A MATERIAL OF CHOICE FOR THE AUTOMOTIVE INDUSTRY

Insight into consumption and recovery in Western Europe

APME
ASSOCIATION OF PLASTICS MANUFACTURERS IN EUROPE

Published summer 1999

PLASTICS • The driving forces for the car of tomorrow

The demands on the modern automotive industry are ever challenging – motorists want high performance cars but at the same time they are looking for improved reliability and safety, greater comfort, fuel efficiency, style, competitive pricing and, increasingly, reassurance about environmental impact. There is one family of materials that is rising to the challenge of these potentially conflicting demands: plastics. With their unique combination of properties they are key to providing technological innovation with cost-efficiency and sustainability in mind.

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.

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[1].

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 also provides data on the consumption and recovery of plastics and highlights the influence that the principle of sustainable development is having on car design[2]. The conclusions help determine where future emphasis should be directed for greatest environmental gain and innovation.

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.

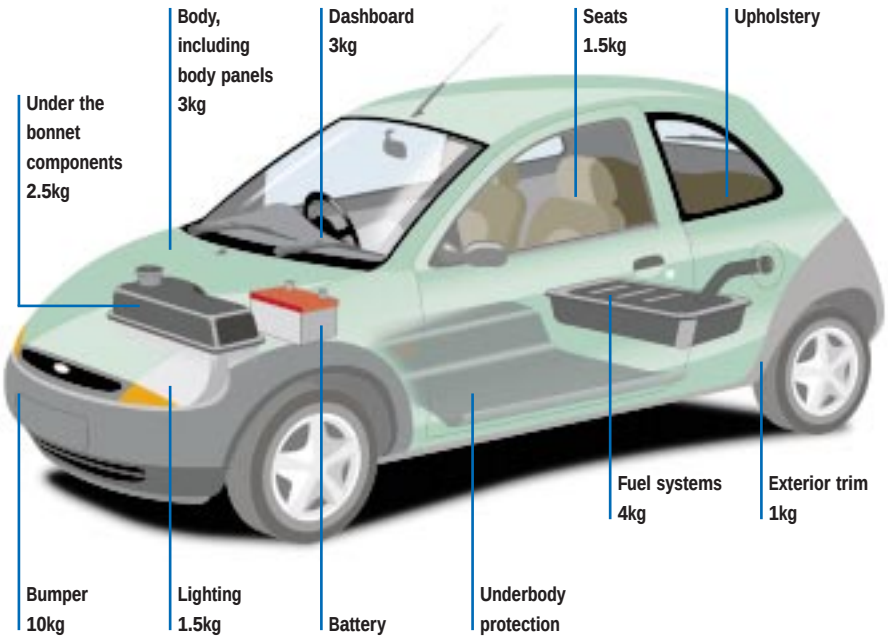
Growing demand

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**
- **compared 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**

EXAMPLES OF PLASTICS' USE AND RELATED WEIGHT SAVINGS IN MAIN CAR COMPONENTS



Total direct weight reduction 26.5kg **Secondary weight reduction 26.5kg**

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.

[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

PLASTICS • Leading car design

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.

INNOVATIVE DESIGN

Plastics' versatility allows for advanced shapes and forms without compromising the safety, comfort or stability of a car. This makes them very attractive materials for designers. Their strength and durability has also played an important part in expanding the average life span of a car to over 12 years, for example by providing better protection against corrosion.

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.**

The result is greater demand for engineering thermoplastics. For example, in smaller, advanced applications, new engineering plastics such as polybutyleterephthalate, aliphatic polyketone and liquid crystal polymers are increasingly used in new highly demanding applications, including connectors and housings for electrical components

- **the new rear bumper of GM's Saturn coupé which is now a single moulded part called a 'solitary beam', replacing the function of 13 parts in the former aluminium bumper system**

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.

PLASTICS: CASE STUDY

Despite its retro look, 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 plastics bumpers to be integrated into the painting process.

INCREASED SAFETY

Thanks to their strength and impact properties, plastics provide essential safety features, from shock absorption for bumpers to air bags, side impact protection and seat belts.

- **the Opel Astra T 3000 incorporates impact resistant plastics in each side door which considerably enhances the safety of the vehicle occupants in a side-on crash, since the plastics neither splinter nor fracture**
- **plastics replacing glass in windows and lights are 250 times stronger**

PLASTICS • Leading car design

PLASTICS: CASE STUDY

Renault's new Clio takes full advantage of the versatility of plastics. Accounting for more than 10 per cent of its 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.

LOWERING THE COSTS

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 polyetherimide throttle housings which are 40 per cent lighter than the aluminium equivalent and cost up to 40 per cent less**

IMPROVED PERFORMANCE

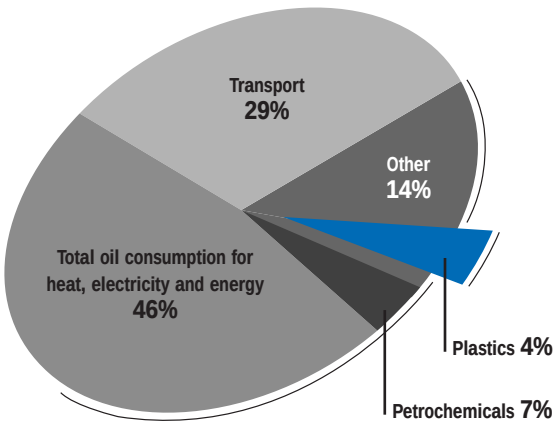
Because plastics are also champions of source reduction – using less to do more – their use in car design helps minimise environmental impact and save resources.

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 CO_2 by 30 million tonnes per annum in Western Europe.

- **nylon air-intake manifolds in the new Porsche Boxster weigh 50 to 60 per cent less than their aluminium counterpart. 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



Weight reduction
Plastics are increasingly replacing metal under the bonnet. For example, plastics throttle bodies are 40 per cent lighter than their aluminium counterparts and cost up to 40 per cent less.

PLASTICS • Growing demand in the automotive sector

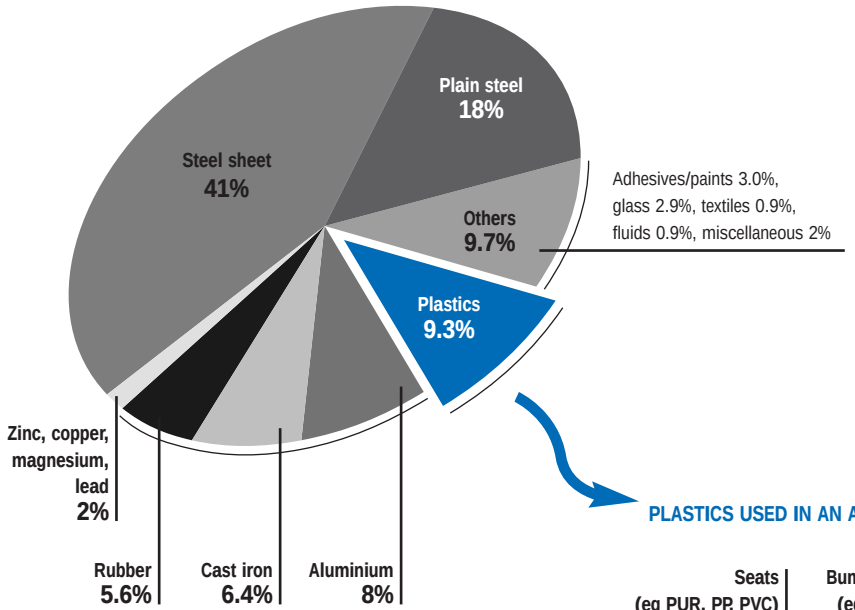
By volume, from bumper to bumper, cars today contain more plastics than traditional materials. Yet, thanks to their light weight, they account for on average only 9.3 per cent (or 105kg) of the total weight.

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.

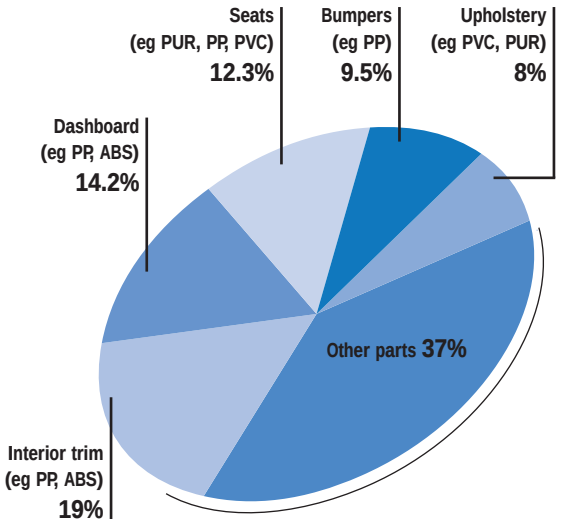
PLASTICS' USE BY TYPE AND WEIGHT IN AN AVERAGE CAR

PART	MAIN PLASTICS TYPES	WEIGHT IN AVERAGE CAR (kg)
Bumpers	PP, ABS, PC	10.0
Seats	PUR, PP, PVC, ABS, PA	13.0
Dashboard	PP, ABS, PA, PC, PE	15.0
Fuel systems	PE, POM, PA, PP	7.0
Body (including body panels)	PP, PPE, UP	6.0
Under the 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, ASA, PP	4.0
Lighting	PP, PC, ABS, PMMA, UP	5.0
Upholstery	PVC, PUR, PP, PE	8.0
Other reservoirs	PP, PE, PA	1.0
Total		**105.0**

MATERIALS USED IN EUROPEAN AUTOMOBILE PRODUCTION 1998



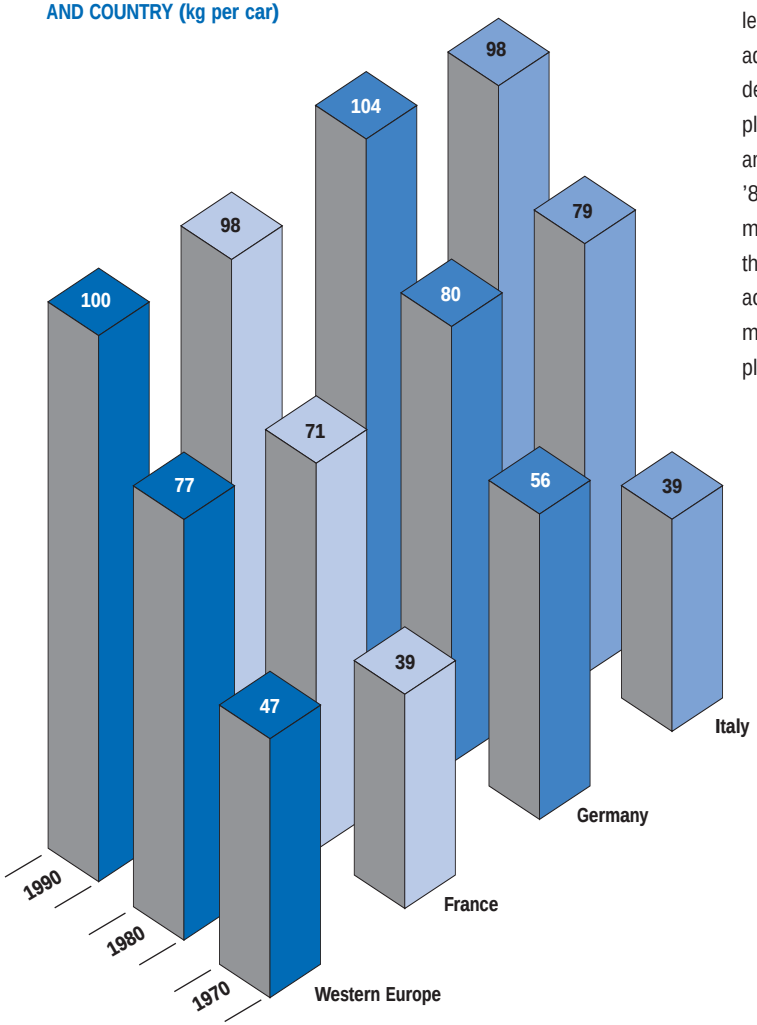
PLASTICS USED IN AN AVERAGE CAR



PLASTICS • Consumption by decade of car manufacture and country

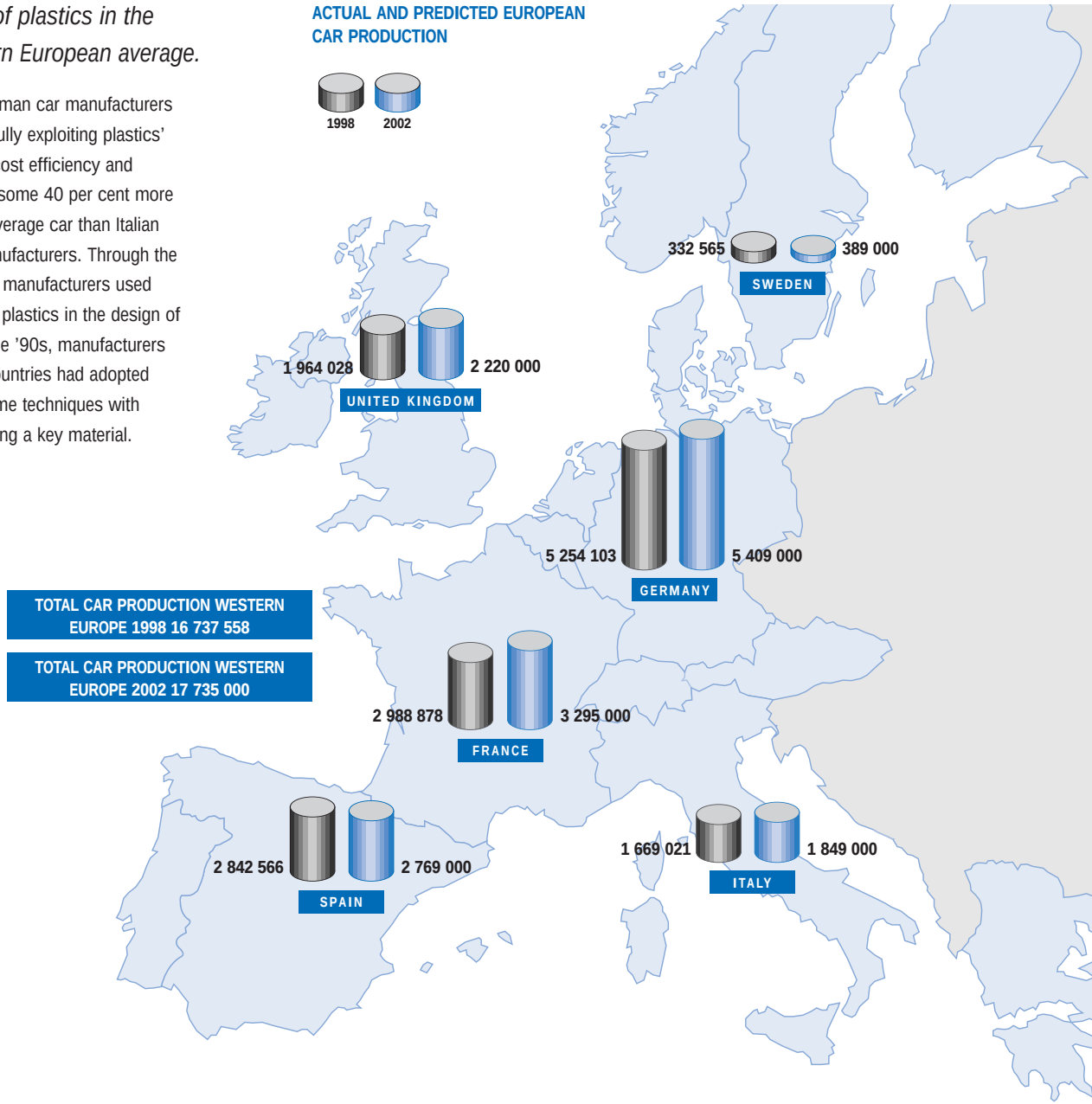
The study by Mavel, commissioned by APME, examined in detail the use of plastics in the automotive industry in France, Germany and Italy compared to the Western European average.

PLASTICS CONSUMPTION BY DECADE OF CAR MANUFACTURE AND COUNTRY (kg per car)



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.

ACTUAL AND PREDICTED EUROPEAN CAR PRODUCTION



PLASTICS • Contributing to sustainable development

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 effect 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 100kg 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 CO_2 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 CO_2 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 life cycle, rather than just recovery at the end of life.

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.

Prevention – reducing the use of natural resources in the first place – is the first environmental goal and focus on recovery must not reduce the significant opportunity to save natural resources during life.

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: CASE STUDY

Plastics have made a substantial contribution to automotive safety. Some plastics-based innovations include reinforced side panelling, air bags and seatbelts.

Since the introduction of regulations enforcing seatbelt wearing in 1983, it is estimated that in the UK alone, up to 7 830 lives have been saved and that 133 950 serious casualties have been prevented.

With full compliance to seat belt regulations, a further 108 lives and 970 serious casualties could be prevented each year.

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

Plastics recovery

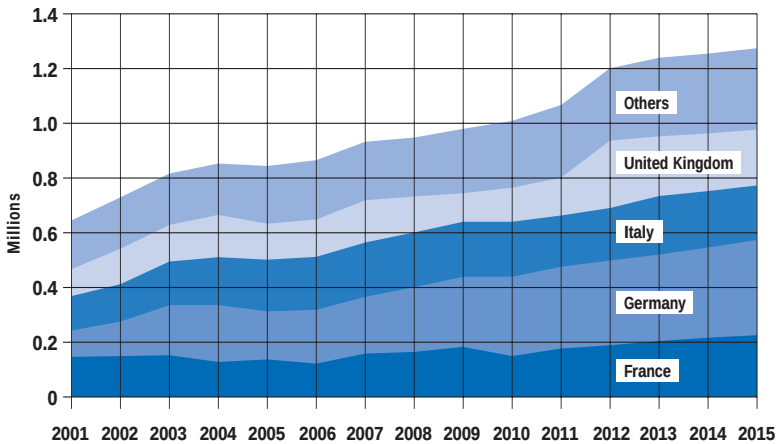
The recovery of plastics waste continues to keep pace with growing consumption and, as experience grows, greater attention is being given to finding eco-efficient solutions – achieving optimum balance between environmental and economic considerations from the range of recovery options available.

Increased recovery requires changes in operational practices and new technologies. As a result, APME, in co-operation 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.

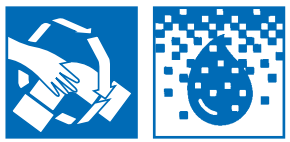
NUMBER OF ELVs PER YEAR BY COUNTRY



RECOVERY OPTIONS FOR 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.



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, eight 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.

- **FIAT has collated information about the plastics used in each FIAT model and published it in a dismantling manual. Within six years, more than 31 000 tonnes of plastics have been diverted from landfill**
- **In April 1999, supported by the American Plastics Council (APC), the Japanese Plastics Waste Management Institute (PWMI) and the European Plastics Converters (EuPC), APME organised the second international conference and exhibition – *Identiplast* – which addressed various issues connected with plastics recycling. Subjects included the significant technological and practical advances that have been made in the identification, sorting and separation of plastics waste, since the first event held in 1997**

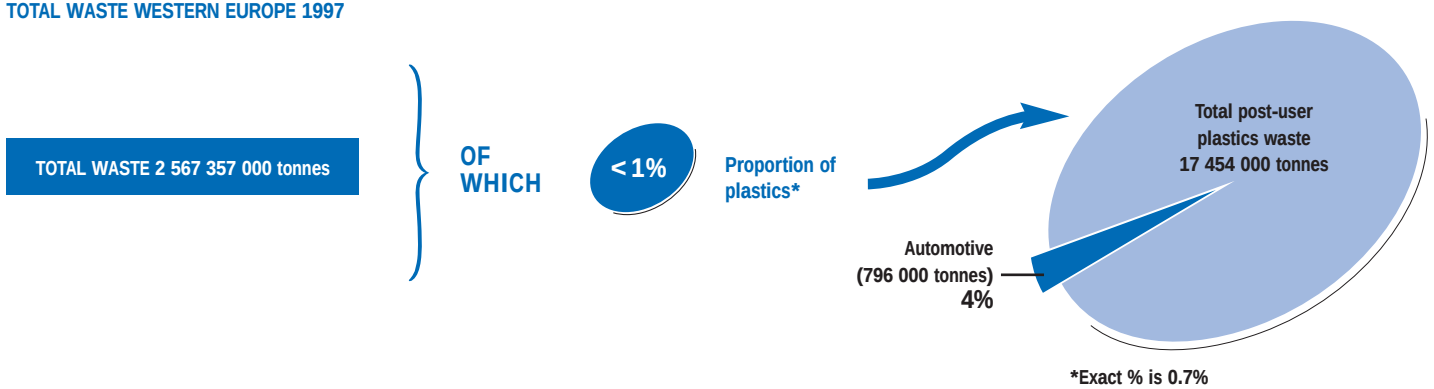
Feedstock recycling is another recycling process which breaks down polymers into the petrochemical feedstock components from which they originate. This method of recycling is complementary to mechanical recycling as it can more easily and effectively process mixed plastics waste. Projects are underway to explore this relatively new technology's potential in the automotive sector. Feedstock recycling should be considered among other available processes. However, it should be recognised that feedstock recycling is not a low-cost option as all material requires pre-treatment before recycling and costly plant investments also need to be made.

ENERGY RECOVERY

For those automotive plastics not suited to recycling for environmental and economic reasons – energy recovery provides a valuable alternative. Plastics 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 or pre-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. Another exciting development which can help reduce the consumption of fossil fuels is recovered fuel derived from plastics waste for use in power generation.

- **The European Commission recently recognised that the incineration of waste with heat recovery will form an important part of an integrated waste management system – with adequate controls required to prevent adverse environmental impacts**

TOTAL WASTE WESTERN EUROPE 1997



*Exact % is 0.7%

PLASTICS • Drivers for the 21st century

Thanks to plastics, the cars we dream of today are quickly being developed – offering high performance, cleaner driving and advanced safety and convenience features.

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-part-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 CO_2.

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 40 member companies across 15 countries which represent over 90 per cent of Europe's polymer production capacity. The wider plastics industry, which also includes converters and machinery manufacturers, employs well over one million people and generates sales in excess of 135 billion euro.

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

ASSOCIATION OF PLASTICS
MANUFACTURERS IN EUROPE

Avenue E. Van Nieuwenhuyse 4 Box 3 B-1160 Brussels
Telephone (32-2) 672 82 59 Facsimile (32-2) 675 39 35
Internet http://www.apme.org

XXXX/GB/09