 Detroit Motor Show to introduce its redesigned Prius, its first hybrid-only Lexus sedan and an electric vehicle concept based on the new iQ city car. Toyota said the redesigned third-generation Prius offers better performance and fuel efficiency along with new design features, including an optional solar power glass sunroof positioned over the rear seat that powers a new ventilation system. This system uses an electric air circulation fan that eliminates the need for engine assistance. The system prevents the interior air temperature from rising while the vehicle is parked. Toyota points out that vehicle weight has been reduced through use of aluminium in the bonnet, rear tailgate, front axle and brake calliper while super high-tensile steel has been used in the rocker inner, centre pillar and roof reinforcement.

BMW's new 7-Series is of lightweight construction. The doors, roof, engine hood, side panels and crankcase are all made of aluminium.

Tata is working on reducing emissions from the Jaguar and Land Rover brands to help them comply with future European Union CO_2 emissions limits. Tata Motors managing director, Ravi Kant, told *The Times of India* that measures were underway. A spokesperson for the brands said that an 18% reduction in fleet CO_2 emissions was expected over the next few years. The EU legislation is targeting overall average fleet CO_2 emissions of 130g/km by 2012, down from 160g/km in 2007.

During summer 2008, General Motors introduced new, more fuel-efficient versions of its North American market full-size pickup trucks and SUVs. Thanks to a combination of mechanical, aerodynamic and weight-reducing innovations, the automaker's new 'XFE' versions of the 2009 Chevy Silverado, Chevy Tahoe, GMC Sierra and GMC Yukon offer a 5% increase in EPA-estimated highway fuel economy and 7% improved mileage in city driving. The XFE models have a 320hp 5.3-litre flex fuel V8 with aluminium cylinder block and heads. Aluminium wheels and low rolling resistance tyres are fitted as standard on the XFE models adding to fuel savings. The Silverado XFE and Sierra XFE feature a soft tonneau cover, extended front lower air dam and lowered suspension with revised chassis tuning to improve aerodynamics.

In late 2007, Novelis Inc was selected by General Motors to supply aluminium sheet for the bonnet and liftgates of the 2008 Chevrolet Tahoe Hybrid and GMC Yukon Hybrid SUVs. Novelis says the body of the hybrid vehicles is approximately 400lbs lighter than a standard model, achieved in part through significant application of aluminium. The use of aluminium helped GM to offset the weight of the hybrid drive, battery pack and related hybrid hardware. GM already sources Novelis' aluminium sheet material for its GMC Acadia, Buick Enclave, Cadillac CTS and Buick Lucerne models.

Mercedes-Benz is sourcing Alcan's aluminium Crash Management System for its C-Class vehicle. The system features crash boxes inserted in the front structure of the car for improved safety. The bumper beam and crash boxes are produced at Alcan's Automotive Structures Europe plant in Gottmadingen, Germany.

Bosch points out that, since 1994, an aluminium body has been in use on one of the German luxury sedans. The vehicle's frame is constructed from aluminium extruded sections, and the panel parts are integrated as self-supporting parts (ASF or Audi Space Frame). The implementation of this principle, says Bosch, required the use of suitable aluminium alloys, as well as new production processes and special repair facilities.

Furthermore, Mitsubishi used the 2008 Detroit motor show to premiere its Concept-RA coupe. The coupe concept features the S-AWC vehicle dynamics control system driveline and the Twin Clutch SST used in the Lancer Evolution X, is powered by a new diesel engine. For improved crashworthiness and to reduce vehicle weight, the Concept-RA features a new body structure using an aluminium space frame made from extruded aluminium sections and die-cast aluminium members, as well as engine bonnet, bumpers and other outer panels made from high impact-resistant and recyclable plastic resin.

Q&A with Stadco

In April 2009, Matthew Beecham talked with Paul Jaggers, product engineering director, Stadco about the use of steel and aluminium in vehicle manufacture and Stadco's role.

***just-auto*:** To what extent are aluminium car bodies making progress?

Paul Jaggers: Aluminium in body structures is still mainly in the luxury car sector and rarely makes an appearance in the smaller car sector due to the incremental cost of the raw material. It is also difficult to introduce aluminium components into steel structures because of the corrosion problems, different expansion rates and the differing joining methods. If aluminium is added to a steel structure it would normally be as a ‘hang-on’ part such as a door, hood or tailgate. I do not see evidence of the use of aluminium in body structures increasing at present and feel it is unlikely in the near future.

***j-a*:** In terms of fuel and CO_2 savings, is there much to be had from switching to a lightweight material? Surely, only a reduction of total mass will help in a measureable way?

PJ: All weight savings will have an effect on the vehicle efficiency and should not be overlooked. The issue generally is that the lightweight material comes at a premium cost which immediately restricts its use.

***j-a*:** I guess that there is not much room for the use of premium-priced structural materials in small- and mid-segment cars. So that just leaves scope for adding new materials on executive and luxury vehicles?

PJ: High-strength steels are being used in the small- and mid-segments more than aluminium. Although the trend discussed below is more prevalent in the luxury segment there is a steady increase in the use of these materials in all body structures.

***j-a*:** Are you seeing more use of high-tensile steels? Consequently, could we see more vehicles coming which are lighter but use only steel?

PJ: High-strength steel’s usage in body structures has increased considerably over the past five years or so adding strength to the structure in areas critical to the safety performance.

These steels are easier to add into existing structures and adopt the same assembly methods as the normal structure so there is no need for special attention in the production environment.

***j-a*:** As we understand it, an increasing proportion of both structural and non-structural components are being made from plastics rather than steel. Some of the structural components include grille opening retainers, floor panels, bumpers and support beams. Non-structural components include exterior trim panels, grilles, duct systems, tail lights, fluid reservoirs, intake manifolds, valve covers and drive train components. Would you agree? How do you see that trend developing?

PJ: Structural plastic components are difficult to integrate with the rest of the structure and so at present they are generally restricted to parts that can be added after the steel structure has been completed. There are some restrictions with regard to durability and repairability if they are used in some areas of the vehicle.

***j-a*:** Although the manufacture of body panels and various assemblies have historically formed part of the vehiclemaker's in-house activities, these parts are increasingly being outsourced. In these difficult economic times, do you see that continuing?

PJ: As the volumes have taken a downturn, the OEMs have had to juggle with the requirements of their own organisation and capacity with the requirements of the suppliers to stay in business. Long-term we see no shift away from body-in-white being outsourced due to the massive investment required to add capacity in-house.

***j-a*:** In December 2007, the US federal government passed a new energy law raising corporate average fuel economy standards substantially. The new tougher standards swing into force on 1 October 2010. To what extent do you envisage new body panel and material innovations emerging to meet the new rules or can existing technologies already meet the new standards?

PJ: This can't be addressed solely by looking at low-weight materials and there needs to be a fundamental look at what affects the fuel economy. Cars have been growing in size for the last 50 years and although much can be attributed to the increase in safety standards, the size of cars needs to be addressed by the manufacturers.

***j-a*:** The first phase of the European Union's stringent pedestrian protection rules took effect in October 2005. Do you see more use of plastic/metal (or hybrid solutions) for structural applications to help meet these EU rules?

JP: I believe that any significant move in pedestrian impact performance will only be addressed in the styling and engineering of [the] vehicle front end.

About Stadco

Stadco is a major supplier of BIW panels and assemblies to vehicle manufacturers including Ford, BMW, Jaguar, Land Rover, Aston Martin, GM and Toyota. Stadco has five established manufacturing sites, four in the UK and one in Germany. It also operates in South America and plans to start operations in Russia soon. Stadco's core capabilities include:

- Aluminium stampings – Stadco specialises in stamping aluminium panels for its customers. It produces major panels, including the skins, for a wide range of vehicles.
- Steel stampings – from the smallest bracket to the largest body panel, Stadco has the ability to stamp every panel on the vehicle, in many steel grades including high strength alloys.
- Metal assemblies – Stadco produces sub-assemblies for certain vehiclemakers.
- Painting – the company offers eCoat, Powder Coat, Top Coat painting and associated sealing solutions.
- Product design – the company offers a full product engineering service.

Plastics and composites

The use of plastics, aluminium, magnesium and different grades of steel are all under scrutiny by the vehicle makers in a bid to optimise factors. While the use of plastics in vehicles has significantly increased over the last five years, the steel industry has also proved flexible by reducing the weight of components without sacrificing strength.

The trends toward the increased use of plastics in exterior and structural/functional/ powertrain components have been driven by innovations in material, moulding and painting technologies, which have improved the performance and appearance of moulded plastic components as well as lowering their costs. The design freedom that plastic offers is also key to its increased use. Not only does plastic allow for the manufacture of products that cannot be manufactured with other materials, but plastic makes it possible to combine several parts, saving weight and cost. Additionally, recently introduced plastics that can withstand the hot, corrosive environment of the engine compartment are becoming more prevalent.

More and more concept cars on display at motor shows are using transparent body panels. For example, the Chevrolet Volt incorporates a number of products from SABIC Innovative Plastics, including:

- roof made with Lexan GLX resins and Exatec coating technology;

- rear deck lid and side glazing made with Lexan GLX resins and Exatec coating technology;
- doors and bonnet made with Xenoy iQ thermoplastic composites;
- global energy absorber and hybrid rear energy absorbers with Xenoy iQ resins;
- steering wheel and instrument panel with integrated airbag chute made with Lexan EXL resins
- front fenders made with Noryl GTX resins;
- wire coating made with flexible Noryl resins.

As Bosch points out, plastics replace steel in a limited number of cases for separate body components. The following table sets out some examples of alternative materials to steel.

Table 4: Examples of alternative materials to steel

Typical applications	Material	Abbreviation	Processing method
Structural components, e.g. fender cross members	Glass fibre mat reinforced thermoplastics	PP-GMT	Injection moulding
Mouldings/covers, e.g. front apron, spoiler, front section, radiator grill, wheel-well liners, wheel covers. Bodyshell components, e.g.bonnet, fenders, boot lid, sliding sunroof	Glass fibre mat reinforced thermoplastics	PP-GMT	
	Polyurethane	PUR	RIM (reaction injection moulding) RRIM (reinforced reaction injection moulding)
	Polyamide Polypropylene Polyethylene Acrylonltrite-butadiene-stylene copolymers Polycarbonate (with polybutadiene theraphthalate	PA PP PE ABS PC-PBT	Injection-moulding, glass fibre content determines elasticity
Flexible protective moulding rails	Polyvinylchloride Ethylene-propylene-terpolymers Elastomer-modified polypropylene	PVC EPDM PP-EPDM	Injection moulding/ extruding
Energy-absorbing foam	Polyurethane Polypropylene	PUR PP	Reaction foams
Fenders	Thermosetting plastics with reinforcing fibres (sheet moulding compound)	SMC	Pressing

Source: Bosch

General Motors' scientists at the vehiclemaker's research and development centre in Warren, Michigan have claimed a technological breakthrough in so-called smart materials, which will be ready for series production in vehicles from 2010. These shape memory alloys and polymers can change their shape, strength and/or stiffness when heat, stress, a magnetic field or electrical voltage are introduced. This opens new possibilities for many movable vehicle features, as shape memory alloys, and polymers in particular, ‘remember’ their original shape and can return to it. *“Smart materials will change the look and feel of our cars and trucks,”* said Larry Burns, GM vice president of research and development and strategic planning. *“With these new materials, functionality can be ‘programmed in’ to enable innovative designs, improved efficiency, and new and improved features that will make our vehicles more exciting to own and operate than the automobiles of the past.”* Actuators and sensors made from these materials have the potential to improve vehicle performance and fuel economy, as well as enable new comfort and convenience features. These actuators and sensors can provide significant benefits when used to replace conventional motorised or hydraulic devices by reducing vehicle mass, component size and complexity, as well as improving design flexibility, functionality and reliability. A few example applications include active vehicle surfaces, such as spoilers and air inlets that adjust to govern airflow; improved aerodynamics and performance; as well as hood, door latch and glove compartment releases for more convenient access.

According to Alan Taub, GM executive director of research and development, smart materials are building on previous materials advances GM has introduced over the last several years. *“These new smart materials follow a long list of material applications we are already using,”* said Taub. *“A few examples include novel aluminium forming processes that provide enhanced body panels and lightweight, polymer nanocomposites that provide superior mechanical properties at lower cost, and magnetorheological fluids for improved chassis systems. “The properties inherent in shape memory alloys and polymers have the potential to be game-changers in the automotive advanced materials field, eventually leading to vehicle subsystems that can self-heal in the event of damage, or that can be designed to change colour or appearance.”* Smart materials are being used in other industries in various applications including medical devices, mobile phone antennas, toys and sporting goods. GM is collaborating with HRL Laboratories and the University of Michigan in developing potential applications. To date, GM has more than 175 US patents issued or pending based on research work and application development in the field of smart materials.

A new bioplastic which can be used for car parts has been developed by an industry-government-academia joint research project based in Hiroshima

Prefecture and involving Mazda. The automaker claims that the bioplastic, which is made of natural materials, offers improved exterior surface quality and high-strength. It can also be used for vehicle interior parts. Mazda points out that it has three times the shock impact resistance along with 25% higher heat resistance when compared to contemporary bioplastics used for items such as electrical appliances. In addition, it is made with a fermentation process that includes natural materials such as fermented starches and sugars which, compared with the process to make polypropylene, reduces energy use by 30%.

The main raw materials used to manufacture automotive products include aluminium, copper, resins and steel.

For the past three years, component manufacturers have faced commodity cost increases, most notably copper, aluminium, petroleum-based resin products, steel and steel scrap and fuel charges. Consequently, they have sought to manage these and other material-related cost pressures using a combination of strategies, including working with their own supply base to mitigate costs, seeking alternative product designs and material specifications, changing suppliers and hedging of certain commodities.

The demand for environmentally friendly (‘green’) products used in vehicle manufacture continues to increase unabated. Such products represent technologies designed to help reduce emissions, increase fuel economy and minimise the environmental impact of vehicles. Vehiclemakers continue to focus on improving fuel efficiency and reducing emissions in order to meet increasingly stringent regulatory requirements in various markets. As a result, suppliers are competing intensely to develop and market new and alternative technologies, such as hybrid vehicles, fuel cells, and diesel engines to improve fuel economy and emissions. Green is a key trend today because of the convergence of several issues: global warming, higher oil prices, increased concern about oil dependence, and recent and pending legislation in the US and in the rest of the world regarding fuel economy and carbon dioxide emissions.

Q&A with JSP

JSP is the world leader in the production and development of expanded polypropylene (EPP) and its applications, branded as ARPRO. An essential product for the automotive, packaging and consumer product industries, ARPRO is a source of strength, durability and weight reduction and is used in over 23m vehicles per annum. Matthew Beecham talked with Paul Compton, executive vice president and chief operating officer of JSP (Europe).

***just-auto*:** Could you sum up the main properties and advantages for automotive OEMs in using ARPRO EPP?

Paul Compton: ARPRO expanded polypropylene can reduce system mass by 25-35% in systems like seating. It is inert, unaffected by exposure to oil, grease, petroleum and most chemicals. For safety, it has an extremely high strength-to-weight ratio, quickly returns to its original shape following dynamic stress, withstands multiple impacts without significant deformation and provides acoustical enhancement in components used throughout the vehicle.

***j-a*:** The dimension creep syndrome is making each successive generation of cars heavier, so what is JSP doing to assist the auto industry in making lighter cars?

PC: I believe we can offer the OEM and systems supplier a solution that can take kilograms out of a car and this can be in many areas. On a recent example, the new Volvo XC60, we helped replace the anti-submarine ramp, traditionally a body-in-white element, with a moulded ARPRO unit. Not only did this deliver a weight saving, therefore improving fuel economy and responsiveness, but it also considerably simplified costly body-in-white tooling. ARPRO is strong and resilient enough to enable the ramp to be incorporated into the seat, replacing the traditional metal structure and contributing to a simpler vehicle platform. Tooling costs are also lowered.

***j-a*:** How are the tooling costs reduced?

PC: Hatchbacks, MPVs and SUVs engineered on the same platform have differing H-Points, where the passengers' seat heights are raised in relation to the ground. The H-Points are usually created with tool inserts or different tools. Using ARPRO, the variants can be accommodated in the seat itself simplifying costly metal pressing tooling to a single variant. This reduces tool changeover, maintenance and complexity.

***j-a*:** Does the seat therefore become more difficult to manufacture?

PC: No. Parts are consolidated. In fact we have developed a J-clip arrangement for attaching the upholstery to the seat bench. Serviceability and assembly are also easier, demonstrating that through good relationships with the OEMs and Tier 1s we can deliver benefits through all areas.

***j-a*:** So what are the benefits to the end customer, i.e. the consumer?

PC: In this example, the flat floor delivers a more efficient load space with fewer structural obstacles when the seat is folded. This can make the car more marketable. In other areas of the vehicle, it can reduce noise, an attribute that can severely impact perceived quality. We think this is an area that car manufacturers are increasingly focussing on as powertrain noise levels continue to reduce. Our engineers work closely with Tier 1s and OEMs to create specific variants of the core product to deliver improvements. As an example, we have recently launched a low-squeak application for sun visors and car interior trim. Sun visors are a prime example of noise generation, where the interaction between multiple materials creates alternating sound frequencies and noise harshness. Using the tailored ARPRO provides simpler moulded inserts, enhanced energy absorption, component consolidation, easier assembly, lighter weight and enhanced recyclability.

***j-a*:** Where else is the technology applied?

PC: ARPRO is in the hidden areas, such as bumpers, stowage, consoles, and the ever critical safety impact zones. We are developing many space, noise and weight reducing products. We are also active in diverse areas such as the ‘Search and Rescue’ markets, where ARPRO’s multiple impact resistance and high buoyancy properties are in demand. Solutions from other markets are very often transferable with automotive, and vice versa.

***j-a*:** Is the technology cost-competitive?

PC: Absolutely. Through intelligent design we are able to minimise part complexity which can enhance piece and manufacturing costs. Our engineers work closely with OEM design and package engineers from the outset to maximise the benefits. ARPRO’s material capabilities such as strength or reduced mass mean it can be used to replace more costly or heavier components. These properties benefit the OEM right through vehicle life, simplifying servicing and recyclability. Our strong and close relationship with the OEMs is key to delivering this and we are proud of the levels of co-operation we enjoy with the vehicle manufacturers.

***j-a*:** What kind of challenges are you facing and anticipating with recycling and end-of-life regulations?

PC: ARPRO is 100%-recyclable and easily recoverable, and as well as automotive components it can also be used for automotive dunnage. When producing ARPRO, the waste streams are water and CO_2, with imperfect product being recycled on site. The water is screened for any solids and then released to the local water supply.

***j-a*:** Are there any future developments in ARPRO you can discuss?

PC: Amongst our ongoing tailoring and research activities, we are developing an improved surface finish for enhanced aesthetics and perceived quality. This will enable even more application growth.

Q&A with 3M

Novel adhesives, bonding techniques and tackling ‘dimension creep’ head-on are just some of the activities 3M’s automotive engineers are currently working on. The author talked with Simon Holmes, general sales and marketing manager for 3M’s automotive business. 3M’s automotive business is introducing innovations for a number of areas of vehicle design and manufacture, catering for applications including body-in-white, interior, exterior, powertrain and paint shops. It has hosted the 2008 Low Carbon Vehicles Conference, an event involving OEMs, suppliers and academia. 3M, Thinsulate, Glass Bubbles, Scotch-Weld and Precision Lighting Elements are trademarks of 3M Company.

***just-auto*:** What does 3M supply to the automotive market?

Simon Holmes: Our automotive offering covers all stages of the vehicle manufacturing process, from body-in-white design to aftermarket and repair. Key areas include structural adhesives and films for joining and bonding vehicle structures, additives for plastic injection moulding and many diverse bonding solutions.

We also supply Thinsulate Acoustic Insulation and some advanced interior ambient lighting systems as recently highlighted in the 3M Visteon Technology Showcase.

***j-a*:** How proactive is 3M in carbon emissions and weight reduction?

SH: Lighter-weight materials require specialist adhesives to bond them together. Bonding also uses less energy – therefore producing lower carbon emissions – than welding. Our range of automotive adhesives covers structural, semi-structural and non-structural applications. The advantages of these adhesives are combined with durability, structural performance to facilitate safety critical composite structures, creep and corrosion resistance.

***j-a*:** In automotive engineering, increased weight is often an inevitable consequence of ‘dimension creep’ and increased safety measurements. How is 3M helping combat this effect?

SH: Simple yet innovative solutions, such as applying 3M’s Thinsulate low-bulk insulation material, can improve packaging and NVH as it doubles up as a thermal insulator for wrapping air conditioning units as well as a noise vibration and harshness acoustic reducer.

j-s: For lightweight methods, you have referred to prestigious car brands. What does 3M’s automotive business offer to the volume and budget sectors?
SH: With the injection moulding of plastics, 3M’s glass microspheres reduce density and improve shrinkage properties. Hyundai are using our microspheres to manufacture lighter and cheaper high-volume interior components. The bubbles are capable of withstanding injection moulding and extrusion pressures of 30,000psi and, after a 19-month long series of instrument panel tests, Hyundai achieved a 16.8% weight reduction. Ultimately, the finished part cost was half that of a comparable PC/ABS IP core.

The higher-end-vehicle OEMs are, generally, more open and responsive to new innovations, but this is changing as all markets are experiencing increased pressure on weight reduction to meet pressing CO_2 targets.

***j-a*:** You mention interior enhancement and lighting. Could you elaborate?

SH: 3M and Visteon recently displayed a jointly developed concept car featuring about 50 technologies designed to enhance the driving experience of future vehicles.

To display more information within the vehicle in novel ways, 3D technologies from 3M are incorporated into the instrument cluster by utilising eye-catching turn-by-turn navigation graphics on the instrument panel. Static 3D technologies can display branding, enhancing not only the driver experience but also reinforcing the OEM's image. As we have seen in some premium cars, lighting can greatly enhance interior ambience, and the concept benefits from 3M's integrated light guide technologies, such as 3M Precision Lighting Elements in the door panels, map pockets and instrument panel.

The lighting elements are made from flexible polyurethane and use reflective patterns to create focused ambient light pools in the interior, enhancing A-surfaces. The same light guide also has the potential to be used in multiple locations in the vehicle (right, left, front, or rear), further reducing tooling and programme costs.

***j-a*:** Going back to diversification, what industries have helped 3M assist the automotive market in weight reduction?

SH: 3M operates by developing opportunities and synergies across different divisions. For example, Thinsulate Acoustic Insulation was originally developed for its thermal properties and used in the marine sector. Now it is used in automotive applications specifically for its lightweight and acoustic properties.

***j-a*:** Are there any future 3M developments you can discuss?

SH: Wheel balancers: they are an everyday commodity that 3M is about to enhance. Instead of attaching pre-prescribed balancer weights to a wheel, we can supply an extruded tube that can be cut to definable block sizes. The 3M Wheel Weight System is designed to have less impact on the environment than the traditional lead wheel weights, and involves fewer re-work stages at the workshop and the production line.

Finally, in early 2009, Dow Automotive introduced a new bonding system for the roof of the new BMW 7-Series. In addition to plastic technologies for reducing weight of car bodies, Dow Automotive has developed a new bonding system for the structural bonding of aluminium roofs with steel car bodies which was applied on the new BMW 7-Series. It says the new system demonstrates the effectiveness of bonding as an assembly technology for both lightweight constructions and mounting processes, important factors for the hybrid construction of materials where weight reduction advantages only come into play through use of a combination of materials.

Carbon fibre

Carbon fibre reinforced polymer or carbon fibre reinforced plastic is a strong, light and expensive composite material or fibre-reinforced polymer. For some time, it has been used in a number of applications for aerospace and marine fields. Carbon fibre is now making its way into vehicle manufacture. Since carbon fibre is stronger, tougher and lighter than steel, it can help increase fuel efficiency due to its lighter weight.

Bentley used the 2009 Geneva Motor Show to reveal its Continental Supersports model. It is the Volkswagen-owned brand's fastest and most powerful car and also its first flexfuel model. The car will be sold worldwide from autumn 2009 and flexfuel-compatible in the majority of markets from launch. North American models should be flexfuel-ready by summer 2010, following regulatory approval. More specially, the car is a two-seater with new lightweight sports seats with carbon fibre clamshell rear panels. In the rear compartment, the seats are replaced by a stowage deck with a carbon fibre luggage-retaining beam. Leather trim is standard but carbon fibre panels replace traditional wood veneers.

Nissan's SpecV version of its GT-R 'halo car', introduced in February 2009 in limited numbers in Japan, features include carbon fibre rear spoiler, grille and brake ducts. The car is offered only with black paint. Inside, it has only two seats which are special Recaro carbon fibre units. Carbon fibre insets trim the rear centre storage box, instrument panel and other areas.

Carbon ceramic disc brakes are also being studied and applied, albeit in niche applications. *"Carbon ceramic discs will find their way into high-end car applications today and in the future,"* said Guenther Plapp, executive vice president, engineering of Bosch's Chassis Systems Brakes division in an exclusive interview with *just-auto*. *"Since the manufacturing processes are rather complex, they will remain a special niche product for sports applications* *with high appeal and image potential. Good handling due to low weight is another attribute which sporty drivers will appreciate."* Bill VanderRoest, technical director, Foundation Brakes, TRW Automotive, told us: *"There have been some interesting developments in advanced materials such as carbon fibre discs which provide advantages under extreme braking conditions. Because of their cost premium, the application of such materials is limited to the very high-end performance vehicles."*

Citroen used the 2008 Paris Motor Show to reveal its 'GTbyCitroen' concept, which it claimed was *"the first ever car to be specifically designed to bring the virtual and real worlds together".* Show visitors could 'drive' the car in a 'true to life simulator' on the vehiclemaker's stand. The car, a joint venture between Citroën and the makers of Gran Turismo, was created for the fifth game in the multi-million selling Playstation series. The concept is almost 5 metres long and uses race-car technology including 21-inch, diamond-effect aluminium wheels, gullwing doors, over-sized rear end with mobile spoiler, gaping air intakes and flat underside. Blue LED headlamps and slim-line carbon fibre rear view mirrors are fitted.

Demand for armoured vehicles is growing because of increased criminality, wars and the fact that certain people are fearful for their safety. According to the consultancy, dpa, the more serious the security situation, the more demand there is for armoured vehicles, which carry high levels of profit for companies. BMW adapts its 5-series and X5 for an add-on price of EUR49,000. This involves dismantling cars and rebuilding them with the addition of more than 200 steel plates, as well as carbon fibre panels and special glass. Audi and Mercedes also offer high security versions of the A6 and E-Class respectively.

Organic materials

The use of organic materials in cars is not new. For some time, component suppliers and automakers have focussed on promoting environmentally friendly technologies in all product segments. In the area of seating, for example, coconut fibre seat pads have been used in order to meet manufacturers' economic and ecological objectives while contributing to sustainability. For example, Mercedes-Benz uses coconut matting, crushed olive stones and even sawdust in certain vehicles. More specifically, the automaker uses rubberised coconut matting as seat padding in a number of its models. Meanwhile, the crushed, carbonised olive stones are used as air filtration material inside the fuel tanks of C- and S-Class models, thereby reducing gasoline vapour smells when refuelling. The vehiclemaker also uses abaca fibres originating from the stem of a banana-type plant grown in the Philippines. These fibres are used in the underfloor cladding of A- and B-Class cars.

Continuing the organic theme, Toyota is using plastic components made from plants for its new-generation Prius. Known as ecological plastic, the plant-based foam and injection-moulded parts are found in several locations throughout the new car including the scuff plates, deck trim and seat cushions. The plant-based plastics replace conventional plastics made using petrochemicals, cutting CO_2 emissions over the life of the product (from manufacture to disposal) and helping to reduce petroleum use. Ecological plastic emits less CO_2 during a product's life cycle because most of the CO_2 emitted at disposal was originally captured during photosynthesis while the plant was growing. The vehiclemaker plans to increase the use of plant derived ecological plastic in future vehicles.

Meanwhile, BMW is looking at improving efficiency by using solar energy. In Central Europe a square metre of photovoltaic (PV) solar cells can produce around 200W of electricity. PV modules could be incorporated into roof, or the whole surface of the car. The vehiclemaker says these could be used to help pre-warm engine fluids to reduce emissions during the cold-start phase, where emissions are high. BMW says that 1kwh of electricity produced from the sun rather than from the engine would reduce fuel consumption by 0.3l/100km. The automaker is also looking at using software to take information from the navigation system and various vehicle sensors to help the engine predict vehicle manoeuvres and improve fuel efficiency that way. But it is not yet sure what kind of fuel saving this might achieve.

Coatings

There are basically three markets for automotive coatings:

- Coatings applied to vehicle bodies – following pre-treatment of the vehicle body to remove grease, oils and dust, four generic types of finish are typically applied, i.e. electrocoat, primer-surfacer, basecoat (or colourcoat) and clearcoat.

- Coatings used to coat automotive plastic components – there are certain differences between products used to coat plastic components and those supplied for coating vehicle bodies. In particular, a coating product such as electrocoat is not used to coat plastic components
- Coatings for aftermarket applications – the principal aftermarket customers are independent bodyshops (accounting for 55% of aftermarket sales to motorists) and vehicle maker franchisees. Coating products supplied for the OE and aftermarket constitute different relevant product markets. Six principal products are supplied to the aftermarket: primer, basecoat, clearcoat, thinners, activators and putty.

Times have truly changed since Henry Ford offered his black-only Model T in 1909. DuPont pioneered the first fast-drying lacquer paint in 1923, giving consumers their first colour options beyond black for mass-produced vehicles. Paint manufacturers, such as BASF Coatings, PPG Industries and DuPont, typically offer some 150 new colour shades each year. Today, the vehicle exterior is a vitally important element in the brand differentiation of vehicle makers and a kind of business card for its owner. Although people spend huge sums of money on their cars, wanting to see and be seen from inside them, their choice of colour for the bodywork is still conservative. Subdued colours appear to be the order of the day across the globe. Shades of silver, grey and blue are the preferred choice, worldwide. According to researchers at PPG, although a silver medal is often associated with a second-place finish, the colour silver was the number one vehicle colour worldwide for the 2002 model year.

However, not so long ago, there were clear national differences influenced by racing team colours. The British racing team opted for green, the Germans silver, blue for the French while the Italians opted for Ferrari red. The Japanese, meanwhile, chose white.

DuPont, BASF and PPG collectively dominate the OE automotive coatings market in Europe and North America. In Japan, two main coatings suppliers dominate the market: Kansai Paint Co Ltd and Nippon, although East-West alliances are becoming increasingly common.

New entrants to the global automotive coatings market face massive investments in production machinery and plant. PPG's dominance of the OE automotive electrocoat market is due to the fact that the company developed and introduced this technology in the early 1980s and that other suppliers subsequently commenced production of electrocoat using PPG's technology.

In the vehicle refinish paint supply market, recent acquisitions have rationalised the supply base. Currently, the market is effectively supplied by four global operating companies: BASF, DuPont, Akzo Nobel and PPG. Between them they account for about 85% of the European vehicle refinish market, with the remainder being distributed amongst a number of smaller companies, many of whom provide niche products not generally supplied by the majors.

In September 2008, BASF opened a new training centre in Shanghai for automotive spray painters. The company said demand is growing strongly for body shop and spray painting staff. The Refinish Competence Centre provides training for spray painters from authorised service centres including those of Mercedes Benz, Audi, Volkswagen, and Peugeot Citroën. The Shanghai training centre is BASF Coating's fourth such facility in China. Others are in Beijing, Shenyang and Guangzhou.

During summer 2008, BASF Coatings Services (Pty) Ltd took over the business of MAB Auto Body Parts and Paint Centre Ltd in Johannesburg, South Africa. MAB sales activities related to automotive refinish products, non-paint products, body panels and services, as well as the staff and parts of the management became integrated into BASF Coatings Services (Pty) Ltd. The automotive refinishing market in South Africa is one of Africa's largest markets. 50% of the continent's vehicles are found on the roads of South Africa. Seven vehiclemakers manufacture cars in South Africa. In addition, there are over 1,000 paint and bodyshops in South Africa. MAB has sold products and services for all aspects of automotive refinishing for 14 years from its locations in Johannesburg and Pretoria.

Chapter 3 Market forecasts

Aluminium

Although aluminium content in cars is increasing, albeit slowly, we should expect to see significant inroads emerging over the next few years. The automotive market has lately become the largest and fastest-growing single market sector for aluminium producers.

A recent study, commissioned by the US-based Aluminium Association, showed that North American use of automotive aluminium is at an all-time high, averaging 8.6% of vehicle kerb weight[1] in 2009 calendar year vehicles, up from just 2% in 1970 and 5.1% in 1990. The integration of aluminium in cars and light trucks is projected to be nearly 11% of kerb weight by 2020. On a worldwide basis, the amount of aluminium content for light vehicles is 7.8% of the average worldwide light vehicle kerb weight of 3,185lbs in 2009. Content growth is predicted to continue at a rate of 4-5lbs per vehicle, per year, and approach 300lbs per vehicle worldwide in 2020.

"The data demonstrate that automakers in North America and around the globe continue to recognise the value of automotive aluminium," said Buddy Stemple, chairman of the Aluminum Association's auto and light truck group. *"As automakers seek to innovate and differentiate themselves with more fuel-efficient cars and trucks with a reduced carbon footprint, the time to use advanced materials like aluminium is now – and this study shows that automakers agree."*

North America ranks as the world leader in aluminium penetration in cars, pickups, SUVs and minivans where a net increase of more than 8lbs between 2006 and 2009 calendar year vehicles despite a 10% loss in share for large, full-frame vehicles with high aluminium content. More than 50 vehicles produced in North America contain over 10% aluminium content.

Honda and BMW are now the aluminium content leaders, replacing General Motors and Nissan, with each averaging more than 340lbs of aluminium per vehicle. General Motors, Honda, Toyota, BMW, Hyundai and Volkswagen all

[1] Kerb weight is the weight of a car with no passengers or luggage but with a full fuel tank.

increased the amount of aluminium content of their North American vehicles from 2006 to 2009.

On a component basis, the study cites engine blocks and steering knuckles with the largest increase in growth over the last three years; with penetration of aluminium blocks reaching nearly 70% – the largest driver of aluminium growth in this decade. In addition, more than 22% of vehicles currently made in the US have aluminium bonnets (hoods), an all-time record. *"We're seeing continued growth of automotive aluminium because of the relevant advantages it offers, such as improved fuel economy and vehicle safety,"* said Stemple. *"In fact, hybrid and diesel vehicles when paired with aluminium can actually pay consumers back faster than if those vehicles were made of heavier steel."*

Since the 2006 model year, aluminium content has also experienced steady growth in light vehicle applications in other regions of the world, but especially in Europe and Japan. Long-term growth rates remain in line with the significant growth rates of the late 1970s to early 1990s, despite the shift to smaller vehicles.

Worldwide aluminium content is projected to grow from approximately 16bn lbs in 2008 to 29bn lbs by 2020, not taking scrap and spare parts into account. An estimated total of 67 vehicles from the European (49) and Japanese (18) markets now contain more than 400lbs of finished aluminium.

As the future of the global automotive industry quickly shifts to more fuel-efficient products, vehicles around the world will be manufactured with a variety of solutions and powertrain improvements. In fact, material experts and body engineers surveyed in this study expect 25% of fuel economy improvement to come from weight savings, while powertrain experts predict that 50% of the improvements will be the result of weight reduction.

For North America specifically, vehiclemakers and other experts ranked the use of aluminium as a replacement for heavier materials as a significant option to improve average fuel economy to 35mpg by 2020 and nearly as important as hybrid technology.

The study also showed that secondary (recycled) aluminium is expected to continue to represent at least 50% of the total amount of automotive aluminium used to the end of 2020; aluminium use in Chinese vehicles is predicted to surpass Japanese vehiclemakers by 2020; aluminium anti-lock braking system housings will be on 85% of 2009 vehicles; and nearly half of all 2009 models will have at least one pair of aluminium steering knuckles.

The following table sets out *just-auto's* estimates and forecasts of aluminium in a medium-sized passenger car in Western Europe, North America and Japan as a percentage of total vehicle kerb weight from 2005 through 2016.

Table 5: Aluminium as a percentage of total kerb weight of a medium-sized passenger car in Western Europe, North America and Japan, 2005-2016 (%)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Western Europe	7.2	7.4	7.6	7.9	8.1	8.3	8.6	8.9	9.1	9.4	9.7	10.0
North America	7.5	7.7	8.0	8.2	8.4	8.7	9.0	9.2	9.5	9.8	10.1	10.4
Japan	7.4	7.6	7.9	8.1	8.3	8.6	8.8	9.1	9.4	9.7	9.9	10.2

Source: *just-auto*

Plastics

The increased use of plastics reduces the weight of vehicles and consequently emissions. The weight reductions brought about through the increased use of plastics has also offset the extra weight brought about by improved safety features such as airbags. The British Plastics Federation points out that using 100kg of plastics in a car can replace between 200-300kg of traditional materials. Over the average lifespan of a vehicle every 100kg of plastics will reduce fuel consumption of the vehicle by 750 litres.

The following table sets out *just-auto's* estimates and forecasts of plastics in a medium-sized passenger car in Europe, North America and Japan as a percentage of total vehicle kerb weight from 2005 through 2016.

Table 6: Plastics as a percentage of total kerb weight of a medium-sized passenger car in Western Europe, North America and Japan, 2005-2016 (%)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Western Europe	7.2	7.3	7.5	7.6	7.8	7.9	8.1	8.3	8.4	8.6	8.8	9.0
North America	8.1	8.3	8.4	8.6	8.8	8.9	9.1	9.3	9.5	9.7	9.9	10.1
Japan	7.8	8.0	8.1	8.3	8.4	8.6	8.8	9.0	9.1	9.3	9.5	9.7

Source: *just-auto*