

THE MARKET FOR PLASTICS AUTOMOTIVE COMPONENTS IN EUROPE

During the next decade, plastics will continue to help automobile designers and engineers to innovate and take car performance much further

As the old Millennium ended (at least symbolically), sales of vehicles in Western Europe reached an all-time high of 15 million units. The use of plastics in automobiles during the past century has been large - in fact, historically one might say there have been plastics in automobiles almost as long as there have been plastics.

The first production automobiles came out in 1900 and for many years cellulose nitrate sheet was used as side curtains in horse and buggy rigs. Cellulosics were later used for moulding the steering wheel, and some phenolics and ureas were employed for electrical components and control knobs.

The great revolution began with the development of thermoplastics on a large scale, during the 1950s, but it received its largest impetus with the development of engineering thermoplastics, starting with ABS and going on to polyamide and polyacetal and polycarbonate. A significant development in materials came with the technological "leap" from blending of different plastics to alloying new materials with useful combinations of plastics, of which the first was probably polystyrene-modified polyphenylene oxide.

Parallel with this activity during the 1960s, however, was considerable development of thermosetting composites for the automobile industry, firstly for complete monocoque bodies, in glass fibre reinforced polyester resin, and later with factory-made polyester/glass combinations that could be moulded by compression and a form of injection: Sheet Moulding Compounds (SMC) and Bulk Moulding Compounds (BMC).

Materials used in automobiles	
Steel sheet	41 %
Plain steel	18 %
Aluminium	8 %
Cast iron	6.4 %
Zinc, copper, magnesium	2 %
Rubber	5.6 %
Plastics	9.3 %
Other materials*	9.7 %
<i>*Adhesives/paints 3.0 %, glass 2.9 %, textiles 0.9 %, fluids 0.9 %, miscellaneous materials 2 %</i>	

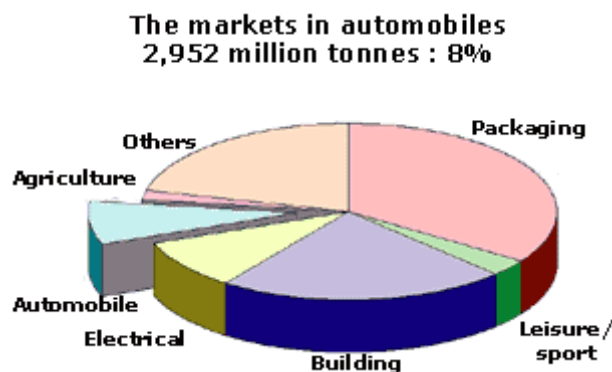
Since those beginnings, the use of plastics components in automobiles has undergone enormous growth - particularly during the last 20 years - from a few kg per car to roughly 105 kg per average automobile built in the year 2000.

During this period, the advantages of using plastics have changed. Originally, plastics were specified because they offered good mechanical properties combined with excellent appearance, including the possibility of self-colouring.

As the automotive industry has developed - and particularly under the legislative pressures that have been imposed on it during the past few years - so plastics have responded.

Mounting costs are being met by the ability of plastics to be moulded into components of complex geometries, often replacing several parts in other materials, and offering integral fitments that all add up to easier assembly, helping to reduce costs on the assembly line.

The lightness in weight of plastics has proved itself a genuine benefit to the automotive industry, not only in reducing overall weight of cars, in order to reduce fuel consumption to legislated limits, but also in allowing more sophisticated systems and components - including safety systems - to be included in the modern car, without paying the penalty of additional weight.



In practical terms, this has allowed more sophisticated heating ventilation and climate control systems to be installed in the car of today, with in-car entertainment and information systems, not to mention providing the additional safety of airbags - all without adding to overall weight.

Without plastics, it is estimated that today's cars would be around 200-300 kg heavier. The resulting fuel savings are estimated at 0.5 litre per 100 km which represents 750 litres for a car with a lifetime of 150,000 km.

Decreased fuel consumption and hence reduced associated pollution are the major benefits that lighter plastics parts bring to the automotive industry.

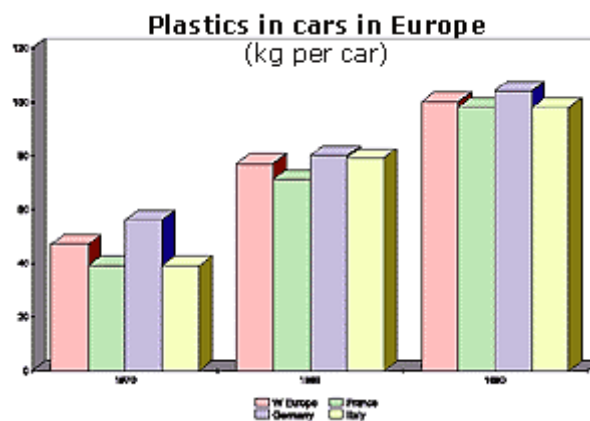
Many types of polymers are used in more than 1,000 different parts of all shapes and sizes. Although up to 13 different polymers may be used in a single car model, just three "families" make up some 66 % of the total plastics used in a car: polypropylene (32 %), polyurethane (17 %) and PVC (16 %).

Plastics used in a typical car		
Component	Main types of plastics	Weight in av. car (kg)
Bumpers	PP, ABS, PC/PBT	10.0
Seating	PUR, PP, PVC, ABS, PA	13.0
Dashboard	PP, ABS, SMA, PPE, PC	7.0
Fuel systems	HDPE, POM, PA, PP, PBT	6.0
Body (incl. panels)	PP, PPE, UP	6.0
Under-bonnet components	PA, PP, PBT	9.0
Interior trim	PP, ABS, PET, POM, PVC	20.0
Electrical components	PP, PE, PBT, PA, PVC	7.0
Exterior trim	ABS, PA, PBT, POM, ASA, PP	4.0
Lighting	PC, PBT, ABS, PMMA, UP	5.0
Upholstery	PVC, PUR, PP, PE	8.0
Liquid reservoirs	PP, PE, PA	1.0
Total		105.0

A quick look inside any model of car shows that the passenger compartment is dominated by plastics. This is the area where plastics are more traditionally established. But besides instrument panels, interior trim and upholstery, plastics are used in lighting, bumper systems, fuel storage and delivery systems, ducts, fenders and exterior body panels and increasingly in engine compartment or other under-the-hood components.

Recent years have seen a veritable invasion of the under-bonnet region by plastics, leading to widespread adoption of large (1.5 to 2.5 kg) mouldings for air intake manifolds. These are not only half the weight of their metal counterparts: they also allow engineers to optimise the airflow to the engine, helping to make it

more efficient, and also playing a valuable role in reducing noise levels. Moulded in glass fibre reinforced nylon, these are highly sophisticated parts, marking the true arrival of plastics as engineering materials in their own right.



How plastics save weight in cars

The "invasion" of plastics in the engine compartment is by no means over. Engineers in plastics and automobiles are working together closely now to optimise other systems, integrating injection and blow moulded parts, and harnessing plastics and elastomers that give a range of properties from "soft" to "hard", but can be moulded simultaneously or in sequence, offering a better product without expensive assembly work.

Plastics are also beginning to make a significant contribution to the structural make-up of the car.

Intensive development of thermoplastics has opened the

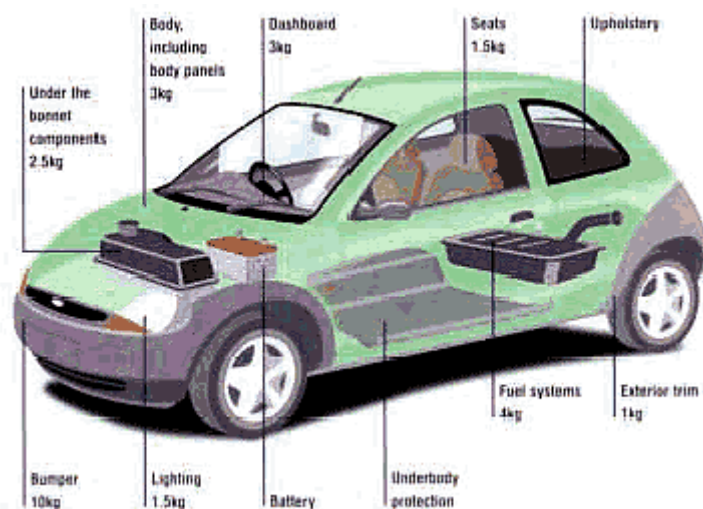
way to production of individual bodywork panels by injection moulding, to meet the high temperature of the paint stoving ovens used by the automotive industry, and electrically-conductive grades, for electrostatic painting.

Structural parts such as integrated front end modules are also being developed in plastics - and, significantly, in combinations of metal and plastics. This latter development may well point a way forward, in combining materials to get the best performance out of each.

Another important area of development is in fuel systems. Again, this is an area which (for the safety of all) is a focal point for legislation, to conserve fuel and minimise emissions.

For more than a decade, all-plastics fuel tanks have been produced, by blow-moulding in ultra-high molecular weight high density polyethylene. Seamless, these one-piece tanks are much lighter in weight than their metal counterparts, and also, by their good mouldability, give more design freedom for locating tanks in difficult spaces.

It is estimated that some 90 % of all new cars in Europe have plastics tanks, and the technology has been exported to North America, where about 70 % of cars now use this system. In Japan, the market share is considerably lower, at about 7 %, but considerable growth is expected there also, to meet tighter fuel emission standards.



The development of fuel tanks presents a remarkable demonstration of the potential of plastics. Originally, tanks were treated internally to reduce the permeability of polyethylene. But, to meet tightening emission standards, particularly in the USA, multi-layer tanks are blow moulded, incorporating a layer of a high barrier polymer, and tie-layers to bond it to the structural inner and outer layers. A sixth layer is usually added, to re-use the scrap produced in manufacturing.

Multi-layer extrusion technology is coming rapidly into the production of plastics fuel tubing, to reduce permeability to nearly zero and, where required, to include electrical conductivity.

The next stage will be the integration of the total fuel system, to be designed as a complete unit. This will almost certainly change the methods of assembly and connection (as research shows that it is at these points that there is greatest risk of emissions). Again, we may expect that plastics will rise to meet this challenge.

Reinforced thermosetting resins also have a key part to play. While there is nearly fifty years of experience of the use of glass fibre-reinforced resins in production of bodywork, this has tended to be restricted by the nature of the material to low-volume production (of sports cars and "specials"). More recently, however, great strides have been made in the development of processes for moulding fibre-reinforced polyesters and polyurethanes at viable mass-production levels, and there is an increasing number of exterior bodywork panels and bumper systems that are produced in volume in these thermosetting materials.

Perhaps the greatest challenge to plastics in the automotive sector, however, is in recycling. Although the automotive industry has probably the best record of all industries when it comes to recycling its materials, with an average of around 75 %, the requirements now laid down by the European Union set even higher targets, and it is clear that something more productive must be done with plastics than dumping them in landfill.

For its part, the plastics industry has effectively demonstrated that its thermoplastics can readily be recycled by conventional melt processing, and its thermosetting composites can be handled by grinding to powder and reuse in new compounds. For both, the industry is fast developing chemical technologies.

Most of the automotive groups, in partnership with plastics material suppliers and the key automotive moulders, have developed "closed loop" approaches, in which certain parts are designated to be recycled to produce other parts. Collection and dismantling of the complex sub-assemblies of an automobile will certainly prove a challenge, but is not insurmountable.

It has also been demonstrated that plastics open up more avenues to efficient recycling than simply reprocessing the materials by mechanical means. Technologies are being introduced that will permit mixed (and contaminated) plastics parts to be broken down chemically, for reformulation as new plastics. Nor should the high calorific content of plastics be ignored: in modern incineration plants it can return that value, in heating and saving conventional fuel.

The real challenge now, both to the automotive industry and its plastics suppliers, is to work together to develop new assemblies that not only meet cost/performance requirements but also allow easier dismantling and recycling.

It can be seen that the development of plastics in automotives is all the time prompting engineers to take an integrated systems approach. This can only be aided by the emergence of "Tier One" suppliers to the industry - large, well-financed groups, operating globally, able to undertake the engineering, manufacture of whole modules, and deliver them to assembly lines Just-In-Time.

Computer-aided design and manufacturing systems also make this possible, allowing "simultaneous engineering" by all the participants in a project.

Driver and passenger "cockpit" modules, complete doors, air control systems and fuel systems are even now being developed by such giants.

Parallel with them, in Europe also, large plastics engineering groups are also emerging, both integrated with the new groups and independent of them. They not only have the moulding equipment and the latest CAD/CAE systems. They also have behind them decades of human skill, in working with plastics to get the best value from these materials.

In short, plastics meet the challenges of an industry whose demands are greater than ever. While motorists want high performance cars with greater comfort, safety, fuel efficiency, style and lower prices, society demands lower pollution levels and increased recovery at end of life.

Continual innovation is a key feature in the use of plastics in cars. Plastics will continue in the next decade to help designers and engineers to innovate and take car performance further.

Claude Thibaut de Maisières
Chairman of the EuPC Automotive Strategic Committee