Plastics

A MATERIAL OF CHOICE FOR
THE AUTOMOTIVE INDUSTRY

Insight into consumption and
recovery in Western Europe

Published summer 1999
This report explores the role of modern materials and the developments that are shaping cars and the automotive industry in the 21st century. It also examines the latest automotive developments based on new research into plastics' use in cars. In particular, the report explores the trends which are resulting in ever increasing demands for plastics in cars and the challenges in balancing safety, cost and environmental requirements. It provides data on the consumption and recovery of plastics and highlights the influence that the principle of sustainable development is having on car design. The conclusions help determine where future emphasis should be directed for greatest environmental gain and innovation.

Many debates at European level are influencing car design, from cleaner air to the management of cars at the end of their useful life. It is a challenge to all players – legislators, manufacturers and consumers – to ensure that all activities are undertaken in synergy in the overall drive for better safety and environmental protection.

1. Research commissioned by APME on plastics consumption undertaken by TN Sofres Consulting and on plastics waste from end-of-life vehicles by Mavel
2. Research commissioned by APME on cars and sustainable development by Mavel

Reducing fuel consumption
Plastics panels in Daimler-Chrysler’s ‘smart’ car are strong but lightweight, improving fuel efficiency. On average, the car only uses 4.8 litres of fuel every 100 kilometres and emits less than 120 grams of carbon dioxide per kilometre.

Growing demand
The demand for plastics is simple to explain: they are strong yet lightweight, versatile and flexible allowing technological innovation and design freedom. The automotive engineer demands a material which can adapt to sophisticated aesthetics, safety, comfort, fuel efficiency, engineering demands and electronic performance in a cost-effective way – plastics meet this need and continue to help designers and engineers innovate and take performance further.

In 1997, 1.7 million tonnes of plastics were used by the automotive industry, representing six per cent of total plastics consumption.

In comparison to 20 years ago, the use of plastics in automotive manufacturing has grown by 1,096,000 tonnes or 114 per cent – this represents an average increase of 30kg per car, from 70 to 100kg.

Substituting conventional materials with plastics leads to a direct primary weight reduction. The figures show the typical weight savings that can be made in various car parts. These then have a secondary effect as chassis, drive train and transmission parts can all be made lighter as a result.

Examples of plastics' use and related weight savings

<table>
<thead>
<tr>
<th>Component</th>
<th>Primary Reduction</th>
<th>Secondary Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under the bonnet components</td>
<td>2.25kg</td>
<td></td>
</tr>
<tr>
<td>Seats</td>
<td>1.15kg</td>
<td></td>
</tr>
<tr>
<td>Luggage</td>
<td>0.5kg</td>
<td></td>
</tr>
<tr>
<td>Fuel systems</td>
<td>4kg</td>
<td></td>
</tr>
<tr>
<td>Bumper</td>
<td>10kg</td>
<td></td>
</tr>
<tr>
<td>Lighting</td>
<td>1.5kg</td>
<td></td>
</tr>
<tr>
<td>Battery</td>
<td>2.5kg</td>
<td></td>
</tr>
<tr>
<td>Underbody protection</td>
<td>4kg</td>
<td></td>
</tr>
<tr>
<td>Body, including body panels</td>
<td>3kg</td>
<td></td>
</tr>
<tr>
<td>Dashboard</td>
<td>3kg</td>
<td></td>
</tr>
<tr>
<td>Seats</td>
<td>1.5kg</td>
<td></td>
</tr>
<tr>
<td>Upholstery</td>
<td>1kg</td>
<td></td>
</tr>
<tr>
<td>Exterior trim</td>
<td>1kg</td>
<td></td>
</tr>
</tbody>
</table>

Total direct weight reduction: 26.5kg
Secondary weight reduction: 26.5kg
Innovative car body developments are seeing an increase in the plastics content of cars. Approximately 100kg of plastics replace 200 to 300kg of traditional materials in a modern car.

Innovations include:
- Use of computers to control engine performance, creating novel applications for plastics where metal parts could not perform. As cars change from mechanical to more "electronic" machines, the need for car components to provide electronic shielding as well as heat- and chemical-resistance increases.

Technological innovation by the plastics industry is a key feature in the continuing development and use of plastics in cars. Today, they provide multi-component, tailor-made solutions for many new requirements, replacing more traditional and heavier materials in the process.

Despite its retro looks, the new VW Beetle is entirely modern, from plastics bumper to plastics bumper. Advances in polymer technology have improved plastics' heat resistance so that today large automotive components such as bumpers, remain in perfect shape, even at high-temperature processing. The VW Beetle is one of the first high-volume vehicles to benefit from this technology, allowing its plastic bumpers to be integrated into the painting process.

Freedom of design
Plastics have replaced glass in the headlights of the Mercedes Benz S Class, allowing greater design freedom as well as offering a clear, easy-to-fit, scratch-resistant and strong alternative.

Increased safety
Side doors which considerably enhance the safety of the vehicle occupants in a side-on crash, since the plastic neither splinters nor fractures
- Plastics replacing glass in windows and lights are 250 times stronger
Because plastics are also champions of source reduction – using less to do more – their use in car design helps minimise environmental impact and save resources. Greater use of plastics is vital to produce ever more energy efficient cars. Technological innovations mean lighter, thinner yet stronger plastics parts are being used to perform a growing range of roles in the modern car.

Despite their widespread use, the natural resources needed to produce automotive plastics represent just 0.3 per cent of global oil consumption. At the same time, the weight savings achieved through plastics’ use are significant – approximately 100kg of plastics in a modern car replaces 200 to 300kg of traditional materials. All other factors being equal, this has cut fuel consumption in the average car by 750 litres over a life span of 150,000km. Additional calculations suggest that this reduces oil consumption by 12 million tonnes and consequently CO2 by 30 million tonnes per annum in Western Europe.

nylon air-intake manifolds in the new Porsche Boxster weigh 40 to 60 per cent less than their aluminium counterparts. The low flow resistance on inner walls improves fuel economy and performance. At the same time the nylon components offer low thermal conductivity and can be recycled.

A common origin for fuel and plastics – oil

Low oil consumption is reduced fuel consumption. Consequently, the use of plastics can contribute to lower fuel consumption. For example, nylon air-intake manifolds are 40 to 60 per cent lighter than their aluminium counterparts and cost up to 40 per cent less.

By using plastics, manufacturers have been able to reduce vehicle assembly time and costs. Bumpers, fenders and dashboards can now be moulded as single parts. In the past, these elements were made of traditional materials which required the production of many parts and multi-component assembly.

Plastics have begun to replace conventional materials in throttle bodies and a number of companies are now leading the development of polyamide in throttle housings which are 40 per cent lighter than the aluminium equivalent and cost up to 40 per cent less.

Renault’s new Clio takes full advantage of the versatility of plastics. Accounting for more than 10 per cent of the total weight, plastics provide a different benefit for every application. Their use in the car’s wings has dramatically increased their shock resistance. They have also enabled better design of the intake manifold and a more cost-effective fuel system.

A common origin for fuel and plastics – oil

Transport 25%

Total oil consumption for
heat, electricity and energy 46%

Plastics 45%

Petroleum 7%

Other 34%
PLASTICS • Growing demand in the automotive sector

By volume, from bumper to bumper, cars today contain more plastics than traditional materials. Yet, thanks to their light weight, they account for on average only 9.3 per cent (or 105kg) of the total weight.

Different types of polymer are used in over 1,000 parts of all shapes and sizes, from all-plastics dashboards and fuel tanks to radiator grilles. Each polymer in turn can be tailored to meet exact technical, safety, economic, environmental and aesthetic specifications.

<table>
<thead>
<tr>
<th>PART</th>
<th>MAIN PLASTICS TYPES</th>
<th>WEIGHT IN AVERAGE CAR (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bumpers</td>
<td>PP, ABS, PC</td>
<td>10.0</td>
</tr>
<tr>
<td>Seats</td>
<td>PUR, PP, PVC, ABS, PA</td>
<td>13.0</td>
</tr>
<tr>
<td>Dashboard</td>
<td>PP, ABS, PA, PC, PE</td>
<td>15.0</td>
</tr>
<tr>
<td>Fuel systems</td>
<td>PE, POM, PA, PP</td>
<td>7.0</td>
</tr>
<tr>
<td>Body (including body panels)</td>
<td>PP, PPE, UP</td>
<td>6.0</td>
</tr>
<tr>
<td>Under the bonnet components</td>
<td>PA, PPF, BFT</td>
<td>9.0</td>
</tr>
<tr>
<td>Interior trim</td>
<td>PP, ABS, POM, PVC</td>
<td>20.0</td>
</tr>
<tr>
<td>Electrical components</td>
<td>PP, PE, PBT, PA, PVC</td>
<td>7.0</td>
</tr>
<tr>
<td>Exterior trim</td>
<td>ABS, PA, PBT, ASA, PP</td>
<td>4.0</td>
</tr>
<tr>
<td>Lighting</td>
<td>PP, PC, ABS, PMMA, UP</td>
<td>5.0</td>
</tr>
<tr>
<td>Upholstery</td>
<td>PVC, PUR, PE, PE</td>
<td>8.0</td>
</tr>
<tr>
<td>Other reservoirs</td>
<td>PP, PE, PA</td>
<td>1.0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>105.0</td>
</tr>
</tbody>
</table>
The study by Mavel, commissioned by APME, examined in detail the use of plastics in the automotive industry in France, Germany and Italy compared to the Western European average.

In the '70s, German car manufacturers led the way in fully exploiting plastics' advantages of cost efficiency and design – using some 40 per cent more plastics in an average car than Italian and French manufacturers. Through the '80s, Italian car manufacturers used more and more plastics in the design of their cars. By the '90s, manufacturers across these countries had adopted many of the same techniques with plastics becoming a key material.
Apart from selecting plastics for the benefits they bring to automotive design and performance, manufacturers are increasingly choosing these materials for their environmental benefits and contribution to sustainable development - using the world’s resources in a way which does not limit the range of economic, social and environmental options open to future generations.

Plastics have a major role to play in developing the sustainable car of tomorrow and shaping the future success of the automotive industry. As well as contributing to minimising emissions which affect climate change and conserving resources – two of the key environmental goals of sustainable development – through improved fuel efficiency, extension of car life and increasing options for recovery, plastics also provide increased safety and protection features for drivers and passengers.

**Balancing safety and lightweight efficiencies**

In recent years, increased safety and comfort features have led to a slight rise in the overall weight of the average car from 1,015kg in 1990 to 1,132kg in 1998. But plastics components have ensured that the balance between safety and lightweight efficiency is maintained by consistently reducing weight without compromising safety features. It is estimated that without plastics, today’s cars would be at least 200kg heavier resulting in increased fuel consumption.

**Increased fuel efficiency – improved air quality**

Replacing conventional materials with plastics has resulted in a substantial reduction in weight of the average car, leading to energy savings throughout the car’s life.

As previously mentioned, it is estimated that 200kg of plastics have replaced between 200 and 300kg of conventional materials in the modern car. This weight saving is estimated to reduce fuel consumption by 750 litres over a life span of 150,000km. All things being equal, further calculations suggest that, in total, this reduces oil consumption by 12 million tonnes and CO₂ emissions by 30 million tonnes per year in Western Europe.

**Extending the life of our car**

Plastics components are frequently more durable than those produced from conventional materials. In addition, plastics coating the underbody of a car protect it against corrosion and contribute significantly to extending the car’s life.

**Designing for reduced environmental impact**

Initiatives by several European cities to reduce CO₂ emissions and improve air quality have led to a greater focus on battery-powered cars. These cars use increasingly more plastics in their basic structural components to reduce weight and help make the limited power sources last longer.

For example, General Motors’ Electric Vehicle (EV1) uses plastics throughout its body, including the battery and rear suspension.

Looking ahead, plastics will increasingly play an integral part in the production and use of fuel cells, an exciting new development designed to generate the power to run electric cars.

**Towards sustainable development**

Considering environmental impact within the wider framework of sustainable development encourages innovation throughout the whole lifecycle, rather than just recovery at the end of life.

**Prevention – reducing the use of natural resources**

In the past, an end-of-life focus has often dominated environmental improvement discussions to the potential detriment of fuel efficiency, total resource savings and safety performance.

Nevertheless, the plastics industry is actively and continuously researching ways to develop optimum recovery options, ensuring that end-of-life vehicles are treated in a way that achieves maximum environmental gain.
Plastics recovery

The recovery of plastics waste continues to keep pace with growing consumption and, as experience grows, greater attention is being given to finding eco-efficient solutions – achieving optimum balance between environmental and economic considerations from the range of recovery options available.

Increased recovery requires changes in operational practices and new technologies. As a result, APME, in cooperation with the European Car Manufacturers Association (ACEA), established “The European Information Network for Eco-Efficient Treatment of End-of-Life Vehicles.”

The project started in July 1997 with the support of 45 industry partners, including car manufacturers, plastics producers, recyclers and dismantlers. The Network gathers, assesses and validates all projects, activities, technologies, infrastructure and resources available across Europe in the fields of dismantling, recycling, recovery and automotive shredder residue treatment. The results are shared with practitioners to improve technology transfer, with a focus on small- and medium-sized enterprises.

Although the project’s focus is plastics, its findings will provide significant learnings across all ELV treatment sectors and help improve recovery of all types of materials.

---

**PLASTICS • Making the most of end-of-life vehicles**

**Plastics recovery**

The recovery of plastics waste continues to keep pace with growing consumption and, as experience grows, greater attention is being given to finding eco-efficient solutions – achieving optimum balance between environmental and economic considerations from the range of recovery options available.

Increased recovery requires changes in operational practices and new technologies. As a result, APME, in cooperation with the European Car Manufacturers Association (ACEA), established “The European Information Network for Eco-Efficient Treatment of End-of-Life Vehicles.”

The project started in July 1997 with the support of 45 industry partners, including car manufacturers, plastics producers, recyclers and dismantlers. The Network gathers, assesses and validates all projects, activities, technologies, infrastructure and resources available across Europe in the fields of dismantling, recycling, recovery and automotive shredder residue treatment. The results are shared with practitioners to improve technology transfer, with a focus on small- and medium-sized enterprises.

Although the project’s focus is plastics, its findings will provide significant learnings across all ELV treatment sectors and help improve recovery of all types of materials.

**RECOVERY OPTIONS FOR PLASTICS WASTE**

- **MATERIAL RECYCLING**
  - Reprocessing in a production process of waste plastics for the original purpose or for other purposes excluding direct energy recovery.

- **FEEDSTOCK RECYCLING**
  - Material reprocessing of waste plastics by chemical means into basic chemicals, monomers for plastics or hydrocarbon feedstock.

- **ENERGY RECOVERY**
  - Plastics are made from oil – this gives them a calorific value equal to or greater than coal. This energy value can be recovered via combustion.

**NUMBER OF ELVs PER YEAR BY COUNTRY**

- France
- Germany
- Italy
- United Kingdom
- Others

- **MUNICIPAL SOLID WASTE (MSW)**
  - The incineration of plastics waste along with other materials in MSW can safely and cleanly generate heat and/or power.

- **HIGH CALORIFIC ALTERNATIVE FUEL**
  - When separated from other waste, the high energy content of plastics makes them excellent substitute for fossil fuels in energy-intensive processes, for example in cement production.

- **PRINCIPLE VOLATILE OIL**
  - The extraction of volatile oils along with other materials in ELVs can safely and cleanly generate fuel and/or power.
ENERGY RECOVERY

For those automotive plastics not suited to recycling for environmental and economic reasons – energy recovery provides a valuable alternative. Plastic have an energy content comparable to oil and coal. This energy can be recovered from automotive plastics waste alongside household waste in modern municipal waste incinerators. In addition, selective separation prior to treatment of the waste can produce an excellent alternative fuel for use in energy-intensive industries such as cement production reducing the need to use fossil fuels.

For those automotive plastics not suited to recycling for environmental and economic reasons – energy recovery provides a valuable alternative. Plastic have an energy content comparable to oil and coal. This energy can be recovered from automotive plastics waste alongside household waste in modern municipal waste incinerators. In addition, selective separation prior to treatment of the waste can produce an excellent alternative fuel for use in energy-intensive industries such as cement production reducing the need to use fossil fuels.

In almost all areas of plastics use, a mechanical recycling infrastructure is continuing to develop. Larger car parts such as bumpers, are most suited to mechanical recycling because they can be easily dismantled and offer a single type of plastic, providing good recycle quality.

However, because many plastics car components are very small or encasing other materials such as electronic devices, disassembly to create large quantities of single-type plastics waste can be very difficult and costly. Alternative recovery routes are therefore required in order to balance the environmental gains of lightweight components with the challenge of increasing recycling.

Currently, eighty per cent (67 000 tonnes) of total automotive post-user plastics waste (796 000 tonnes) is mechanically recycled. TN Sofres Consulting research estimates that this has the potential to increase to 10 per cent. Considering the ever increasing number of vehicles reaching end-of-life, this represents a big challenge for plastics recyclers. Industry is currently involved in a number of projects to identify ways of meeting this challenge.

Less than 1 per cent of all waste generated in Western Europe is plastics. Of this, just a tiny fraction is automotive plastics waste.

### MATERIAL RECYCLING

In almost all areas of plastics use, a mechanical recycling infrastructure is continuing to develop. Larger car parts such as bumpers, are most suited to mechanical recycling because they can be easily dismantled and offer a single type of plastic, providing good recycle quality.

However, because many plastics car components are very small or encasing other materials such as electronic devices, disassembly to create large quantities of single-type plastics waste can be very difficult and costly. Alternative recovery routes are therefore required in order to balance the environmental gains of lightweight components with the challenge of increasing recycling.

Currently, eighty per cent (67 000 tonnes) of total automotive post-user plastics waste (796 000 tonnes) is mechanically recycled. TN Sofres Consulting research estimates that this has the potential to increase to 10 per cent. Considering the ever increasing number of vehicles reaching end-of-life, this represents a big challenge for plastics recyclers. Industry is currently involved in a number of projects to identify ways of meeting this challenge.

Less than 1 per cent of all waste generated in Western Europe is plastics. Of this, just a tiny fraction is automotive plastics waste.

### PLASTICS • Recovery options

Less than 1 per cent of all waste generated in Western Europe is plastics. Of this, just a tiny fraction is automotive plastics waste.

Less than 1 per cent of all waste generated in Western Europe is plastics. Of this, just a tiny fraction is automotive plastics waste.

### TOTAL WASTE WESTERN EUROPE 1997

<table>
<thead>
<tr>
<th>Category</th>
<th>Total Waste (tonnes)</th>
<th>Proportion of waste (tonnes)</th>
<th>Proportion of total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive</td>
<td>796 000</td>
<td>44%</td>
<td>&lt; 1%</td>
</tr>
<tr>
<td>OF WHICH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total automotive</td>
<td>17 454 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total waste</td>
<td>2 567 357</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
As we enter an era of mass customisation, where products will increasingly be tailored to meet individual requirements, diversity will become the new rule. Cars will come in all shapes and sizes, metamorphosing into new ‘part-car/parts-truck’ combinations. Plastics’ versatility and flexibility will support the trend in the automotive industry to build very different cars based on the same chassis and a core set of components, thus reducing research and development time and the retail price.

Plastics-based composite materials will substantially reduce the weight of the future car and, as a result, less energy will be required to propel it. In fact, the 100kg of plastics that have been added to the average car have already displaced 200 to 300kg of other materials.

Thanks to lightweight plastics, driving 50 kilometres on one litre of fuel will soon be possible and the commercialisation of electric cars that need just 40kW instead of the 120kW a conventional-size vehicle requires today, could be only a few years away. As we move into the next century, cars will be fitted with hybrid engines that draw their energy from a combination of sources including fuel, plastics-based solar panels, batteries, and fuel cells – which generate electricity catalytically from hydrogen – thus further reducing emissions of CO₂.

In 20 years time, cars may even drive themselves, using satellite-based Global Positioning Systems (GPS) to take their passengers safely to the nearest hotel on a cross-country trip. New plastics are increasingly being tailored to meet the needs of the electronic car of the future.

Looking forward to the 21st century, plastics in automotive applications will continue to contribute significantly to the drive towards building better, safer and cleaner cars. The plastics industry will continue to work closely with the automotive industry to meet this challenge by developing technologies and products to turn transport dreams into a reality.
The Association of Plastics Manufacturers in Europe (APME) is the voice of the plastics manufacturing industry in Western Europe and has more than 60 member companies across 15 countries which represent over 90 per cent of Europe's polymer production capacity. The wider plastics industry, which also includes convertors and machinery manufacturers, employs well over one million people and generates sales in excess of 135 billion euros.

The information contained in this report was sourced by member companies, by independent consultants commissioned by APME and published literature.

Any presentation or publication using data from this report should give APME as source reference.