ipp

integrated product policy

instruments from practice using the automobile as an example

A Project by State and Business Community as part of the Environmental Agreement for Bavaria

UMWELTPAKT BAYERN

Preface

Integrated Product Policy (IPP) is a focus of the "Environmental Agreement for Bavaria – Sustainable Development in the 21st Century", which was concluded in October 2000. The Bavarian government and Bavarian industry are thus continuing their successful cooperation for better environmental protection. Furthermore, there could be no more suitable instrument than IPP, especially since IPP relies primarily on cooperation and is therefore neither an instrument of industry nor of politics alone.

IPP is a response to the complexity of environmental problems that can no longer be solved by additive environmental protection. Ever-increasing expenditure on environmental protection is being demanded of industry, often for more and more marginal improvements, which is quite contrary to the basic idea of efficiency. At the same time, it is demonstrably the case that environmental policy measures that pinpoint individual sources of pollution often only shift the problems elsewhere. By contrast, considerable potential is opened up if, through cooperation between the political world, industry and consumers, product responsibility is used as a lever to reduce the environmental impact of products.

Bavarian industry and the Bavarian Ministry of the Environment are in agreement: new approaches to a solution must look at the product itself and its effects on the environment over the entire course of its life cycle. Therefore, as far back as the conception and design stage, IPP, seen in its totality, looks at all life cycle stages from the beginning of the life of a product through to its disposal. In this manner, optimisation becomes possible throughout all life cycle stages with the inclusion of all environmental media. At the same time, the focus is more on the consumers and users. After all, it is their choice of product that to a large extent decides whether resources are used sparingly and environmental impact is minimised.

Hence, the crucial factor is integration, that is, an overall examination of the ecological, economic and social effects of a product over the entire course of its life cycle, cooperation between industry, the political world and the social forces as well as communication with foresight between all stakeholders. However, the central elements do not include – and here too Bavarian industry and government agree – state-regulated additive environmental protection.

As to the concrete shape of IPP, numerous instruments of industry and the political world are already in existence, and these now have to be joined to an overall concept. They include principles of ecological product development and material flow management as well as statutory product liability, voluntary self-regulation and cooperative solutions such as the Environmental Agreement for Bavaria. For successful implementation, two factors are crucial: IPP must remain practically based and easy to keep track of. At the same time, according to the subsidiarity concept, federal and state regulations should generally only be applied in those areas where they establish jointly worked out goals, or limit risks.

Since for the political sphere, IPP is a means of realising sustainability in society, the Ministers of the Environment of the European Union discussed this topic in May 1999 and formulated the "Weimar IPP Propositions". The European Commission published a Green Paper on IPP in February 2001. The Bavarian Ministry of the Environment, in its turn, has declared IPP a central political arena for action, set up an organisational unit of its own and in April 2000 organised a conference on this topic. To give this new arena for action further shape, industry and politicians in Bavaria have jointly initiated various activities within the Environmental Agreement designed to identify the opportunities and limits of IPP in practice. The present guidelines are one example of these initiatives. Designed, entirely in the spirit of IPP, as a cooperation project, they integrate various stages of the product life cycle and are aimed at contributing to communication between the stakeholders.

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1. the challenge of ipp

"As one approaches one's goal, the path becomes ever more difficult". This quotation from Goethe precisely relects the challenges we are currently facing. It is in pro - duction-related environmental protection especially that industry has made enormous progress over the last few years. Thanks to billions of Deutschmarks invested in advanced environmental technologies, German companies are playing a leading role in environmentally friendly production. Environmental management systems aimed at continuously improving production-related environmental protection are today taken as read. In Europe, the implementation of the Eco-Audit-Act is being pioneered by Bavarian companies.

Today, the focus of attention is increasingly directed at those products that have an environmental impact during all stages of their life cycle. "From the cradle to the grave" or, in other words, from the extraction of the raw materials to their disposal, these products have a more or less marked environmental impact. Raw material consumption, energy requirements, emissions and pollution depend on how a product is designed, produced, used and disposed of. It is true that industry has made significant progress in this area, for example, by considerably reducing the energy consumption of motor vehicles or household appliances, while improving product quality. All the same, in the interests of sustainable improvement, we should try to make the most of the potential for improvement which still exists in this field. However, the responsibility for improvements cannot be placed on the producer alone. Significant improvements can only be achieved if industry, consumers and state work towards the same objective.

1.1 About the Concept of IPP

At the EU level, the term "Integrated Product Policy (IPP)", which covers both products and services, has been coined to describe this approach. The present manual is based on the following definition by the IPP Study Group within the Environmental Agreement for Bavaria:

"Integrated Product Policy promotes and works towards a continuous improvement of products and product-related services, with the aim of reducing their impact on man and the environment during all stages of the product life cycle."

Industry has already developed successful approaches and practical examples of how to achieve the above-mentioned objectives. While research has produced valuable results, too, in most cases the emphasis has been on specific properties (e.g. recyclability) or individual aspects of the life cycle of a product (e.g. cumulative energy demand for production).

However, to date, nowhere do we see any fully developed and effective practices for adapting the various IPP instruments to the numerous stages of the production process. The participants in the Environmental Agreement for Bavaria have therefore initiated a joint pilot project entitled "IPP – Product-Related Environmental Management in the Automotive Industry". The three key objectives of the project have been defined as follows:

- The various stages of the life cycle of an economically significant product – from the extraction of raw materials and their transformation into materials for car components, to the assembly, service life and disposal of the vehicle itself – shall be summarised and their relevance to IPP analysed.
- An overall assessment of existing product-related regulations and IPP activities in industry shall be made. The relevant instruments shall be explained and, where necessary, suggestions be made regarding their further development to meet practical needs.
- Above all, the pilot project is designed to explore a widely known, highly complex example with respect to the structures typical of IPP and to illustrate them with reference to examples of best practice. The resulting guidelines will focus on a realistic evaluation of what can be achieved and show priorities for a successful IPP, thus encouraging the implementation of IPP in other industrial sectors and providing companies with a concrete framework for their activities.

IPP Addresses the Entire Life Cycle of a Product

An assessment of the environmental impact of a product traditionally focused on one clearly defined stage of its life cycle. In recent years, this has often been waste disposal, which is the last stage of the life cycle.

The preceding stages such as the various stages of production or the impacts during a product's service life have been regarded as somewhat less significant. IPP takes a different approach altogether: From the extraction and processing of the raw materials to manufacture, transport, marketing, utilisation, consumption and disposal, the whole life cycle of a product is taken into consideration.

IPP Gives Product Design a Key Role

The development of marketable products is a core competence of a company, considering that the achievement of long-term corporate economic objectives depends on it. To be successful in the marketplace, a product must fulfil a specific purpose reliably and at a reasonable cost. In the past, ecological aspects were often regarded solely as an additional cost factor. The integration of environmental requirements into the product design stage is intended to support environmental protection while achieving savings in costs and creating a competitive edge. It is always more economical to get things right from the outset than to try to improve a product at a later stage.

IPP Takes a Cross-Media Approach

Up to now, environmental impact has often been reduced by shifting it, at least partly, from one medium to another. Take the example of wastewater treatment: Most treatment processes generate sludge which must be dehydrated in an energy-intensive process before it can be disposed of. This procedure has ultimately been the result of current legislation which has traditionally concentrated on one particular aspect. However, attempts to replace a host of individual laws by a uniform Environmental Code have so far failed because the Federal Government and the German states have been wrangling over their respective areas of competence.

Experts in corporate environmental protection have often discovered that adjusting one particular screw produces an unexpected effect in a totally different place. Especially when the whole life cycle of a product is analysed, the effects on the various environmental media can be very diverse or even work in opposite directions. The assessment of environmental impacts in various environmental media is one of the most difficult aspects when dealing with life cycle analyses. A successful IPP will have to find viable solutions to this problem.

IPP Uses Communication as a Key Factor for Success

As IPP deals with very complex issues, there are no instant recipes for success. Communication between all parties involved, that is, between industry and policy makers, between the companies along the product chain, and between industry and consumers, plays a crucial role for the success of product-related environmental protection. This is the only way for the companies to know at an early stage what ecological and functional requirements their products will have to meet, thus allowing them to develop their products accordingly and, most importantly, to sell them. However, in order for communication genuinely to serve this purpose, certain rules must be obeyed.

IPP Has a Technical and a Political Dimension

IPP is a relatively new area of environmental policy which is only now taking on a clearer shape. However many instruments and areas related to IPP are not new at all. They range from research projects on environmentally responsible product development and design to individual product- and material-based approaches in environmental law. These two poles represent the two most important cornerstones of Integrated Product Policy, namely the technical and the political dimension.

The technical dimension is characterised by standards and technical regulations, by instruments such as material flow analyses and ecological balance sheets and concepts such as ecological efficiency. The first part of the present manual will provide examples of how companies are already putting this dimension into practice.

The political dimension of IPP is of great importance. Since companies have to act in accordance with the principles of market economy, they expect the state to define clear, long-term objectives, while giving them as wide a scope as possible for achieving them. While both European and national policy makers consider the freedom of the industry to act independently a key factor for the success of IPP, companies fear that the state will not always refrain from intervening in an area of conflict between different interests. Therefore, industry expects the state to establish the conditions which will improve rather than impair the competitive edge of companies practising IPP. Not least, they also include consumers, who appreciate

1.2 The Guiding Principles of IPP

the IPP concept and act accordingly when using and disposing of a product.

It is not without reason that communication, cooperation and integration are the cornerstones of IPP. The guiding principle is that it is impossible to "go it alone". Demands, prerequisites, requirements and possibilities must be linked to achieve an optimum result. All participants must work closely together on the development of new products, using natural resources wisely to secure sustainable development. Not only does this mean that the environmental impact must be minimised while meeting demand. It is also necessary to support economic structures that are in harmony with both the above-mentioned objectives. All stakeholders – industry, politicians, distributors and consumers – must assume their responsibility.

>> Communication
exchange of information between all stakeholders

>> Cooperation
working together towards a joint objective, joining forces

>> Integration
taking into account all environmental media and all stages of the product life cycle, as well as ecological, economic and social aspects

2. IPP taking the automobile as an example

In selecting the automobile, the initiators of the project have not chosen a straightforward research object. Very few people know precisely how many thousands of individual components a car comprises. The present publication will therefore describe the various stages of the product life cycle by way of example, focusing on typical or economically significant areas. A crucial factor in choosing examples was the level of involvement of the various companies in the Environmental Agreement for Bavaria.

Characteristics of Automobiles

>> economically significant high-volume product

>> high degree of vertical integration

>> a high percentage of the production takes place in Bavaria/Germany

>> high environmental relevance (energy consumption, emissions, noise, CO_2, waste, land use)

>> high demand (need for mobility)

>> high social status

>> strong interaction between and polarisation of the various groups of stakeholders

2.1 Automobiles as an Important Factor for Mobility

Today's society would be impossible to imagine without individual mobility. Cars have allowed people who live in the country to participate in the wide range of opportunities offered by towns and cities and to look for jobs outside their immediate surroundings. Conversely, thanks to cars, inhabitants of conurbations are able to relax in the countryside and to get in touch with their environment. At the same time, the mobility of urban dwellers has in the recent past contributed significantly to structural improvements in rural areas. Farmers' markets and direct sales from the farm via which organic farmers market their products rely on customers from conurbations with money to spend. And for pastimes ranging from mushrooming to hill-walking, the car is often indispensable when it comes to arranging leisure activities.

2.2 Individual Mobility as an Economic Factor

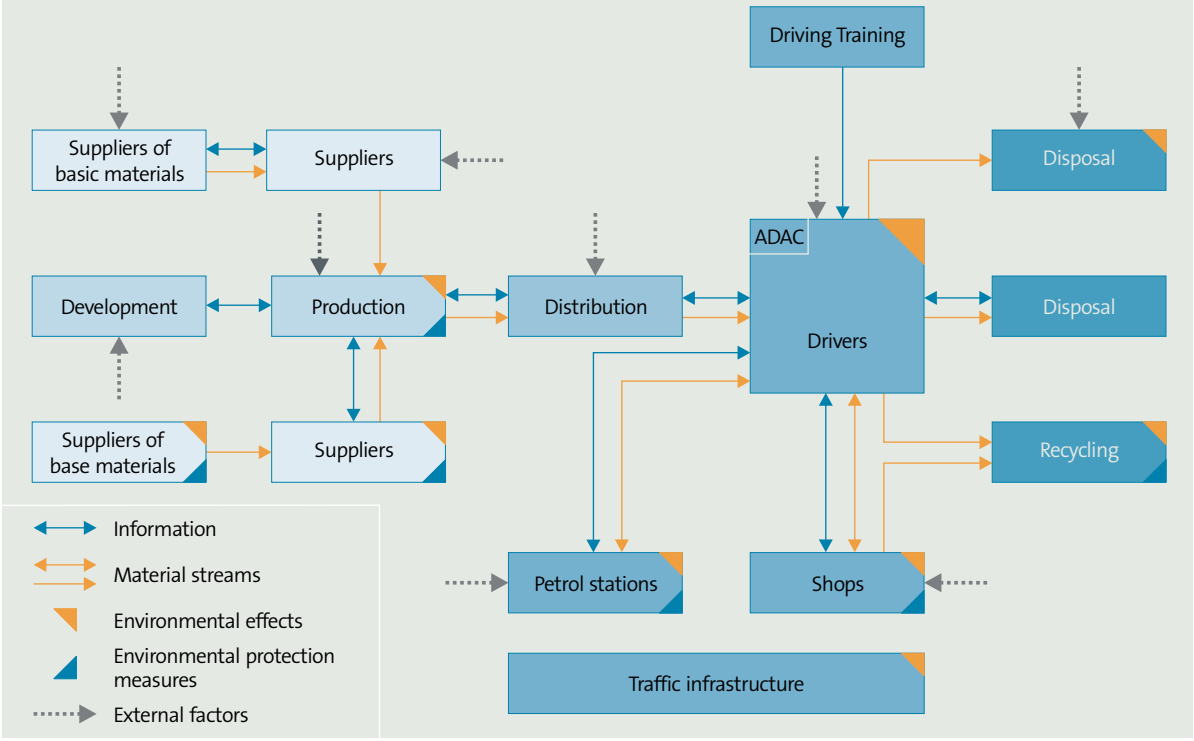
In view of the scarcity of parking spaces, traffic jams and pollution, ecologically responsible concepts for individual mobility are urgently required. These do not focus on the environmental impact of motor vehicle usage alone. IPP includes the environmental impact of a car over its entire life cycle and spans a variety of media. A car designed in accordance with IPP principles offers the following benefits:

- lower consumption figures
- lower emissions of hazardous substances and lower noise levels
- lightweight, compact construction with sparing use of materials, high potential for recycling
- environmentally relevant additional devices such as consumption meters

In addition, mobility concepts are needed which achieve a cleaner environment by virtue of encouraging a maximum number of road-users to choose their means of transport in accordance with their actual needs. In order to offer innovative system solutions, the focus must be on the needs of consumers rather than on the product alone.

With an annual production of about 40 million cars worldwide, motor vehicles are a mass product, with the automotive industry a cornerstone of the economy, especially in Germany. In 2000 alone, almost 5.5 million cars with a gross production value of nearly DM 256 billion were manufactured in Germany. Transport-related taxes supplied about DM 70 billion to the German Treasury in 1997. According to calculations by the Institute for Transport Studies at the University of Cologne, road transport accounted for almost 50 per cent of the growth in national income of DM 1,500 billion during the period 1950 – 1990. Road transport supports about 3.8 million jobs, accounting for some 11 per cent of total employment volume in Germany. Worldwide, the number of vehicles is forecast to increase fivefold by the year 2030 as a result of increasing industrialisation and motorisation. Continuous technical progress results in the integration of many innovative material applications, manufacturing processes and equipment, securing jobs in the automotive industry and the supplier firms in Germany.

Aspects of the Product System "Automobile"



2.3 Internal Costs of Transport

In 1998, the Federal Government spent a total of DM 43 billion on transport, about 9 per cent of current government expenditure. Of this, DM 10.3 billion was invested in new construction and maintenance of Federal trunk roads, and DM 3.3 billion on improvements to local traffic conditions. DM 24.4 billion was spent on the railway system, DM 3 billion on inland waterways and almost DM 1 billion on air transport. In addition, there was capital investment in the transport sector from previous years with a residual value of DM 20 billion in 1998. These included investments for construction of roads and bridges, Federal-owned facilities for local and long-distance transport as well as Federal-owned vehicle fleets. Capital investment in the private sector, including commercial transport, totalled DM 36 billion.

The police registered more than 2.4 million road accidents in Germany in 1999, in which more than 7,700 road users died, while about 520,000 were seriously injured. According to calculations by the Federal Highway Research Institute, injuries to persons generated external costs of DM 38.4 billion in 1998, with damage to property accounting for an additional DM 29.6 billion.

2.4 External Costs of Transport

Damage, nuisance and reductions in value due to pollution or noise, the knock-on effects of accidents, as well as disturbance and harm to other market participants generate external costs that must be met by society. According to the Federal Environmental Agency, the external costs of transport are estimated at about DM 160 billion. It is impossible to quantify the social effects resulting from the fact that town and city centres are no longer suitable for human habitation or communication. Important urban spaces are occupied by parked cars, while children cannot be left to use the streets unaccompanied, and the lives of the elderly are made insecure by today's traffic.

2.5 Environmental Effects

Energy

Over the last twenty years, energy consumption in the transport sector has increased steadily. While traffic accounted for only 22 per cent of total energy consumption in 1980, by 1997 the figure had risen to 28 per cent. Even though specific energy consumption went down, this

Determinants of energy consumption of passenger cars/minibuses in Germany

	1999	2005	2020	Units
Total vehicle population	41,732	46,000	48,000	x 1,000
Mileage/year	12.7	12.8	13.1	vehicle kilometres x 1,000/vehicle
Total mileage	528	586	635	billion vehicle kilometres
Vehicle occupancy	1.41	1.41	1.44	passenger kilometres/vehicle kilometres
Total fuel consumption	1,508	1,540	1,280	million litres
Specific consumption				litres/100 kilometres
Cars running on				
petrol	8.9	8.2	6.4	
diesel fuel	7.5	7.0	5.3	
biodiesel	7.6	7.0	5.3	
fuel cells	—	4.2	3.2	
natural gas	5.6	5.6	5.6	

Source: Prognos, Energie Report III, 2000, ARAL Verkehrstaschenbuch 2000/2001

was more than offset by a dramatic increase in road traffic. Thus, the distances travelled in the passenger and freight traffic sectors in West Germany rose by about 54 and 66 per cent, respectively, during the period 1975 – 1992 – a trend that seems set to continue, as both vehicle population and distances travelled are forecast to increase further.

Every EU citizen travels on average 35 kilometres per day. Commercial vehicles travel on average 12 tonne-kilometres (tkm) per inhabitant every day. Passenger transport thus accounts for more than 900 billion passenger kilometres/year and freight transport for more than 440 billion tonne-kilometres/year in Germany alone.

Land Use

In Germany, 120 hectares of land are given over to development and traffic areas every day. By 1997, traffic areas already constituted 5.1 per cent of the total surface area. Traffic-related facilities such as utility buildings, petrol stations, repair shops, road maintenance facilities, storage areas and most car parks are not even included in the statistics.

German transport network

	Kilometres
Federal motorways	11,427
Federal highways	41,386
Secondary roads	86,798
District and municipal roads	504,054
Total road network	643,665
Navigable inland waterways	7,467
Railways	82,413
Tram network	3,082
Oil pipeline network	2,370
Air traffic network of Deutsche Lufthansa	909,121

Source: Aral Verkehrstaschenbuch 2000/2001

Emissions

In Bavaria, about 31 per cent of carbon dioxide emissions, 80 per cent of nitrogen oxide emissions and 33 per cent of hydrocarbon emissions (VOC) are generated by road traffic. The formation of ozone also plays an important role. It is formed by insolation from nitrogen oxides (NO_x), which are mainly due to motor vehicle emissions, and from hydrocarbon (VOC) and carbon monoxide (CO).

Although average peak noise levels of vehicles have been reduced over the years, road traffic still remains the major source of noise. Almost 50 per cent of the population is exposed to a continuous noise level of more than 55 dB(A) by day, with about 16 per cent suffering noise levels of more than 65 dB(A). At these levels, there is an increased risk of cardiovascular diseases. The proportion of people exposed to average noise levels of more than 50 dB(A) during the night, which is likely to result in sleep disorders, is 31 per cent.

Fluid losses and the abrasion of brakes, tires, and pavement as well as maintenance and winter road clearance pollute the roadside with oil residues, unburned fuel and aromatics. Every year, about ten tonnes of pavement material per kilometre are abraded from the surface of a single carriageway alone.

EU legislation on exhaust emissions has led to technical improvements which have drastically reduced emissions generated by individual vehicles. More than 70 per cent of petrol-driven cars registered in Bavaria have three-way catalytic converters and more than half the commercial vehicles meet low-noise and low-emission standards in compliance with EURO 1 or EURO 2 emission regulations.

Total traffic emissions in 1996 in Bavaria

	Tonnes
Carbon dioxide (CO_2)	31,000,000
Nitrogen oxides (NO_x)	268,000
Sulphur dioxide (SO_2)	9,000
Non-methane volatile organic compounds (NMVOC)	115,000
Particulates	16,000

Source: Landesamt für Umweltschutz (LfU)

3. state and the business community: the ipp framework

IPP can only be implemented if the existing framework conditions are taken into account. Accordingly, the following review describes the existing legislation and agreements in this area with respect to the automobile industry and its partners. It thus delimits the area into which the IPP activities must be incorporated (as of: January 1st 2001).

3.1 Laws and Regulations

Like any other sector, the automobile industry is also subject to the traditional media-oriented environmental protection laws as well as to the Recycling Management and Waste Disposal ("Ecocycle") Act (KrW-/AbfG). They enable regulatory and supervisory intervention in production plants, in relation to product development and plant waste disposal, for example through plant permits, the prohibition of certain substances, obligations to notify or waste disposal. The traffic regulation code, which in the final analysis regulates how the user must handle the product, is by contrast particular to the automobile sector. The most important regulations for the automobile industry and its partners are listed below, including the EC Eco-Audit-Scheme, which is implemented by many companies in this sector and its suppliers, on a voluntary basis. The following KrW/AbfG regulations apply especially to the automotive sector.

Recycling Management and Waste Disposal ("Ecocycle") Act

This act is intended to contribute to the sparing use of natural resources and to ensure the elimination of waste in an environmentally compatible way. An absolute priority is the prevention of waste through measures such as in-plant recirculation or low-waste product design. The next step is the reutilisation of materials and energy. As with the manufacturer's product liability, the basic obligations of the Recycling Management and Waste Disposal Act are regulated by prohibitions or restrictions, labelling and take-back obligations.

- The Waste Oil Act (AltölVO) on the one hand regulates the processing and separate disposal of waste oils. On the other hand, it formulates the requirements designed for the reacceptance of combustion engine or gearbox oils. The reacceptance of waste oil at reception points has been set down as an obligation.
- The Reacceptance of Used Batteries and Accumulators Act (BattVO) establishes the reacceptance, reutilisation and disposal obligations for batteries. For batteries generally used in automobiles for starting, ignition and lighting, vendors must charge a deposit when selling them if no used batteries are returned, except if the batteries are already installed in the vehicles.
- The Regulation on the Surrender and Disposal of Old Automobiles in an Environmentally Compatible Manner (End-of-Life Vehicle Act – AltautoVO) obliges owners to surrender their obsolete car to a recognised recycling factory or to a recognised reception point. The operators of reception points, recycling facilities or shredder plants must handle old automobiles and their bodies in accordance with the requirements applying in each case in an environmentally compatible manner, reprocess them properly and without causing damage, and dispose of them in a way that is compatible with the common good.

Water Resources Law

The Water Resources Law (WHG) is designed to maintain the functions of water (surface water, coastal waters, groundwater). To meet this requirement, details are regulated in secondary regulations. They relate, for example, to the handling of substances which are water pollutants, the introduction of waste water from certain sources or the levying of surcharges on highly polluted waste water.

German Pollution Protection Act

The German Pollution Protection Act (BImSchG) together with its regulations determines the maintaining of air purity and noise protection in Germany. Its aim is to protect humans, animals, plants, soil, water and the atmosphere (as well as cultural and other assets) against the detrimental environmental effects of air contaminants and noise. In the case of industrial plants requiring special approval, it is also intended to prevent the incidence of hazards, significant disbenefits and nuisance. Accordingly, the BImSchG regulates the characteristics of industrial plants, substances, products, fuels, propellants and lubricants and makes stipulations on the nature and operation of vehicles. Further regulations relate to the construction of and alterations to roadways and railway tracks.

The various regulations passed in order to implement the BImSchG include a small number relating directly to the handling of motor vehicles:

- The 3rd BImSchV establishes the sulphur content of light heating oil for use as fuel and diesel fuel for the operation of engines.
- According to the 10th BImSchV (fuel grades), petrol for internal combustion engines may only be sold if its properties at least meet the requirements of DIN EN 228.
- The 16th BImSchV (Traffic Noise Protection) establishes pollution limits for the protection of local neighbourhoods against traffic noise, which must be complied with during construction or in the case of significant changes to roadways and railway tracks.
- The 19th BImSchV regulates the addition of chlorine and bromine compounds to fuels.
- The 20th BImSchV limits the emissions of volatile organic compounds during replenishment, refuelling and storage of petrol for internal combustion engines for both fixed and mobile installations.
- The 21st BImSchV limits the hydrocarbon emissions during the refuelling of motor vehicles and also applies to the construction, characteristics and operation of petrol stations.
- The 22nd BImSchV (Regulation on Pollution Values) includes definitions of the pollution limits for sulphur dioxide, airborne dust, lead, nitrogen dioxide and ozone. In areas where one or more of these pollution values are exceeded, plans for maintaining air purity must be drawn up.
- The 24th BImSchV (Sound-proofing Measures for Highways) establishes the nature and scope of the requisite sound-proofing measures for rooms in buildings in need of protection.
- Emission limits for internal combustion engines have been established in the 28th BImSchV.

The Technical Directives (TA) of the BImSchG are regulations which are binding on administrative bodies with respect to approval and monitoring

- The TA "Air" is designed to protect the general public and local neighbourhoods against the detrimental environmental effects of air contaminants, and includes preventive measures.
- The TA "Noise" specifies the requirements of the BImSchG with respect to avoiding detrimental effects on the environment caused by noise generated by industrial plants.

Law on Lead in Petrol

The law on the reduction of air contaminants caused by lead compounds in fuels for vehicle engines, or the Law on Lead in Petrol (BzBIG), limits the content of lead compounds and other metal compounds added in place of lead in fuels for petrol engines.

Law on Chemicals

The objective of the Law on Chemicals (ChemG) is to protect humans and the environment against the detrimental effects of hazardous substances and preparations. These include substances which represent a risk of explosion, accelerate ignition, are highly flammable, highly toxic, toxic, hazardous to health, corrosive, irritant, sensitising, carcinogenic, pose a risk to reproductive functions, alter the genetic makeup or are dangerous to the environment. It regulates their distribution, rating, packaging and labelling as well as the protection of employees when handling hazardous substances.

- The Regulation on Prohibited Chemicals (ChemVerbotsV) prohibits or limits the distribution of hazardous substances, preparations and products in accordance with the Law on Chemicals. However, the obligation to licence and notify, to provide information and to register, the prohibition on self-service as well as the required competence when handling hazardous substances do not apply to the delivery of fuels for petrol engines at filling stations and other refuelling installations.

- The Regulation on Hazardous Substances (GefStoffV) for protection against hazardous substances regulates the rating, labelling and packaging of hazardous substances and preparations.

- The Regulation on the Prohibition of CFCs-Halons prohibits the use of specific halogenated hydrocarbons that degrade the ozone layer in pressurized-gas packages, refrigerants, foams, cleaners, solvents and extinguishing agents, and their distribution.

Road Traffic Act

The Road Traffic Act (StVO) and the General Administration Regulations of the StVO, including the List of Offences Punishable by Fines and the Road Traffic Permit Act (StVZO), also include regulations relevant to the environment, such as, for example, the obligation of the owners to have exhaust gas emission tests performed on their vehicle. The limits for motor vehicle noise contained in the EU Directives have been incorporated in the StVZO. The last time they were made stricter was in 1995/1996.

The Criminal Code regulates driving bans, i.e., withdrawal of a driver's licence for reckless driving. The paragraphs relating to leaving the scene of an accident without permission, failure to give assistance, and dangerous behaviour in road traffic also relate to non-motorised road users.

The commercial transport of goods for a fee using motor vehicles of more than 3.5 tonnes is subject to the regulations of the Law on Transport of Goods by Road.

Road Tax Law

The taxing of passenger cars takes into account emissions of hazardous substances, emissions of carbon dioxide and the cubic capacity. Trucks are taxed according to their weight, hazardous substances and noise classifications.

Mineral Oil Tax Law

This law regulates the taxing of fuels. Substantially more than 50 per cent of the selling price consists of tax. The Ecological Tax Reform Law plans further increases in 2002 and 2003 by 0.06 DM per litre respectively.

Draft of the Environmental Code

Environmental law in the Federal Republic of Germany has developed over the years against the backdrop of various problems, so that today many special environmental laws, which are directed in most cases at individual environmental media, co-exist side by side. As a result of the historical development, there are often different nomenclature, regulatory approaches and weightings for individual environmental concerns, which are not always justified from an objective point of view. The planned Environmental Code is designed to remedy this situation by summarising, simplifying and harmonising the central provisions of environmental law. A further development resulting in integrated or all-embracing environmental protection is to be achieved by putting all environmental concerns on an equal footing. However, even when agreed by the various bodies, the draft available to date (UGB I) will still require adjustment in many respects. The German Ministry of the Environment will continue working on the UGB I as soon as a secure constitutional basis is available.

Current European Union Regulations

The EC Directive 98/70/EC (Auto Oil Programme) has established specific characteristic values for fuels for petrol engines and for diesel fuels for the years 2000 and 2005. Thus, starting from 1st January 2000, the maximum sulphur content for fuels for petrol engines is 150 milligram per kilogram (mg/kg) and for diesel fuels the maximum value is 350 mg/kg.

The EC Directive 99/96/EC EEC (exhaust gas emissions for light motor vehicles and heavy goods vehicles) makes the EC Directive 70/220/ and the Directive 88/77/EEC more stringent, and reduces the maximum allowable values for exhaust gases by another 30 (for 2000) and 80 per cent (for 2005), respectively. The emissions of gaseous hazardous substances from spark ignition engines which utilise natural or liquid gas are also lowered. It is planned that by 2005, passenger cars and minibuses that emit no more than 120 grams of carbon dioxide (CO_2) per kilometre, which corresponds to a consumption of 5 litres of petrol and 4.5 litres of diesel fuel, respectively, per 100 kilometres, are to be put on the market.

According to the EU Directive on End-of-Life Vehicles, starting from 2002, all cars licensed from this date onwards and, starting from 2007, all old cars, may be

returned at no cost. By 2006, at least 85 per cent of the average weight of an old vehicle must be reprocessed and at least 80 per cent reused or recycled. By 2015, these reutilisation targets are to be increased to 95 percent (reprocessing) and 85 per cent (reusing or recycling), respectively. As from 2005, proof must be furnished with the type approval that these requirements are fulfilled. Starting from 2003, the production of vehicles and components must avoid the use of the heavy metals cadmium, mercury, lead and hexavalent chromium, except for the special regulations listed in Annex 2.

The EU Directive 99/94/EC stipulates that marketing departments must provide the consumer with more information on fuel consumption and CO_2 emissions of new passenger cars.

The draft of a directive on limiting the tyre noise of vehicles, which has been discussed for several years, has not yet been passed. However, the types of tyres being on the market today probably already meet the limits contained therein.

EC Eco-Audit-Scheme (EMAS)

In order to make advances in environmental protection on a voluntary basis, the EC Scheme introduced in 1993 commits the participating companies, through the voluntary participation of commercial companies in a communal system for environmental management and environmental company audits (EEC 1836/93), to establishing an environmental protection management system at each location, and testing it regularly and systematically. The aim must be the steady improvement of corporate environmental protection by complying with the legal prerequisites and going beyond them. Independent environmental experts approved in Germany by the Deutsche Akkreditierungs- und Zulassungs-GmbH (German Accreditation and Approval) (DAU), which receives loans from the state and is organised by private industry, audit the system at regular intervals. After the first audit and at regular intervals, the public must be informed of the on-site environmental situation in a readily comprehensible manner by means of an environmental statement. The statement includes a description of the corporate activities relevant to the environment, numerical data on the emissions of hazardous substances, the amount of waste produced, the consumption of raw materials, energy and water and, where applicable, of noise and other aspects relevant to the environment. A revised version of the EC Eco-Audit-Scheme was enacted at the EU level in February 2001.

White Paper of the European Commission

The systems used to charge for transport route costs existing in the individual EU member states vary widely. They range from nine different charging systems for the railway infrastructure to different road use fees and road taxes and different value-added taxes and energy taxes. Since this situation not only leads to significant distortions of competition but also limits the incentives for reduced environmental costs and a more efficient infrastructure policy, the EU Commission wishes to harmonise the legislation and the charging systems.

Green Paper on Integrated Product Policy

On 7 February 2001, the European Commission presented a Green Paper on Integrated Product Policy. It proposes a strategy to "strengthen and refocus product-related environmental policies to promote the development of a market for greener products." The strategy is to use so far untapped potential to improve a broad range of products and services throughout their life cycle. Its focus is on a pricing mechanism that pays due regard to environmental issues. The Commission also suggests investigating a reduced VAT rate for products carrying the EC eco-label. This should be augmented by instruments to promote consumer demand for more environmentally compatible products and incentives for industry to produce more such products. The Commission intends to initiate a public debate on the proposed strategy and organise a number of consultative events with the participation of the interested stakeholders [www.europa.eu.int/comm/environmental/ipp/home.htm].

3.2 Standards and Technical Specifications

Standards are voluntary agreements entered into by private industry, drafted and agreed upon in a formal process with the participation of all parties interested in the issues involved. Although standards are not legally binding, owing to their importance in the marketplace they certainly represent an obligation to comply with their stipulations. Since the state, too, increasingly makes reference in its laws to existing standards (e.g. in measuring and test methods), they have a considerable effect on product development and the associated environmental aspects. Apart from international and national standardisation

DIN/ISO Standards Relevant to IPP	
DIN 33924	Guidelines for Carrying Out an Environmental Audit within Environmental Management
DIN 33926	Environmental Management – Product-Related Ecological Balance Sheets – Site-Specific Report Sheets
DTR 14062 (Draft)	Guidelines for the Integration of Environmental Aspects into Product Development
ISO 14001 f.	Environmental Management Systems
ISO 14020 f.	Environmental Labelling (see chapter 3.5 on "Environmental Labels", page 21)
ISO 14040 f.	Ecological Balance Sheets (see chapter 3.4 on "Methods", page 20)
VDI Directives Relevant to IPP	
VDI 2221	Methodology for the Development and Construction of Technical Systems and Products
VDI 2243	Construction of Technical Products Suitable for Recycling
VDI 2440	Emission Reduction, Mineral Oil Refineries
VDI 2588	Emission Reduction: Coating of Metallic Surfaces with Organic Substances
VDI 3455	Emission Reduction: Installations for the Series Coating of Automotive Bodies
VDI 3456	Emission Reduction – Repair Coating and Coating for Passenger Cars and Commercial Vehicles (Small and Medium-Sized Companies)
VDI 3479	Emission Reduction, Distribution Storage for Mineral Oil Far from Refineries
VDI 3780	Technical Assessment – Terms and Basics
VDI 4600 und 4600-1	Cumulated Expenditure of Energy
Company Standards Relevant to IPP	
Audi/VW Standard	Environmental Standard for Vehicles
Audi Standard	Technical Specifications "Environmental and Human Compatibility"
BMW Standard	Recycling Standard
MAN Standard	Environmentally Friendly Construction
Siemens Standard	Environmentally Compatible Products – Guidelines for Product Design
VDA	Motor Vehicles: Identification of Components Made of Polymer Materials

committees such as the International Organisation for Standardisation (ISO) or the German Institute for Standardisation (DIN), professional organisations such as the Society of German Engineers reg. Soc. (VDI) or the German Association of Automobile Manufacturers reg. Soc. (VDA) also publish guidelines and technical specifications for certain areas (e.g. VDI Directive 2243 "Construction of technical products suitable for recycling").

The German work on standards in the automobile sector has been coordinated and driven forward for 75 years by the efforts of the DIN Standards Committee for Motor Vehicles (FAKRA), to which vehicle manufacturers, suppliers, consumers, fleet operators and the scientific community have access. Since international standardisation has since become the priority, the ISO committees related to motor vehicles are reflected in FAKRA, which consists of approximately 60 specialist committees, study groups and ad-hoc committees. The fields of study range from long-standing problems such as standardisation of vehicle parts and test standards, to operational safety and road safety aspects such as lighting technology and the securing of loads and to current problems in data communication or innovative motive power systems (hydrogen-driven systems and fuel cells). Moreover, they increasingly include so-called system standards, which address the setting-up and implementation of management systems (ISO 9001 for quality, ISO 14001 for environmental protection). As early as 1992, DIN and the German Ministry of the Environment agreed that standardisation work should take into account environmental concerns, and established the bases of environmental protection (NAGUS) for the standardisation committee. Currently, one standardisation initiative relating to Design for Environment is tackling the development of guidelines for the integration of environmental aspects into product development.

In addition, all major manufacturers have developed so-called in-house standards (e.g. Siemens standard "Products Compatible with the Environment – Guidelines for Product Design", page 32; Audi standard "Environmental Standard for Vehicles", page 46), which contain binding prerequisites for suppliers.

3.3 Voluntary Measures

As early as in 1978, the German automobile industry promised the then German Minister of Economy that it would reduce the average petrol consumption of the motor vehicles sold in Germany by 15 per cent by 1985. This commitment was clearly surpassed with a figure of 23 per cent. By 1998, the automotive sector managed to lower the specific fuel consumption by another twelve per cent. Moreover, at the Berlin Climate Summit in 1995, it committed itself to lowering the fuel consumption of passenger cars sold in Germany, by 2005, by an average of one quarter – compared with the 1990 level. In order to protect the ozone layer, the German automobile industry promised in the Montreal Protocol of 1987 that by the end of 1993 it would discontinue the use of fluorinated hydrocarbons (CFCs) in all automobile air-conditioning systems, and sandwich-construction panels for insulation units.

Environmental Agreement for Bavaria

In October 1995, the Bavarian Government and the Bavarian business community concluded the Environmental Agreement for Bavaria, initially limited to five years, as a voluntary agreement aimed at intensifying environmental protection. This mutual agreement involving various topics and sectors marked a "first" for Germany. In October 2000, the environmental agreement was renewed, incorporating new objectives: Sustainable economic development in the 21st century – Agreement between the Bavarian Government and the Bavarian Industry of 23rd October 2000. [**www.bayern.de/stmlu/umw_pakt/**].

As regards voluntary participation in the Europe-wide Ecological Audit Scheme (EMAS), the German automobile industry is among the most progressive, and almost all domestic locations have now been validated.

Based on these successful examples of voluntary self-regulation, the European Council of Ministers and the European Commission, in conjunction with the European Association of Automobile Manufacturers (ACEA), has since promoted this instrument. Thus, by 2008, it is planned to reduce the average CO_2 emissions of newly licensed passenger cars and minibuses by 25 per cent and the emissions of the remaining pollutants by 75 per cent, compared with 1995. This means that the target value is a CO_2 emission of no more than 140 grams per kilometre, which corresponds to an average fuel consumption of approximately 6 litres per 100 kilometres for petrol engines and of 5.3 litres per 100 kilometres for diesel engines.

Worldwide Fuel Charter

The worldwide fuel charter drawn up by the European Association of Automobile Manufacturers (ACEA) jointly with the American Automobile Manufacturers Association (AAMA), the Japan Automobile Manufacturers Association (JAMA) and the Engine Manufacturers Association (ema), was concluded in December 1998. This document is also supported by Canada, China, Korea and South Africa and contains, for the various regions of the world, minimum requirements (depending on motorisation levels in the country concerned) relating to fuels for petrol and diesel engines.

Environmentally Friendly Disposal

In the "Voluntary Self-regulation on Environmentally Compatible Management of End-of-Life Passenger Cars" (FSV) of 1996, automobile manufacturers, importers and related sectors undertake:

- to establish a comprehensive take-back and reprocessing system for old vehicles and used parts recovered during the repair of passenger cars,
- to recycle end-of-life vehicles in an environmentally compatible manner (draining of fluids, selective dismantling),
- to reduce the amount of waste requiring disposal (by 2002 to less than 15 per cent, by 2015 to less than 5 per cent).

Further commitments relate to the continuous improvement of reprocessibility (design for recycling), the reacceptance of old cars on customary market terms, and the reacceptance at no cost of all vehicles up to twelve years old, licensed after the introduction of the disposal certification. In order to achieve the objectives mentioned,

experts from representative associations, industry and research are collaborating in the End-of-Life Vehicle Committee (ARGE-Altauto), specially founded for the purpose, which reports to the German Ministry of the Environment and the German Ministry of Economy on its activities every two years.

Activities within the Chemical Industry

The "Self-regulation on Material Data" of the Association of the Chemical Industry reg. Soc. (VCI) requires those of its member companies whose yearly production exceeds one tonne, to gather meaningful information on the effects of the substances used, including the process materials, and make it available.

"Responsible Care" is the name of a worldwide voluntary initiative of the chemical industry which has the aim of consistently improving health and environmental protection as well as safety within the companies. The programme comprises the areas of environmental protection, product responsibility, occupational health and safety, plant safety and risk prevention, transport safety and dialogue. The managements of the majority of German chemical firms have signed up to implementing the demanding programme established by the VCI for this purpose.

With their "Transport/Accident Information and Assistance System" (TUIS), the chemical industry assists the police, fire brigade and other authorities throughout Germany, by providing rapid, expert and "red-tape-free" support from factory fire services and experts in the event of accidents involving chemical products.

Activities of the Electrical Industry

Within a project "Ecological Balance Sheets" supported by the German Ministry of Education, Science, Research and Technology (BMBF), Siemens together with the Fraunhofer Institute for Packaging Technology, and in coordination with the Central Association of the Electrical Engineering and Electronics Industry (ZVEI), has drawn up an ecological balance sheet for two complete products (relay, printed circuit board) which serves as an example for the sector as a whole.

By standardising the term ETN (Equivalent to new), standard requirements for employing used components in new products have been created – a measure which contributes significantly to the sparing use of resources and a reduction in waste.

The "Round Table on Electronic Life Cycle Analysis" created by the ZVEI is designed for the exchange of opinions and information. In conjunction with other sectors and institutions, the association aims at making maximum use of the potential ecological improvements during the entire life cycle of electronic products.

3.4 Methods of Ecological Assessment and Optimisation

A whole series of tools and methods which may be used within the IPP are already in existence. Particular mention should be made of those designed for the analysis and assessment of relevant environmental aspects during the individual stages of the product life cycle or in the entire life cycle. The instruments offer an approach to obtaining better and more precise information on the environmental compatibility of products. Some of these have been standardised worldwide and therefore provide the basis for a generally recognised procedure. However, their implementation in respect of complex products such as cars often involves major outlay, which is why some instruments focus in their analysis only on certain environmental aspects. In the case of comparative statement especially, the order of the day is to proceed with care. In standardised methods such as, say, ecological balance sheets, this is ensured by means of a mandatory critical review. The results of such studies can never absolve politicians or industry of the need to make decisions as to what is or is not compatible with the environment.

Analysis

Area under Consideration	Tools and Methods
Oriented towards the life cycle, certain environmental aspects only	Cumulative Expenditure of Energy (KEA), Material Intensity per Service Unit (MIPS), Design for Recycling
All environmental aspects, certain life cycle stages	Environmental Management Systems, Test for Compatibility with the Environment, Assessment of Technological Consequences
All aspects relevant to environment and sustainability, integrated approach	Product Sustainability Assessment, Design for Environment, Ecological Balance Sheet, Product Line Analysis

Cumulative Expenditure of Energy

The cumulative expenditure of energy (KEA) is the sum of the expenditure of energy on the production, utilisation and disposal of a product. It is a characteristic quantity allowing potential savings in energy to be assessed and products and services to be compared in terms of energy.

The KEA includes the expenditures of energy for the following stages:

- Extraction, processing, preparation and scheduling of manufacturing, auxiliary and raw materials, and the means of production for the preparation, utilisation and disposal of products.
- Transport expenditure for manufacture, auxiliary and raw materials and the means of production for the product, associated services and spare parts, and for its disposal.

A KEA is made up of an element representing the expenditure of process energy, which includes the final energies power, heat, light etc. weighted by the corresponding utilisation ratio of making it available, a proportion made up of material consumption of energy carriers (fossil resources) and a proportion made up of material-bound energy contents (combustible resources other than fossil resources). The KEA is determined by performing a process chain analysis and/or an energy-related input/output analysis. The method is described in VDI Directive 4600. Directive 4600-1 contains various examples illustrating the determining of KEA values.

Material Intensity per Service Unit

The material intensity per service unit (MIPS) is a method developed by the Wuppertal Institute for Climate, Environment and Energy. It deduces the ecological damage potential of a product from its specific consumption of resources, thus taking no account of emissions into air and water.

The MIPS is calculated by dividing the material input required over the entire life cycle to prepare the product in question, by the service unit (measure of product utilisation). The material input, often referred to as the "ecological backpack" of the product, comprises the categories abiotic (non-renewable) resources, biotic (renewable) resources, soil movements in agriculture and forestry, water and air.

Environmental Management Systems

Even though ecological management systems are assessed by different testing methods (e.g. validation according to EMAS, certification according to ISO 14001), they are identical with respect to their structure and implementation and their aim of continuously improving product-related environmental protection. Unlike the ISO, EMAS requires public reporting via an environmental statement which must contain essential details regarding the ecological situation at the location. Conformity with the law, that is, complying with the currently valid statutory provisions, is an essential condition, especially in the case of EMAS, for validation and registration in the pan-European site register. Once this has taken place, the companies may display the EC emblem on their letterhead or on other publications.

Environmental Compatibility Test

The environmental compatibility test (UVP) comprises the early and comprehensive determination, description and assessment of the effects of a project (e.g. road construction) on humans, animals and plants, soil, water, air, climate and landscape, including their particular interactions, and on cultural and material assets. The essential feature of this test is that its implementation should involve the public (UVP Law of 12 February 1990).

Assessment of the Technological Consequences

Assessment of the technological consequences (TFA) involves the planned, systematic and properly organised process of analysing the state of an art and its potential for development to permit the indirect and direct assessment of technological, economic, health, ecological, human, social and other consequences of this technology and possible alternatives (cf. VDI Directive 3780 "Technology Assessment – Terms and Basics").

Environmental Efficiency Analysis

Environmental efficiency analysis makes it possible to compare the economic and ecological advantages and disadvantages of a number of product and process solutions. To this end, an "ecological fingerprint" is taken, encompassing the categories of energy consumption, emissions, material consumption and risk potential, augmented with economic data such as material, energy

and process costs, including all secondary streams. Each category embraces a large number of detailed individual criteria which are weighted using so-called relevance factors. These are derived from qualitative factors influenced by society and quantitative factors based on statistical statements. The positioning of the two values "overall ecological impact" and "total costs" in a twin-axis diagram provides information on the environmental efficiency of the product or process solution. The weighting of the relevant factors is always made on a subjective basis.

Product Sustainability Assessment

The Product Sustainability Assessment (PROSA) developed by the Ecological Institute reg. Soc. (Ökoinstitut e.V.) in Freiburg is a strategic tool which helps companies determine the sustainability of product systems. It comprises the following steps: system analysis, determination of the sustainability references and selection of indicators, application of the indicators to products, identification of influencing variables and the deriving of options for action.

Design for Environment

The expression Design for Environment refers to a method of integrating environmental aspects into product development. It takes into account the entire life cycle, with the aim of minimising the ecological impact caused by products. This can be achieved, for example, by means of functional optimisation, reduced material use or lengthening of the service life of the product. An ISO study group is currently working on a technical report regarding the corresponding guidelines (ISO DTR 14062).

Ecological Balance Sheet

According to ISO 14040 ff, ecological balance sheets take the form of a listing and assessment of input and output streams and of the potential effects on the environment of a product system in the course of its life cycle. Its aim is to determine as comprehensively as possible which environmental influences are associated with the products, processes and services under consideration.

The term "product system" was introduced to delimit the product itself from its life cycle, as it were. It comprises the following stages: extraction of the raw materials, preparation of the product, utilisation of the product, maintenance and repair, recycling, disposal, energy supply and consumption, transport of raw materials, of the product itself and other transport activities.

The very first step which ultimately decides on the assessment and results of the product examination is to establish the investigation framework, including the environmental effects to be considered. Specifically, the quantities to be established are the significant influencing variables (material and energy flows), the geographical and chronological scope of the of investigative framework, the delimiting criteria and the extent of the environmental aspects under consideration.

The investigation framework generally comprises the entire life cycle, starting from the extraction of raw materials and ending with physical disposal. An ecological balance sheet comprises the following essential steps:

>> Target definition
Determining the target and the scope (e.g. functional unit = product system, system limits) of the ecological balance sheet and explaining its purpose and intended application.

>> Material balance sheet
Collection of data and methods of computation for quantifying all relevant input and output streams of the product system under consideration. The resulting data is used for the assessment and interpretation of effects.

>> Assessment of effects
The third stage aims at the assessment of potential effects on the environment (e.g. greenhouse potential, consumption of energy and resources) using the results of the material balance sheet. The choice of environmental effects to be taken into consideration depends on the purpose of the analysis.

>> Interpretation
Summarising the results of material balance sheet and assessment of effects in order to draw conclusions and issue recommendations.

3.5 Environment-Related Product Labels

Interest in environmentally-related product labels issued by independent institutions is growing, not only in Germany. Companies that offer products bearing environmental labels make a contribution to product-related environmental protection and can thus achieve a competitive edge. For consumers, the labels are a welcome and in many cases essential aid to purchasing decisions [www.label-online.de].

Environmental labels are voluntary and positive identification labels for products clearly demonstrating superior environmental characteristics to comparable products used for the same purpose. Both the European environmental label and national labels such as the "Blue Angel" or the "Nordic Swan" are subject to the standard for environmental labels and declarations (ISO 14024, type I Environmental labelling, Basics and Methods), which establishes the modalities for their allocation.

European Eco-Label

The Euro Flower, created in 1992 as European Eco-Label, is intended to identify ecologically safe products for the benefit of consumers in 15 EU countries, Norway, Switzerland, Liechtenstein and Iceland. At present, labelling for 15 product groups may be obtained by applying to the competent authority in each country. In Germany, this is the Federal Environmental Agency or the German Institute for Quality Assurance and Labelling reg. Soc. (RAL). It is generally anticipated that work on the European Eco-Label will in future increasingly be linked into the efforts of the EU Commission to set up the IPP in Europe [http://europa.eu.int/ecolabel].

German Eco-Label

The first eco-label was the "Blue Angel" which was set up in 1992 and has been the model for many other national eco-labels. At present, it appears on some 4,000 products, and is issued for 86 product groups upon application to the above-mentioned institutions.

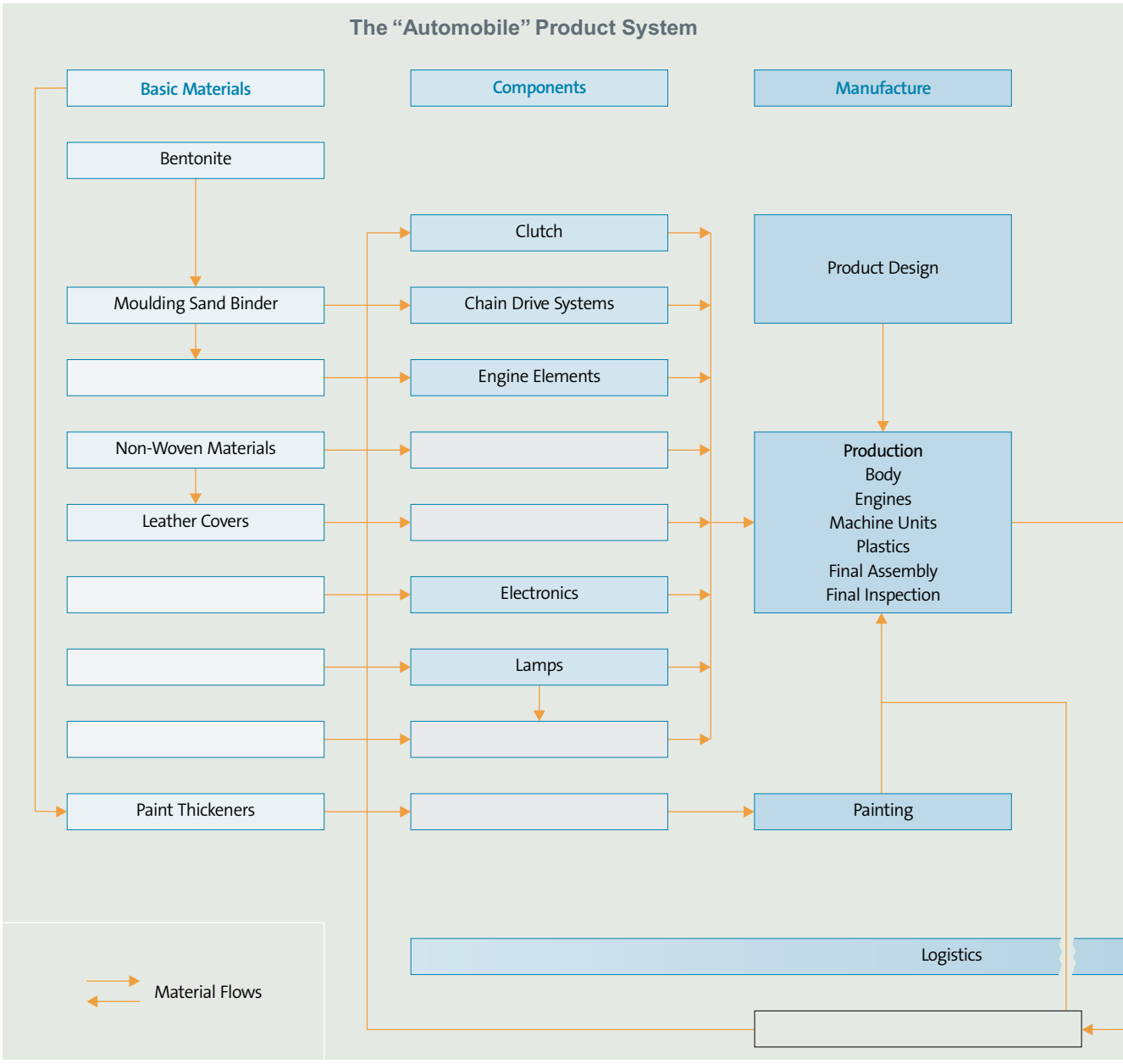
To date, the following products and services within the automotive industry and its partner sectors have been awarded the eco-label [www.blauer-engel.de]:

- Low-noise commercial vehicles, public-service vehicles and buses,
- Remould tyres,
- Low-noise and fuel-saving tyres,
- Car-sharing models,
- Car wash systems equipped with water treatment units and water recirculation systems,
- Ecocards issued by local public passenger transport authorities, including environmentally-oriented fare schemes targeted at motorists,
- Reusable transport packaging,
- Finished products made of recycled plastics; these comprise pure types, pure grades or similar grades of moulding compositions made of used products, produced as waste in households, agriculture, businesses and industry,
- Paints low in hazardous substances, including paint formulations based on water-soluble systems,
- Cadmium-free hard solders according to DIN 8513 Parts 1, 2 and 3 at operating temperatures of 600–850 °C,
- Flush water additives compatible with sewage treatment plants used in the mobile toilets of camper vans and leisure craft, as well as on construction sites, at motorway rest areas, major public entertainment events, in long-distance coaches, aircraft, long-distance trains and on passenger cruise vessels.

4. product life cycle: a practical examination

The challenge of an IPP is to take the existing mix of instruments, that is instruments of industry, state regulations, self-regulation by associations, consumer information, etc., and to use them strategically in pursuing an ecologically oriented product policy. A prerequisite here is communication between the stakeholders in industry, the state and among consumers. It should be pointed out that IPP is not an instrument of the political world nor of industry but rather the linkage of these two areas, plus the consumers, with the aim of initiating ecological product innovation for sustainable development, in other words, approaching optimisation from the product side and thus also following the economic life cycle.

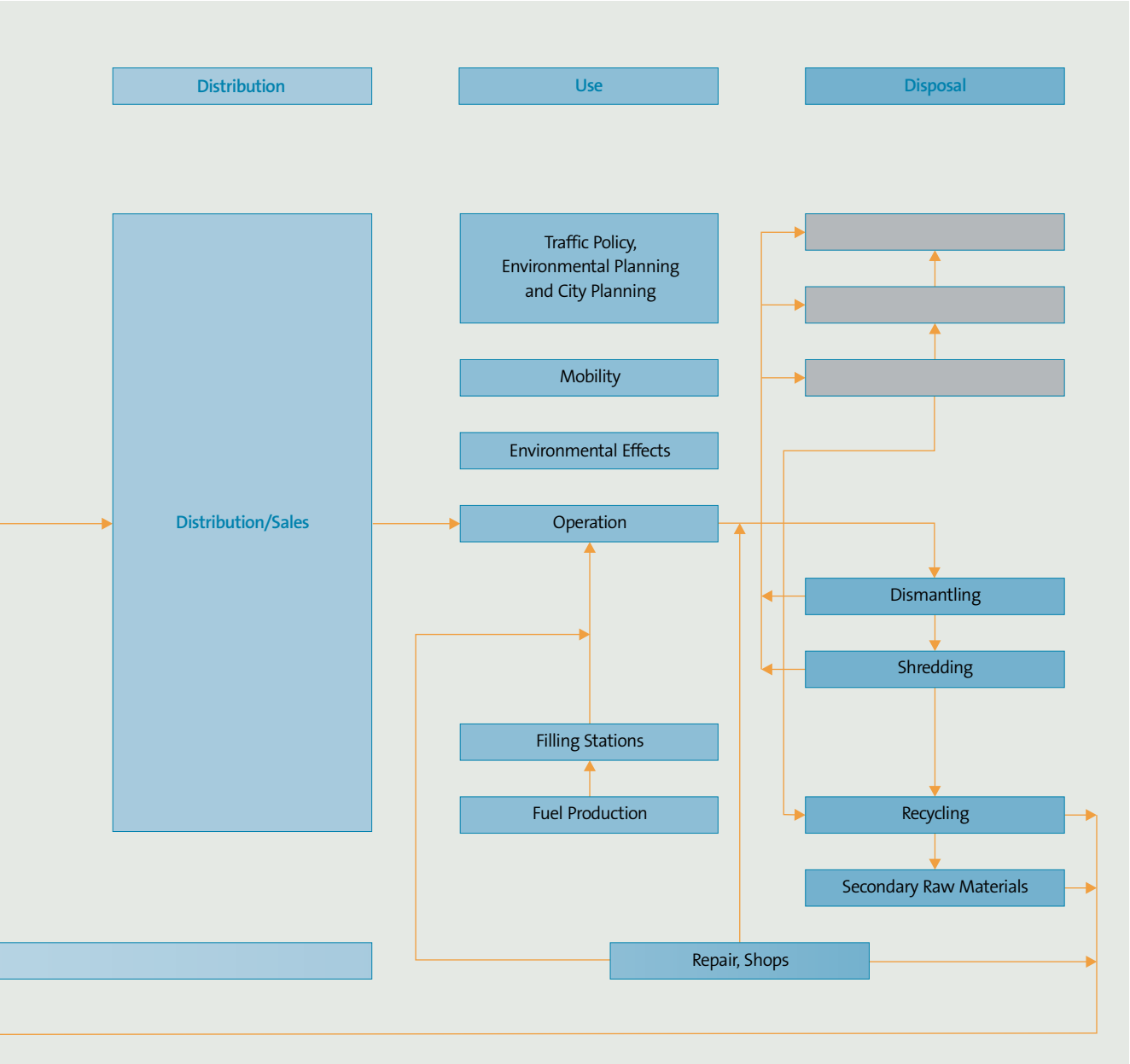
In the diagram below, we follow the product life cycle "from the cradle to the grave", using a number of Bavarian companies as examples, to elucidate the interaction between stakeholders, entitlements, demands and instruments. The aim is to provide an insight into the existing "tool kit" and at the same time to identify interfaces that



represent important points of approach to IPP. At the same time, it is important to develop in each stakeholder a deeper understanding of the complex product system "Automobile" as a basis for future efforts aimed at progressing towards sustainable development via communication, cooperation and integration.

Note for the reader:

Chapter 5 contains a matrix in which the instruments currently employed in the automobile product system are sorted according to IPP dimension to provide a rapid overview. Wherever these instruments are referred to in the subsequent text they are underlined for easy location.



extraction of raw materials using bentonite as an example

Bentonite is used in many sectors: in the foodstuff industry for refining and purifying cooking oils, in the pharmaceutical and cosmetics industry as a raw material in pharmaceuticals and binders and in the mineral oil industry for refining. The automotive sector uses the adhesive and binding capacity of bentonite for preparing moulding sand binders and for producing metal casting moulds. This clay-like material is also used for thickening and emulsifying paints and coatings. Süd-Chemie AG extracts approximately 340,000 tonnes of bentonite per year from eight clay pits in the Moosburg, Mainburg and Landshut region.

Requirements and Regulations

Since the extraction of bentonite is subject to mining law, the purchase of a tract of land must be followed by initiation of the mining law approval process, known as a working procedure plan, which is regulated by the competent mining authority and subordinate technical authorities such as agriculture and forestry authorities. Once the operational permit has been granted, roads and supply facilities can be constructed. Humus, loam and the material initially excavated are removed, and stored separately for the subsequent reinstatement of the worked-out pit.

Instruments of Product Development and Planning

The Süd-Chemie mining plant was one of the first mining companies in Europe to take part in EMAS. The focus of the environmental activities at the location is the regular training of employees, designed to make them aware of possible sources of danger and of behaviour compatible with the environment. The factory further promotes consistent waste management.

Interfaces

Suppliers
Extraction of the raw material calls for heavy machinery such as bulldozers, excavators, dumper trucks and earth movers. When acquiring the extraction and transport vehicles, Süd-Chemie ensures that they reflect the current state of the art. They thus only use vehicles with low-emission and sound-proofed diesel engines and machinery.

Customers
The majority of the bentonite extracted goes to the company-owned clay chemical factories in Moosburg and Kehlheim.

Production: Sequences and Processes

The extraction of bentonite takes place exclusively by means of open-cast mining. First, overlying strata 30 metres or more deep must be removed using giant machines. Bentonite itself is extracted with small excavators, and then transported by truck to the various Süd-Chemie clay chemical plants. Once the deposits of a pit have been exhausted, the company ensures that the areas worked are recultivated and reinstated to their original condition.

Product: Composition

Bavarian bentonites are the weathered products of acid volcanic glass tuffs formed by the action of wind and deposition in lakes and areas of stagnant water over millions of years. The raw material consists predominantly of montmorillonite, a crystalline, layered aluminohydrosilicate. The specific properties of bentonite derive from the shallowness, flexibility and large surface area of the montmorillonite crystals. The chemical composition and the mineral structure of the Bavarian bentonites differ, but a noteworthy feature is their high water content of on average 35 to 40 per cent in the pit-wet state.

Optimisation

Since the extraction of natural mineral substances constitutes a serious interference with nature, the environmental management systems established at the Süd-Chemie sites is intended to help minimise the effects and risks involved. Of particular environmental relevance is the transport of the raw material: every day 1,400 tonnes of raw bentonite are transported by truck from the pits to the clay chemical plants, an activity inevitably generating exhaust gas and noise. Over the last few years, the company has managed to lower its transport volume by 50 per cent by means of improved logistics and the construction of further feeder roads. This has lowered the specific fuel consumption per tonne of raw bentonite by 20 per cent.

Since diesel fuels and hydraulic oils may endanger the groundwater, the engines and hydraulic lines of the earth-moving machines are equipped with protective sumps. Exposed hydraulic lines are additionally protected by means of a double jacket. The use of biodegradable hydraulic fluids is currently being tested.

The largest bentonite pits in Germany are located west of Landshut. Extraction takes place exclusively by means of open-cast mining.

moulding sand binder and aluminium castings

The moulding sand binder, composed of alkali activated clay mineral (bentonite), is an essential component in the preparation of moulding sand. It is required in foundries for the production of casting moulds for engine blocks, crankshafts and camshafts.

Product Requirements

Moulding sands must satisfy various requirements: they must be easy to process, fill the moulding boxes uniformly and be compressible to give solid moulds, at the same time as being flexible. To allow moulding gases to escape, a certain porosity is necessary. The moulding sands must also be reusable and resistant to burning and sintering.

Instruments of Product Development and Product Planning

Süd-Chemie has implemented an Integrated Management System (IMS) which encompasses the areas of quality, occupational health and safety and environmental protection. All three areas are documented in a manual containing the appropriate instructions. The IMS Procedural Guideline "Product, Process and Plant Developments" contains, among other details, the prerequisites for environmentally compatible procurement. The company maintains a central material database containing all current, tested and released safety data sheets, hazardous substances labels and accident leaflets.

Production: Sequences and Processes

The extracted raw bentonite is activated by alkali using an ion-exchange reaction, in other words, the alkaline earth metals of montmorillonite are replaced by alkali metal ions. To this end, sodium carbonate is added to the raw bentonite, the resulting mixture is intensively kneaded and then milled and dried.

Interfaces

Suppliers
The raw bentonite is supplied by the Süd-Chemie AG mining factory.

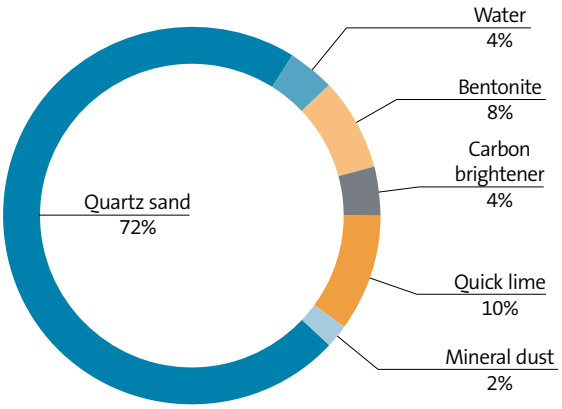
Customers
Product brochures, safety data sheets and technical articles provide information on the handling, use and final storage of the raw material. In addition, the company offers advisory consultations, and regularly organises symposiums.

The main components of moulding sand, which is processed by the foundries themselves, are quartz sand and water, in addition to bentonite. The moulding sand is compressed to provide models which form a negative of the later casting. Usually, two models are needed (e.g. upper and lower part) to enable a mould to be formed by clamping the two mould halves together. The casting is then removed. When the casting is removed, the mould is destroyed. The moulding sand is returned to the processing facility and, after the addition of fresh bentonite and carbon brightener, it is reused. A reutilisation ratio of up to 99 percent can be attained, though the general level lies between 95 and 98 per cent.

Product: Composition

The majority of bentonite used in foundries is mixed by Süd-Chemie in a ready-to-use state, according to customer requirements. Further additives serve to increase its plasticity and surface quality. Thus, for example, carbon brighteners ensure that the casting can be easily removed from the mould and its surface remains smooth.

Composition of the Moulding Sand



Optimisation

Süd-Chemie has developed a new hybrid moulding sand binder consisting of several raw sand components which reduces the amount of bentonite used in the moulding sand by up to 25 per cent. In the moulding sand cycle, this results in a reduction of 20 to 30 per cent in the new sand required, and in individual cases a cut of up to 50 per cent. The volume of waste is also reduced accordingly. Moreover, the new binder system extends the technical range of application for bentonite-bound moulding sands.

paint thickeners

To improve the flow properties of the paints and coatings used in the automotive sector, so-called rheology additives are added. The thickener OPTIGEL manufactured by Süd-Chemie serves to stabilise water-based paint systems. The addition of thickener increases the shelf life and reduces paint consumption.

Product Requirements

Paint thickeners must be easily dispersible in an extremely fine form, should not affect the colour of the paint and be pH-resistant. They should give the paint high stability, so that no sediment is formed upon storage and formation of droplets such as paint run-off – even on perpendicular surfaces – is prevented during painting. This enables thick coats to be applied in a single operation.

Production: Sequences and Processes

The starting material for OPTIGEL is natural bentonite which is activated by alkali, milled and dried (see chapter on “Moulding Sand Binder and Aluminium Castings”) or synthetically prepared hectorite. The paint thickener is only mixed with water after arrival with the customer. This is followed by the addition of coloured pigments, fillers, coloured additives and binders.

Product: Composition

The main constituent of the paint thickener is bentonite. The product is modified according to customer requirements.

Optimisation

The gelling effect of the paint thickener can be selectively modified, for example by means of an organophilic coating of the bentonite. For transparent gels, synthetic layered silicates have been developed. These are synthesised hydrothermally from an aqueous solution of alkali metal silicates and magnesium salts.

Instruments of Product Development and Product Planning

Süd-Chemie has established an Integrated Management System: All management systems include the structural elements of strategy specification, target definition, documentation, management and control as well as employee training. In order to satisfy the requirements stemming from existing management systems or those still to be introduced in the areas of personnel, finance, risk and safety, occupational health and safety, quality and environmental protection in a smooth and efficient manner, it is appropriate to link the various systems together. To this end, the procedures from EMAS, ISO 14000, ISO 9000 ff., VDA 6.1, British Standard 8800, industrial agreements such as Responsible Care or customer-specific requirements must be used as an overarching structure. This makes the objectives and testing of all company performances transparent at all levels and comprehensible to the employees. At the same time, the regulations must be incorporated into the operational sequences of the business processes.

Painting puts the finishing touches to a car. The additive OPTIGEL ensures that paints and lacquers are easy to handle and clean to use.

Interfaces

Suppliers
The raw materials used come from various mines worldwide or are of synthetic origin.

Customers
The paint manufacturers supplied by Süd-Chemie receive information on the handling and use of the products. The company provides safety data sheets and product brochures and holds advisory consultations. The environmental statements published by the company sites provide information on the environmental activities and goals of the company. In general, the use of OPTIGEL does not produce waste.

leather seat covers

Comfortable seating is vital on long car journeys. However, functionality and ergonomics are not the only considerations. Due to the fact that seat covers have to withstand considerable stress over the life cycle of a car, they must satisfy high quality requirements. For seat covers, head rests and centre armrests, Audi AG, Ingolstadt, [www.audi.de] also uses microfibres and leather, in addition to other materials.

Product Requirements and Regulations

The primary requirement for car seat covers is durability. In addition, the leather must be resistant to moisture, cold and heat, and be light-fast. The cover material is subjected to particular stress as a result of the constant relative motion between seat and driver. The leather covers must not contain any ecologically damaging residues or give off unpleasant odours.

Instruments of Product Planning and Product Development

In order to optimise preproduction operations, the automobile group is currently testing a pure vegetable tanning and colouring agent obtained from rhubarb root. The Technical University for Agriculture in Bernburg (Thuringia) has been commissioned by Audi to cultivate rhubarb on a two-hectare site, and to observe strict environmental compatibility. The harvested rhubarb is sent to a leather producer in Saxony, with whom the company has been collaborating for some time and who – like all other suppliers – is committed to complying with the "Environmental Standard for Vehicles" issued by the VW group.

Interfaces

Suppliers
The leather suppliers selected by Audi have committed themselves to using exclusively tanning processes free of heavy metals. When developing new environmentally compatible processes, they work in close conjunction with the manufacturing company and major chemical companies.

Customers
The demand for high-quality leather covers is increasing, while customers are increasingly discriminating with regard to colour, structure and "feel".

Production: Sequences and Processes

The animal hides used at Audi come exclusively from foodstuff production, and are predominately of European origin. Before being made into seat covers, they must undergo a wide range of processes in the tannery. These include, firstly, appropriate storage or preservation methods. Whereas the hides were formerly stored using large quantities of common salt, the leather manufacturer now generally keeps the hides in cold-storage depots, thus contributing to a reduction in the salt content in the waste water. This is followed by the removal of dirt, preserving salts, tissue residues and hair.

Tanning converts the animal hide into a largely decay-resistant, stable material. The tanning process generally makes use of chromium sulphate. The bluish colour thus imparted to the leather has led to this treatment being called the "Wet Blue Process". Since this treatment

produces large amounts of chromium-bearing manufacturing waste which is deposited in landfill sites, Audi uses glutardialdehyde, which is biodegradable and gives the leather a yellowish to white hue (Wet White Process).

After tanning, the leather is dehydrated, brought to a uniform thickness and any remaining uneven patches eliminated. It is then subjected to penetration dying with water-soluble dyestuffs and dried under exceptionally gentle conditions, after which it is tumbled and undergoes a number of finishing processes. The "finishing" gives the leather its final appearance. Depending on the quality requirements, it receives a lustrous or mat, uni- or multi-coloured, smooth or grained surface. The water-soluble lacquer is applied so thinly that the optical properties are not impaired. So-called "natural leathers" are not coloured but instead retain their natural actively breathing surface, though they are somewhat less durable. After undergoing a final quality check, the leather is passed on to dispatch and from there on to the car seat manufacturer.

Optimisation

Where technically feasible, the animal hides are nowadays cooled instead of preserving them with salts which contaminate the waste water. Since 1990, Audi has avoided the use of the tanning substance chromium sulphate, so that neither heavy metal residues nor carcinogenic chromium VI are formed. A tanning and dyeing process using rhubarb root extracts, which is currently at the testing stage, has the advantage that unlimited quantities of the tanning substance can be produced by means of agricultural methods. Moreover, in contrast to other naturally obtained tanning substances, lengthy transport is not necessary. However, the range of colours is limited, since due to the natural colour of rhubarb, only brown hues are possible. The range can be extended to include black, by adding carbon black pigments.

An alternative technology is currently being tested, which involves the extraction of a tanning and colouring agent for leather from rhubarb roots.

non-woven materials

Non-woven materials are used in the interior covering, for example in the headlining, in the luggage boot lining or for the internal padding of trim panels. Textile fibres are also needed for seats, armrests and headrests. The non-woven materials supplied by Sandler Vliesstoffe GmbH [www.sandler.de] are made entirely of polyester, and can be used for all the purposes described.

Product Requirements and Regulations

The design of a three-litre car calls for lightweight materials, since this is the only method of achieving a reduction in fuel consumption. Nevertheless, the non-woven materials must have outstanding form-retention properties, and offer long-term heat resistance. For the headlining, boot and door cover panels, good airborne sound-absorption qualities are essential, to deaden internal noise and external sources such as rain or wind. For armrests and seats, the non-wovens should have high elasticity as well as good microclimatic properties. Also important is suitability for modular assembly, since modern roof upholstery systems integrate communication systems, air ducts and cable conduits. Recyclability in accordance with the EU Directive on End-of-Life Vehicle Management is not least of the requirements.

Instruments of Product Planning and Product Development

Within the quality management systems, design control is also addressed in the management manual. This includes not only design and development planning but also the design prerequisites.

Interfaces

Suppliers
The raw materials (fibre mats) are assessed by Sandler according to environment-related process engineering criteria.

Customers
Total Quality Management (TQM), which has been implemented in 1993, specifies the product requirements. Sandler is certified according to ISO 9001 and since 1996 has also boasted EMAS validation as further evidence for its customers.

Quality Management

At the beginning of the 1980s, international quality management standards were developed (EN ISO 9000 class of standards). Quality management as part of comprehensive management is centred on customer satisfaction and commercial success.

Production: Sequences and Processes

The non-wovens are supplied in bales weighing approximately 250 kilograms and are treated by Sandler, in other words, solidified. This may be achieved in various ways: either mechanically by needling, thermally by application of pressure and temperature or chemically by means of binders. In thermal solidification, the polyester non-wovens are heated in a stream of air, and shaped using a cold pressing tool, during which process a pattern can be applied. Dimensionally stable pressed parts are processed by the cold press method to give dimensionally stable elements with a component thickness of more than 15 mm. Preheating and cold forming allow very deep deformations to be achieved – a method which is also very cost-effective.

Product: Composition and Design

The non-wovens consist of 100 per cent pure polyester grades, which facilitates dismantling and recycling. Preformed polyester non-wovens are designed to reinforce foam seats or rests. They may be applied externally or "foamed in". Almost all trim panels in the car have internal padding of polyester non-woven material. Film-coated non-wovens and others with grey overprinting on one side extend the possible applications. Carrier components containing permanently joined polyester non-wovens are also used for headlining systems. Communication elements for telephone systems, speakers or displays as well as air ducts for air-conditioning, handles or lights can be directly integrated into these moulded parts. This makes it possible to assemble the roof outside the vehicle. The fully prefabricated headlining system can then be installed in the vehicle in one operation.

Optimisation

Changing the fibre parameters allows the properties of polyester non-wovens to be varied. Thus, for example, coarse, thick and soft fibre structures permit high airborne sound absorption capacity coupled with low weight. If the cross-sectional shape is also modified, sound-absorption can be further improved. Combination with high-density layers creates powerful spring/mass systems which are 30 to 50 per cent lighter than customary materials.

Non-woven residues from production can be immediately reused after undergoing mechanical defibrillation. The polyester products can be removed from old cars, melted and directly reprocessed. Multi-stage chemical reprocessing produces pure polyester grades – a process which can be repeated as often as desired without adversely affecting usage properties.

Non-wovens from Renewable Resources

The interior trim panels of a vehicle offer good opportunities for the use of renewable, that is environmentally beneficial resources. Thanks to their low density, natural fibres result in a reduction in the weight of the overall vehicle. They are permeable to air, noise-deadening and can absorb moisture, substantially improving, for example, seating comfort. Since they are not as brittle as polyester non-wovens, they minimise tool-wear during manufacture. Low raw material prices and energy savings during fibre production are additional advantages. In order to test the use of flax fibres in internal door trim panels, BMW AG has initiated a pilot project in conjunction with a supplier, a manufacturer of non-wovens, the Bavarian Ministry of Agriculture and a flax management company which is a member of the Central Agrarian Raw Material Marketing and Development Network (C.A.R.M.E.N. reg. Soc.) [**www.carmen-ev.de**].

The disadvantages of flax fibres include storage requirements, due to the harvest cycles, varying quality due to climatic conditions, the lack of quality standards, non-optimised methods of production and the absence of logistics concepts. Since textiles from renewable resources are sensitive to moisture and micro-organisms, it is necessary to add binders, which in turn makes the recycling of the raw materials more difficult. The recycling of materials involves defibrillation of the structural component using a spiked roller, after which the material is reused. Chemical degradation of the binder is still being studied. A clear advantage of natural fibres is the fact that they can be incinerated leaving virtually no residue – an argument not considered in the EC Directive on End-of-Life Vehicle Management, which limits the percentage of waste to be incinerated or going to landfill to 15 per cent.

For use in interior lining panels: Non-woven materials made of 100 per cent pure polyester grades.

electronic engine management components

Between 25 und 30 per cent of the manufacturing costs of a car are attributable to the electronics. This comes as no surprise, with the number of electronic components increasing all the time. They occur not only in the running gear and navigation technology but also in the engine.

Environmental aspects play a role on various levels:

- Product composition: materials, weight, ease of disassembly
- Functioning: e.g. engine management – Optimisation of the combustion process
- Production: manufacture, if possible, without significant environmental impact

Engine management makes a significant contribution to optimising petrol consumption and reducing emissions. Siemens Automobiltechnik in Regensburg is committed to the construction of systems and components compatible with the environment and suitable for recycling. The Development Division as well as the Construction and Production Division are also responsible for these aspects.

The basic principle is that, in meeting the customers' requirements and their technical specifications, environmental protection during product design is also taken into account. However, it may be necessary to assess different alternatives, if the product must meet highly specific requirements, for example due to its ultimate function within the vehicle. A solution is then arrived at in close cooperation with the customer.

Product Requirements and Regulations

The basic design rules are already contained in the product specifications which attach importance to the sparing use of materials, the environmental compatibility of materials, long service life and ease of dismantling. The furnishing of proof of the use of recycled materials is increasing in importance. It is also essential to avoid a wide range of materials, since the fewer materials used, the faster the subsequent dismantling of the electronic components will be – an essential requirement in keeping recycling costs down. The crucial factor in the recycling of materials is exclusive use of those for which established material cycles exist. A particular criterion is to avoid ingredients regulated by the customer.

Instruments of Product Development and Product Planning

The company standard "Environmentally Compatible Product Design" structures the planning and development of products in the form of a guideline. Environmental aspects are thus taken into account during all stages of production. Sequences and general regulations are stipulated by the Environmental Management System Manuals. They include product design guidelines, a list of prohibited hazardous substances and of those to be avoided, or the use of a check list on recycling-friendly construction.

The planning and development of new products is subdivided into various phases such as the invitation-to-tender stage, completion of contract, production of models. At the end of each stage, critical items must be checked using a list of questions. Only after all questions have been answered satisfactorily can the project pass to the next stage. Examples of the environment-related questions included in this so-called Review Procedure include the following:

- Do we have the customer's current requirements regarding environmentally-compatible product design?
- Have the disposal requirements been taken into account in the bid?

Interfaces

Suppliers
All suppliers of parts are in possession of an in-house standard regarding environmentally compatible product design and have confirmed that they will observe and comply with it. Environmentally-related requirements are reflected particularly in the list of prohibited substances and of those to be avoided. In addition, Siemens takes account of the general status of its suppliers in respect of environmental protection, that is whether recognised standards and systems have been implemented. Supplier assessment is based on a questionnaire harmonised within the sector.

Customers
In the automobile sector a First Model Test Report for the product must be prepared for the customer, documenting all reference parameters and prerequisites. Environmental aspects are also addressed. Thus, in the Material Data Sheet, all materials are listed by weight and identification number and information on the contents is provided.

- Can mechanical actuators be separated from electronics?
- Can plug-in connections be used?
- Is non-destructive dismantling possible?
- Has the number of individual parts been minimised?
- Has the range of materials been minimised?
- Are all materials labelled?

Using an assessment tool that assesses the recyclability of products, including individual parts and components, basic data for various product groups has been prepared. The criteria are the dismantling time, percentage and number of by-products capable of recycling, along with the established substance cycles. A characteristic number quantifies the type and number of operations necessary for dismantling, the associated difficulties such as, for example, a high degree of necessary force, and the number of materials used and to be separated, on which the depth of dismantling depends. According to this assessment, the engineers can orientate the connection methods used and the materials employed in line with environmental aspects.

Production: Sequences and Processes

Together with the customer, the Product Development Division determines the geometry, that is the dimensions and the types of materials. Often, these are predetermined by the specific functions of the component or its subsequent positioning in the vehicle. Thus, the engine management system has to withstand high temperatures, due to its proximity to the engine block.

A large number of components are supplied by the premanufacturer in finished form. The most important production steps performed at Siemens are assembly and loading of the software. The printed circuit boards are populated on automatic assembly lines and soldered or, depending on the type of component, glued or screwed in place. The pin cover is then mounted, before the engine management system finally receives its casing.

Product: Composition and Design

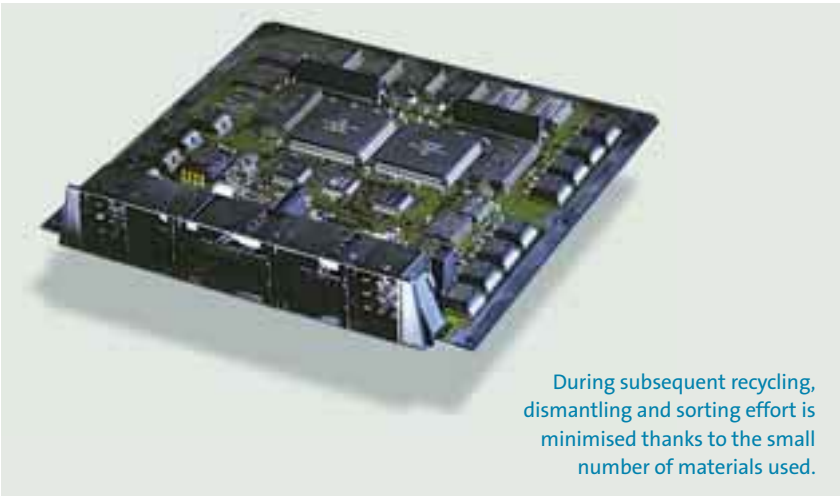
An engine management system consists basically of the cover, multi-point plug with pins, printed circuit board and base plate, pin cover and type plate. The composition of materials is on average as follows:

Cover	Aluminium	about 25 %
Multi-point plug with pins	Plastic with a glass fibre content of 30 per cent, tin-plated with copper-iron and copper-tin	about 15 %
Printed circuit board	Plastic (epoxy resin) and components	about 20 %
Base plate	Aluminium	about 35 %
Pin cover	Polyamide with a glass fibre content of 30 per cent	about 3 %
Type plate	*Switch to laser inscription*	—

Optimisation

In the light of a specific customer requirement (here: the new Euro standard on emission reduction) and in order to reduce costs, a broad-based development team has achieved significant optimisation of the present design. Thanks to the use of advanced technologies and electronic components, Siemens can offer its customers the opportunity of achieving fuel-savings of between 5 and 10 per cent during the usage phase.

Criteria	Optimisation
Weight	−42 %
Number of different materials	−50 %
Quantity of solder metal/lead	−14 %
Utilization of printed circuit board surface area	+10 %



During subsequent recycling, dismantling and sorting effort is minimised thanks to the small number of materials used.

clutch

As a supplier to the automobile industry, Mannesmann Sachs AG (now ATECS) [www.sachs.de] in Schweinfurt has, for seventy years, been producing clutch components and, increasingly, complete clutch systems for passenger cars, commercial vehicles and motorcycles. Its range, marked by numerous new developments, includes simple single-disc clutches as well as automated high-tech components. More than 30,000 clutches, comprising more than 5,000 structural variants leave the factory every day and go to vehicle manufacturers and workshops worldwide. With its products, the company contributes to meeting the growing demands of the users with respect to safety, comfort and environmental compatibility.

Interfaces

Suppliers
The suppliers are rated on their performance, price, quality and environmental protection. Great importance is attached to their participation in the EC Eco-Audit-Scheme.

Customers: Automobile Manufacturers
The technical configuration of the products is coordinated with the prerequisites of the automobile manufacturers. Their requirements with respect to the use of materials and construction are directly applied to the development of new products and production processes. Since the introduction of a new packaging line, a regular transport run for the return of reusable cardboard cartons has been agreed with the customer.

Customers: Shops
A special service which Mannesmann Sachs offers for car workshops is a Germany-wide disposal network for used clutch systems. Moreover, the practically-based workshop concept comprises an environmental consultation service along with a training programme on environmental topics and dismantling techniques. The necessary technical information on vehicle-specific assembly instructions, including starting torques and adjustment values, work settings for precise calculation, and documentation on the recognition and repair of damage are available from Mannesmann Sachs on CD-ROM. Further information can be obtained directly via fax hotline, e-mail and Internet. An on-line ordering system enables workshops to check immediately whether the spare parts are available. A sophisticated scheduling and order-handling system, the latest computer technology and well-harmonized processes in the spare-parts warehouse guarantees a 24-hour delivery service.

Product Requirements and Regulations

The clutch provides a frictional connection between engine and gearbox which allows the running vehicle engine to be decoupled from the gearbox. Product requirements stem from the automobile manufacturers who increasingly demand smaller units, combined with improved performance, thus requiring less installation space. On the other hand, users demand high operating convenience, characterised by very low friction, a wide variety of individual adjustment options and optimum transmission for a smooth driving qualities. Lower clutch weight, combined with smooth gear-changing and clutch engagement are by no means insignificant in reducing fuel consumption. The products also have to satisfy the user's desire for maintenance-free operation and long service life.

Instruments of Product Development and Production Planning

The introduction of a new material is always preceded by a release procedure which takes into account the environmental relevance of the materials. Training sessions for company and factory managers on regulations and new technologies relating to environmental protection contribute to preventive environmental awareness. The environmental relevance of production processes is assessed by means of a basic framework which makes a distinction in relation to type and/or quantity. This allows the most important environmentally relevant on-site activities to be described, and potential improvements identified. One example of the reduction of direct environmental impact is the decision to discontinue the use CFCs (fluorinated hydrocarbons) which became effective in 1993. These were replaced by the use of water-based paints free from heavy metals, and a newly developed process for the coating of bonding additives. Hydrofluoric acid for surface treatment was also completely replaced, and the use of hydrochloric acid substantially reduced. Electrogalvanising, chrome-plating and nitrocarburising are performed using cyanide-free methods.

Production: Sequences and Processes

High-quality materials and treatment methods ensure that the clutches are resistant to corrosion and wear-resistant. During prefabrication, the raw material supplied and semi-finished products are turned into blank parts either in forging presses or by cold-forming. The various elements of the clutch are then finished to their final

dimensions by turning on a lathe, milling, drilling, grinding, honing and eroding, and welded and hard soldered.

The subsequent stove heat treatment tempers, nitrates and carburises parts and tools. Pretreatment and finishing includes blasting in closed units. Chemical processes come into play with the parts being degreased, pickled, phosphated, soaped and plated – either nickel-plated, copper-plated or galvanised, a process performed by electrolytic deposition in treatment baths. Finally, in the finishing and assembly department, the individual parts are connected. Quality testing of clutches and torque converters takes place on test rigs driven by a combustion engine.

Product: Composition and Design

A vehicle clutch consists of a pressure plate, disc and release bearing cup and is essentially composed of the following individual parts and materials

Parts	Composition
Housing	100% steel
Pressure plate	100% steel
Membrane fields	100% steel
Clutch disc	95% steel, 5% plastic
Release bearing cup	98% steel, 2% plastic

When selecting the materials and production methods, environmental compatibility is one criterion taken into account. Great importance is attached to the recommendations of the German Association of Automobile Manufacturers (VDA reg. Soc.), the suppliers and the customers.

Optimisation: Exchange System for Clutches

As long ago as 1963, Sachs started reprocessing clutches. Today the exchange system for used clutches is regarded as the world's largest recycling operation, rendering more than two million worn-out clutch discs and pressure plates fit for reuse every year. In the reprocessing plants, the parts received from the workshops are sorted according to type, fully dismantled, washed, cleaned by blasting and greased. After this procedure, all individual parts undergo a 100% check and are then assembled in the assembly department to original equipment quality standards, to provide functional clutches. Components subject to particular wear, for example clutch pads, friction rings, nuts and bolts, are disposed of in an ecologically sound manner, and replaced by new parts. Since 1989, only asbestos-free pads have been used in clutch assembly. The functioning recycling system achieves a reutilisation ratio of 77 per cent for pressure plates and 63 per cent for clutch discs, thus saving approximately 4,000 tonnes of raw materials per year.

A long service life is important, but clutches with high power transmission efficiency also contribute to reducing fuel consumption.

chain drive systems

To drive camshafts or injection pumps in the combustion engine, it is possible to use either steel chains or toothed drive belts. Whereas belt drives have to be replaced after as little as approximately 80,000 to 120,000 kilometres, chains are extremely efficient, and consequently easy to maintain. A number of other arguments may be advanced in favour of their use: high power transmission efficiency and a more effective use of available space. The company iwis ketten Joh. Winkelhofer & Söhne GmbH & Co. KG [www.iwis.de] produces about 30 kilometres of timing chains a day for the automobile industry, and supplies its control, camshaft, mass balancing and oil pump systems throughout the world.

Product Requirements and Regulations

The control drives are subject to a variety of dynamic stresses, posing high demands on the structural parts used. Failure of the drive chain for the valve control may even result in destruction of the engine. The most important requirements of chain drive systems are therefore long service life and maintenance-free operation. They additionally include: low weight for reduced fuel consumption and silent operation, in line with acoustic optimisation requirements. The various quality requirements are monitored by management systems according to ISO 9001, VDA 6.1 and QS 9000. Use is also made of the most advanced analysis techniques: for example a scanning electron microscope checks the system parts for material defects and damage mechanisms.

Interfaces

Suppliers

The Procurement Guideline ensures on the one hand that the established environmental requirements are observed when purchasing hazardous and potentially pollutant substances and products. On the other hand, it checks the performance of the suppliers with respect to environmentally sound production or environmentally compatible products. In addition, suppliers must prove that they have established a viable environmental management system.

Customers

The customer compiles his quality and performance requirements for the chain drive systems in a Design Specification. In order to implement these as precisely and rapidly as possible, iwis has set up its own project groups in parallel to the manufacturer's engine development projects. The exchange and coordination between both development groups takes place using all the available Simultaneous Engineering tools.

Instruments of Product Development and Product Planning

Since the suppliers can only be required to do what the company also implements successfully in-house, iwis has had its chains certified at an early stage in accordance with the EC Eco-Audit-Scheme. The Environmental Management Manual has been structured according to the rules of ISO Standard 14001 and the regulations of EMAS. It contains various instructions for the environmentally compatible design of products and processes:

- The "Procedural Instruction Design Control" describes the organisational and technical interfaces. The design prerequisites refer on the one hand to the customer's Design Specification and, on the other hand, to internal prerequisites such as use of ecologically safe raw materials, materials and components, use of secondary raw materials, savings on materials, environmentally compatible construction, reprocessing of production waste, savings in energy and emission protection. The design review is completed with construction data suitable for use in production, such as drawings, lab reports and lists of parts.

- The "Procedural Instruction Process Control" describes all production processes, together with their environmental effects, such as emissions of hazardous substances and noise, including the operational permits and maintenance instructions. It also explains how to deal with air and waste water pollution and explains the regulations as to how to avoid, reuse, register and collect waste.

Optimum arrangement of chain links, chain wheels and chain adjustor calls for precise knowledge of vibration and transmission behaviour. This is why iwis ketten attaches great importance to research and development. Dynamic computer simulations and prototyping support the development process.

Production: Sequences and Processes

Timing chains require the manufacture of shackles, sleeves and rollers as well as bolts: the shackles are punched from a steel strip, recut and polished. Sleeves and rollers are wound from a steel strip and calibrated. This is followed by hardening, polishing and blasting. The finished sleeves are assembled together with the inner brackets and rollers to give inner links. The bolts are cut to size from steel wire, shaped and polished. During the heat

treatment, the surface is coated and hardened. The finished bolts are additionally polished and pressed into outer shackles.

Once the individual parts are finished, the final assembly of the control chain takes place. This is followed by oiling, loading and checking of the chains.

Product: Composition and Design

A chain drive system consists mainly of the timing chain, chain wheels, chain adjustor and adjusting and guide rails, and comprises the following materials:

Parts	Composition
Control chain	100% steel
Running wheels	100% steel
Chain adjustor	80% metal, 20% plastic
Adjusting and guiding rails	20% metal, 80% plastic

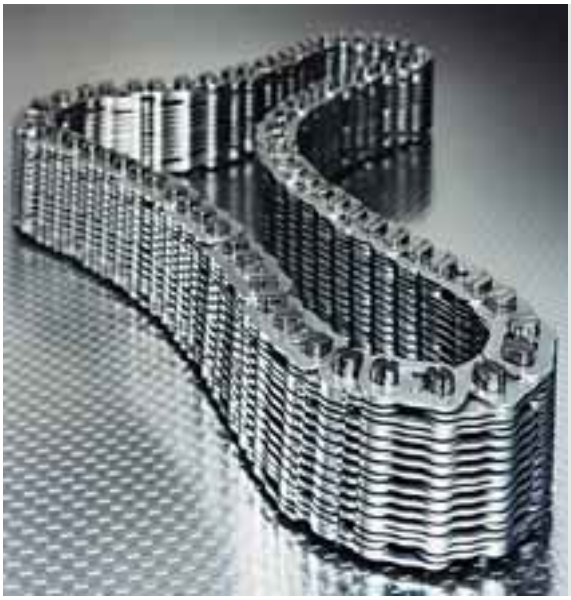
Optimisation

>> Replacing plastic toothed belts subject to wear with steel chains results in lower maintenance; moreover, spare parts are no longer needed.

>> Replacing the heavy metal parts of chain adjustors with lightweight plastic parts results in a saving in weight of 50 per cent.

>> To optimise the service life and the load-bearing capacity, a lightweight simplex chain was developed to replace the previous duplex chain. This "downsizing", using smaller chain wheels and components, also resulted in a reduction in the space occupied in the engine compartment, and thus to a further reduction in weight.

>> Research cooperation for optimising surface coatings not only reduced the friction losses, but also cut noise emissions.



Timing chains made of steel are highly efficient and durable. They can be found in millions of petrol and diesel engines.

lamps

Headlights and direction indicators are not the only things that light up in a car. There are as many as 60 lamps for the dashboard displays, for lighting the road, boot and the cabin, and for signalling. For road safety, the external lights are of crucial importance, especially since today's heavy and fast-moving traffic demands optimum vision and clear signals. This has also increased the quality demands made on the lamps. A high percentage of lamps for headlights or ancillary lights are produced by Osram GmbH, [www.osram.de] the world's largest manufacturer of car lamps.

Product Requirements and Regulations

Headlight lamps must withstand high stresses. In particular, they must have a long service life, a challenge intensified by the fact that in certain countries such as Sweden or Hungary, running lights must be on during daylight hours too. At the same time, of course, the lamps must not lose intensity in the course of their service life and must be efficient, that is, they must have a high light yield while using little energy so as to save fuel. For reasons of environmental protection and health protection, it is desirable to minimise the use of hazardous substances, since lamps may easily splinter as a result of an accident, thus releasing their contents. The same is true of disposal: the fewer the number of hazardous substances, the better. Ease of dismantling and recyclability are prerequisites of the European Directive on End-of-Life Vehicle Management. Starting from 2003, an EU Directive will limit the use of mercury, lead and cadmium in new cars.

Production: Sequences and Processes

The production of lamps is distinguished by a very high degree of vertical integration: at Osram, the activities range from glass production to manufacture of the tungsten filament and to assembly of the lamps. This is performed by sealing a glass tube or the glass bulb together with the filaments or electrodes. The tube is then evacuated, filled with a filler gas and, where applicable, a filler material and then closed off with an airtight seal. This is followed for many lamp types by mounting the base. This means that the glass body is glued onto the supplied metal or plastic base. The electrical connections are created by soldering or welding.

Product: Composition and Design

Car lamps consist basically of glass tubes and bulbs, tungsten filaments or electrodes, various wires, a lamp filler material and, where necessary, cement, base and solder metal.

Composition of D1 gas-discharge lamps	
Lamp incorporating lamp bulb	Quartz glass in UV stop design
Electrodes	Tungsten with an addition of 0.7 % of thorium oxide
Power supply	Nickel or molybdenum pins/film
Ceramic tube	Alumina ceramic
Lamp filling	Compact total of 0.24 mg, mixture of sodium iodide, scandium iodide and thallium
Gas filling	about 0.5 mg of metallic mercury is present in the xenon gas filling
Base part	Recyclable plastic housing with integrated ignition device, 1 or 3 condensers, 1 resistance, 2 diodes, coils, 1 transformer

Interfaces

Suppliers
Osram performs an assessment of its suppliers taking account of ecological aspects. Accordingly, environmental aspects form an integral part of the Assessment of Suppliers, which is currently being set up.

Customers: Lighting Manufacturers
Osram develops new lamps in close cooperation with the design departments of the automobile manufacturers. If, after providing samples, their performance and design are approved, the lamps are manufactured and delivered to the lighting manufacturers, who incorporate them in their systems (e.g. headlights, tail lights, interior lights). For example, in the case of so-called xenon headlights, the gas-discharge lamp is connected to the reflectors. The finished headlights then go to the automobile manufacturers to be installed in the vehicles.

Customers: Workshops and Repair Shops
Customers who sell on lamps – especially workshops and repair shops – are informed by Osram about environmental objectives and measures through environmental reports, environmental statements and product brochures. Reprocessing plants receive product information sheets and brochures on the topic of disposal. Recycling of lamps is carried out in cooperation with the Association of Lamp Processing (AGVL): under the auspices of the Central Association of the Electrical Industry reg. Soc. (ZVEI) [www.zvei.org] companies from the recycling sector and lamp manufacturers have joined forces in order to guarantee the environmentally compatible disposal of lamps. The list of certified reprocessing plants belonging to the AGLV is available from the ZVEI or Osram. Glass and aluminium can be recycled and returned to the production cycle.

Optimisation

For the production of headlights, Osram has developed a new generation of energy-saving lamps: no longer does a filament glow white to produce the light, which comes instead from a gas discharge arc in an extremely small quartz glass tube. Since headlights increasingly consist of plastic, an additional outer bulb made of UV-absorbing quartz glass reduces the UV portions of light, which are damaging to plastics.

Advantage of the D1 gas-discharge lamp:

- >> light intensity increased by more than 100 per cent and therefore also suitable for smaller reflectors,
- >> more effective and brighter, due to a three-fold increased light yield,
- >> less heat generated,
- >> safer, thanks to a four-fold increased service life,
- >> one third less energy consumption,
- >> better replication of daylight.

However, the new headlight system is more than one kilogramme heavier than the previous halogen headlights, owing to the fact that a fluorescent lamp ballast is needed – not exactly advantageous for lowering petrol consumption by reducing car weight. Moreover, its gas-discharge lamp contains a small amount of mercury. New developments aim to eliminate mercury while maintaining the brightness levels achieved. As regards fluorescent lamp ballast, weight-reduction measures are being studied.

VDA Data Base

For each individual part and each component of an automobile, a structured and standardised Material Data Sheet is drawn up in which all materials used are listed with their name and weight, along with material composition, detailed down to individual substances. The purpose of this data base is to give an exact overview of the materials contained in the end product "Automobile" and to make it possible to trace them in the product life cycle chain [**www.vda.de**].

The development of lead-free halogen miniwatt lamps, for example for low beam, and stop lamp soldered without lead has allowed the elimination of lead from production and the product itself. However, production costs for these models are higher, since both lead-free glass and lead-free solder metal require higher processing temperatures. Consequently, more energy and, additionally, more expensive solder metal is needed.

Instruments of Product Development and Product Planning

- >> The "List of Prohibited Substances Environment" lists all substances the use of which is banned or to be avoided according to statute or more stringent internal provisions.
- >> By carrying out eco-analyses as early as during the planning stage, the environmental effects of a product over its entire life cycle are registered. Ecologically safe materials are then selected on this basis.
- >> Eco Indices allow products and production to be assessed ecologically according to transparent and comparable criteria.
- >> Material Data Sheets from the German Association of Automobile Manufacturers (VDA) reg. Soc. are used for almost the entire product range.

The new D1 gas-discharge lamp achieves a three-fold increase in light yield, a four-fold increase in service life and is almost as bright as daylight.

A modern motor vehicle contains more than one hundred ball-and-roller bearing components, ranging from engine elements such as valve and timing units to needle-ring, axial and radial bearings in gearboxes and to impulse rings in antiblocking systems and antiskid devices. The 30 production plants of INA Wälzlager Schaeffler oHG [www.ina.de] supply components for gearbox, running gear and engines worldwide.

Product Requirements and Regulations

Today's engines must meet much more demanding requirements than ten years ago. They must be low in hazardous substances, quiet, durable, economical, maintenance-free and smooth-running. When idling, and under partial loading, reducing friction caused by the valve control plays a particularly important role, since it may produce up to 25 per cent of the total engine friction. Apart from the reduction in friction, the valve drive must meet a series of other demands: low valve contact times, no loss in contact between cams and tapping elements and only small deviations between the actual and theoretical valve elevation curve.

It goes without saying that the internal quality management requirements apply to the products. Worldwide all production locations have been certified to QS 9000 and in Europe and Brazil to VDA 6.1. In addition, INA holds approvals in accordance with the industrial standard QSF-C for air and space travel. INA has received numerous customer awards for the quality of its products and its commitment to the environment, for example the Ford Eco-Award and its selection as Supplier of the Year in 1998 by Audi AG.

Instruments of Product Development and Product Planning

INA also prepares Product Eco-Balance Sheets, although product development is focused on offering integrated system solutions to the customer. Joint ventures, for example with the manufacturers of other valve drive systems, make it possible to provide solutions to complex objectives through synergies.

Computer-aided cine and dynamic simulations allow the effects of different parameters such as masses, moments of inertia, load moments, geometric dimensions or rigidity and damping parameters and friction coefficients on the end product to be studied and determined. Selective variation of these parameters allows the application engineer to carry out simulation calculations. Thus, statements regarding functional safety, thermal and dynamic stresses can be made as early as during the construction stage. The possibility of simulating the functioning of complete systems allows structural modifications which may become necessary to be carried out at an early stage, thus cutting development periods as well as costs.

Product: Composition and Design

The camshaft actuates the inlet and outlet valves of the cylinders through hydraulic cup tappets. These hydrotappets are manufactured from steel, in a number of steps. They automatically compensate for any valve play, thus dispensing with the need for valve play adjustment. Precise valve play and low-friction valve drives are essential to a smooth-running engine and low emission of hazardous substances.

Interfaces

Suppliers
One criterion for selecting suppliers is environmental protection. An internal Procedural Instruction ensures that only those process materials are used which have been released by the in-house chemical laboratory and the occupational health and safety, work medicine and environmental protection departments.

Customers
In the case of special engine requirements, development is carried out in close cooperation with the automobile manufacturers. Joint ventures with other companies result in many synergistic effects. Take for example ContiTech: by working together with the belt manufacturer, it has been possible to shorten development periods and thus also reduce the costs of producing chain- and belt-adjustment units.

Optimisation

In the engine elements field, the system concept that aims to reduce exhaust gases and lower fuel consumption has become widely accepted. Engine elements featuring extremely low friction such as lightweight cup tappets ensure that the rotating camshaft can open and close the valves with little noise. The results are lower noise levels and less friction – plus reduced fuel consumption. In close cooperation with a camshaft manufacturer, a switchable cup tappet was developed which is capable of switching between two different piston stroke lengths. This lowers fuel consumption by about 7 per cent while maintaining the same high performance efficiency of the engine.

To ensure that the production of engine elements is as environmentally compatible as possible, all INA production sites worldwide have been certified according to the EC Eco-Audit-Scheme and according to DIN EN ISO 14001. In order to meet internationally demanding environmental protection standards, all locations, whether in Europe, Asia or America, are additionally tested by the corporate environmental protection department in accordance with strict criteria.

Low-friction engine elements such as the lightweight cup tappet contribute to fuel economy.

In addition to general criteria such as safety and comfort, it is essential for environmental criteria and recycling requirements to be integrated into the earliest stages of the development and the construction of new vehicles. This is achieved by, among other things, recycling-optimised product design, which starts with an assessment of the entire product life cycle of an automobile. This means that development, manufacture, utilisation and, at the end of its useful life, the recycling of the vehicle are treated as a closed-loop system. In order to link research, development and recycling in the most efficient manner possible, at the end of the 1980's BMW AG [www.bmw.com] set up the Research and Engineering Centre (FIZ) as its central "think tank". Some 6,000 engineers, designers, model designers, computer experts and scientists from a wide range of fields, as well as buyers and representatives of suppliers, work together there on the vehicles of the future.

Product Requirements and Regulations

Many things are demanded of a modern automobile: superior driving performance and economical consumption figures, adequate seating capacity and compact external dimensions, attractive design, low weight, a variety of functions, recyclability, high reliability levels and comprehensive safety features – and not least a competitive price.

Development: Sequences and Processes

New developments are accompanied by gateway management, a planning system that is uniform and mandatory for all participants, and even includes the individual components from suppliers. Consistent compliance with the essential prerequisites of the project sequence is crucial to on-schedule completion by the start of series production. One of these points of synchronisation is the "package freeze", which is the point at which the basic space required by all components is fixed. The design process, including the drawing up of alternatives, selection of models and fixing of models is completed with the "design freeze". By means of concept-based invitations-to-tender for selecting the suppliers, it is possible to factor in new technologies and innovations at an early stage. On-schedule construction of prototypes provides timely test results, enabling the series production process to be checked.

Interfaces

In "Simultaneous Engineering", development processes take place simultaneously, under conditions of close cooperation between all participants. Thus, when designing a car door, employees from a wide range of fields such as white body, electronics, equipment or ventilation systems must interact in order to solve the problems at hand. For new developments, 100 to 200 employees are sometimes brought together into a large team. This enables a spontaneous exchange of information, to augment the regular coordination discussions. Vehicle development is divided into "modules", such as cabin interior, doors, cockpit and front end.

Internal Exchange of Experience

In order to facilitate the exchange of experience on recycling and to focus the existing knowledge, BMW has set up a state-of-the-art recycling and dismantling centre (RDZ) as a "know-how pool" and information platform for all specialist departments within the company. The intensive exchange of ideas guarantees that the design requirements of easy-to-recycle and easy-to-dismantle new products can be taken into account at an early stage in the product design process (see also chapter "Recycling concepts", page 72).

Optimisation

Efficient and interdisciplinary cooperation is a fundamental prerequisite for rapid product development. Accordingly, teamwork organisation must also be continuously developed until "Collective Engineering" is achieved: during the development stage of the "3 Series", the manufacturing section was for the first time involved in the development process, for example by having employees from the door production unit assemble the prototypes. Since their proposals were put into practice at an early stage and not only after series production had started, it was possible to avoid the frequently high costs of tool changes. At the beginning of the concept stage, the members of the development team in turn worked in the production area relevant to them on the assembly line, and thus gained a deeper insight into the processes.

Employees from Marketing and Distribution were also involved: on the basis of a written catalogue of targets, which Distribution had derived from customer specifications, a joint formulation of customer wishes was initiated, as part of so-called "Product Clinics" (team discussions involving product visions, and examination of products from competitors). A survey of the public, carried out by development engineers under the direction of marketing representatives, helped to distil a uniform and joint product concept.

The improved exchange of information is also due not least to the early involvement of suppliers. Their physical integration was made possible by allocating workplaces to them at the FIZ.

"Virtual vehicle development", using CAx methods ranging from three-dimensional representation to the construction of the individual components and to the testing of various functions, is making rapid progress. Thus, crash tests can already be simulated on screen. This saves time and costs since a drivable prototype must otherwise be manufactured, involving much time-consuming and cost-intensive manual effort. Computer simulation of manufacturing and assembly processes allows them to be optimised at a very early stage.

The objective of dismantling analyses is to review the recycling requirements defined in the catalogue of targets at the conceptual stage (in virtual form) and then once again shortly before series production commences (near-series vehicle). Results relating to the overall vehicle, such as the recycling ratio, are determined at module or component level. Virtual dismantling analysis (concept stage) is a medium for the discussion of recycling-optimised product design with the project managers responsible for the overall vehicle.

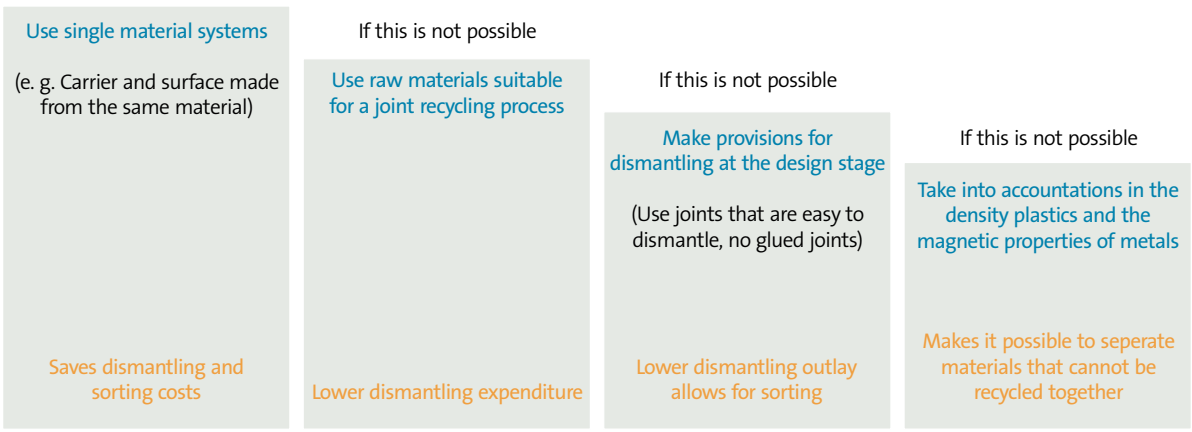
Design for Recycling

The goal of Design for Recycling is to define the environmental compatibility criteria at the overall vehicle level and target values such as the recycling ratio in the planning order, and then combine them in a catalogue of targets.

When developing a concept, energy and eco-balance sheets for components are designed for an initial ecological assessment. In addition, dismantling analyses are carried out and each individual component classified according to its recyclability – an indispensable part of each component drawing. For series development, the recommendations worked out in the previous stages and the measures derived from these are refined. The state of implementation is documented by means of a release process for the overall vehicle. The key objectives are:

- meeting the legally prescribed recycling ratio,
- guarantee of economical dismantling and reutilisation,
- labelling of the plastic components,
- maximum use of secondary materials,
- use of materials free of hazardous substances.

Recycling-optimised product design at BMW



Instruments of Product Design

The “catalogue of overall vehicle requirements” contains, in addition to customary features such as safety, quality and comfort, conditions and measures relating to environmental compatibility. It addresses topics such as Design for Recycling, Life-Cycle Assessment and exhaust gas and noise emissions.

BMW standard 113.89.0 T 1-3 regulates the use of restricted and prohibited substances. Before a material is used for the first time, all chemical-industrial products, along with their physicochemical safety-relevant data, are stored in the Hazardous Substances Information System ZEUS, which helps the designers select environmentally compatible materials as early as the development stage. This is followed by a workplace-related test performed by the Quality Assurance, Occupational Health and Safety and Environmental Protection sections, during which environmental effects relating to the subsequent disposal of the products are also examined. Transport routes, packaging, storage, processing and even measures taken in the event of an accident and selective waste prevention are assessed on an equal footing. A product may only be used at a particular location after release by the relevant department.

The Ecological Balance Sheet or Life Cycle Analysis, which is designed to improve the ecological properties of products and systems, is used selectively during the early stages of product design to make all participants involved aware of the environmentally relevant effects of new concepts or technologies, without drawing conclusions as to the environmental compatibility of the overall vehicle. The building of an ecological basis for comparison within the framework of an interdisciplinary overall decision is designed, among other things, to attain goals relating to environmental policy. For example, the voluntary agreement of ACEA to reduce CO_2 emissions from motor vehicles by 25 per cent.

IPP Challenge: Aluminium parts are more energy consuming to produce but offer greater fuel economy

With aluminium, it is possible to design parts that are much lighter than those using steel, for example. The use of aluminium in chassis, engine and car bodies can therefore make a contribution to fuel economy, which is more than 50 percent determined by weight.

It is true that the manufacturing process for primary aluminium parts is associated with an ecological outlay several times higher than that for the steel equivalent, not least because an energy-intensive electrolysis process is involved. But depending on the weight reduction achieved, the resultant fuel saving can save many times the manufacturing outlay even during the first stage of the vehicle’s life cycle.

Moreover, as the recycling of aluminium is ecologically profitable and thus widely practised today, the additional expenditure for manufacturing primary aluminium occurs once only and does not apply subsequent applications.

Assessment of the Recyclability of Components and Aggregates

Technical and economic suitability for recirculation	Problematical substances	Material reutilisability (% by weight)	Recycling classification
100%	none	> 80%	R 1
80–100%	none	> 65%	R 2
< 80%	present	< 65%	R 3

Recycling Handbook

The “Construction Guidelines for Recycling-Optimised Product Design” contain general guidelines for recycling-optimised construction including the three key areas of joining technology, material selection and component design. In addition to the recycling and dismantling status currently achievable of components and groups of components, they list module- and component-specific recommendations for improvements. The “List of Specifications for Components” contains a detailed list of recycling requirements (e.g. recommended recovery route, recycling ratio, dismantling prerequisites and material selection).

Based on the “Recycling Standard”, each component is classified in an assessment matrix, according to the criteria material reusability, suitability for recirculation and problematical materials, and with regard to its technical and economic recyclability. To assess its suitability for recirculation, the cost blocks for the process chains “material recycling” and “non-recycling of materials” are compared. Components receiving an R3 classification are to be avoided in future developments.

Construction guidelines for recycling-optimised product design focus on dismantling and recycling options for the individual components.

production

Production lies at the heart of automobile manufacture. Before a new car leaves the assembly line, it passes through a wide variety of process sections. Since each series of models is available with a wide range of engines, colours and equipment specifications, almost no two vehicles are identical. As soon as the customer has opted for his model and a particular specification, Audi AG, Ingolstadt, draws up detailed plans defining all the activities necessary at the suppliers and within the production facilities. Computer-aided production ensures optimum material flow. The necessary modules are delivered by suppliers on a "just in time" basis, in order to minimise intermediate storage.

Requirements and Regulations

The "Environmental Standard for Vehicles" approved by Audi back in 1992 is intended to contribute to guaranteeing human and environmental compatibility in the manufacture of automobiles and components, vehicle utilisation, maintenance and repair and during the subsequent disposal, as well as minimising the consumption of resources. This standard contains notes on environmentally compatible construction and lists of substances, which must not be used in the vehicle, and of those, which must be declared. The prerequisites are binding not only on the Technical Development Section but also suppliers and partners.

Planning Instruments

The environmental effects necessarily associated with production are determined and assessed at regular intervals. Since 1995 Audi has been taking part in the EC Eco-Audit-Scheme in order continuously to improve environmental protection at the site, through its environmental management system.

Interfaces

Product Development
For the development of new automobiles, Audi has adopted "Simultaneous Engineering". Representatives from all company divisions work closely together – including on environmental protection issues – in specialist teams that involve suppliers and service providers too. This allows the timely coordination of different interests and the specialist know-how of all participants to be included in the product development. To improve product-related environmental protection, the Technical Development Section has created an organisational unit known as "Environment and Transport".

Purchasing
New materials are not acquired until they have been tested and released by the Material Assessment Group. This committee, created back in 1982, is composed of representatives from the fire protection, environmental, occupational health and safety and processing engineering/safety chemistry sections.

Suppliers
Since most of the components and materials required are bought in, suppliers and service providers are contractually obliged to observe all environmental regulations and the "Environmental Standard for Vehicles" which is in force throughout the VW group. If they have established an environmental management system in accordance with the EC Eco-Audit-Scheme or ISO 14001, no further environmental protection inquiries are required. However, the company has for a voluntary approach rather than a system of enforcement.

Sales/Distribution
Customers can pick up their new car either directly at the factory or at any Audi dealer of their choice. About 65 per cent (as of 1999) of the new cars produced are transported by rail, dependent on Deutsche Bahn's capacity. The vehicles receive a layer of wax or a film coating before being dispatched, to protect them during transport.

Not only customers, but also employees, local residents, suppliers and authorities receive information via the Environmental Statement for Audi's Ingolstadt site. This is published every three years in detailed form and is supplemented by annual abridged versions containing the most important data and essential modifications.

Sequences and Processes

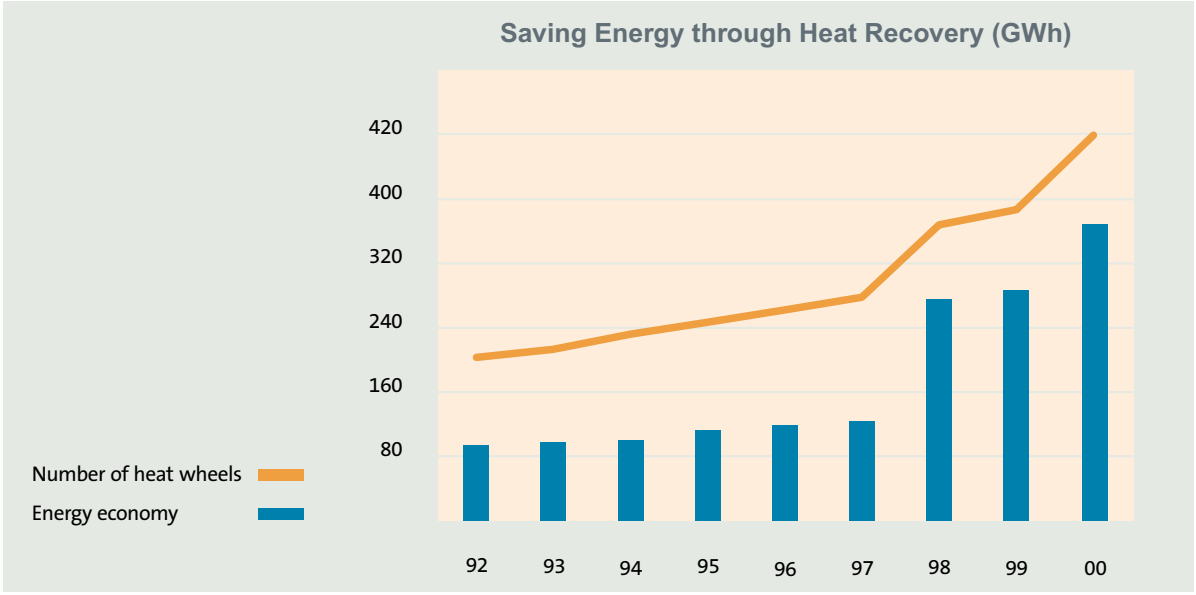
In the pressing plant, electronically controlled strip splitting lines cut the metal sheets delivered in coils into the desired basic sizes, which are then shaped to produce various body parts such as doors and front and rear wings. In the platform assembly unit, freely programmable industrial robots first join the seat rails and front bulkhead, wheel wells, battery console, radiator tank and rear bulkhead to the vehicle floorpan, using spot-welding or glued joints. The other parts such as roof frame, side units, body panels, etc. are then added. In the paint shop, the bodies receive a wide range of coatings, ranging from a phosphate layer to the cavity sealant. As well as the engine, the Machine Parts Manufacturing Department manufactures running gear units such as front and rear axles and drag bearings. The engines consist of hundreds of individual parts, which are combined to produce a single assembly. This is followed by testing of the basic engine tuning on run-in test rigs, while other functions, including oil pressure, induction manifold pressure and exhaust gas back pressure, are checked, along with noise behaviour. The Plastics Production Department turns out relief foamed footwell mats and thermoplastic injection-moulded parts, which are fetched in the right sequence via the assembly control processor, and conveyed directly to the assembly lines. During final assembly, the car is "brought to life", by the addition of the headlining, windows, sun-roof, pedals, dashboard, steering column and steering wheel with airbag. This is followed by the preassembled powertrain and the exhaust unit, bumpers, wheels and seats. Before leaving the production facility, the vehicles are thoroughly tested during a final inspection.

The final production stage involves the fitting of wheels, seats and shock absorbers.

Optimisation

The Ingolstadt location contains 387 heat recovery units, thereby achieving an annual saving in energy of approximately 20 per cent (290 GWh). Since 1999, a combined heat/power/refrigeration plant (KWKK) running on natural gas has augmented the factory's energy supply facilities. The waste heat produced from electric power generation is used to heat production plants and offices. The high (80 percent) efficiency of the KWKK and a utilisation level of about 7,500 hours per year at full load have not only lowered the consumption of natural gas but also emissions of carbon dioxide by approximately 25 per cent – compared with customary energy generation methods The refrigerated air produced in the KWKK serves in particular the air-conditioning of the clean-room areas in the paint shop, and is used to cool the engine test benches in the Technical Development Section.

To reduce water consumption and the volume of waste water produced, Audi has installed separate pipeline systems for process water, cooling water and fresh water. About 96 per cent of the total amount of water used is recirculated. To reduce hydrocarbon emissions produced during fuelling of vehicles on the assembly line, an exhaust gas cleaning unit was installed in the assembly plant. The metal waste produced in the pressing plant is used as far as possible to produce small parts, the reutilisation ratio being almost 100 per cent. This measure contributes to the sparing use of resources and to a reduction in the volume of waste produced.



painting

Paintwork gives the car its individual visual impact. At the same time, it protects the body against environmental influences and thus prolongs the service life of the automobile. The painting process comprises many steps such as dry and wet treatments, heating and cooling processes, chemical and electrochemical processes and automatic and manual operations. The environmental effects of this stage in the creation of the product "Automobile" are correspondingly great. With a view to minimising these effects, in 1998 Audi AG in Ingolstadt started operations in a new paint shop equipped with the most advanced environmental protection technology.

Product Requirements and Regulations

Paintwork requirements result on the one hand from customers' expectation of a perfect finish on their vehicle. Moreover, the paintwork must be highly resistant to damage, calling for properties such as resistance to chemicals, long-term stability, scratch resistance and re sistance to stone chipping.

The emissions produced during painting render the paint shop subject to approval in accordance with the German Pollution Protection Act (BImSchG). The plant must also be designed in accordance with VDI Directive 3455 "Emission Reduction: Plants for the Series Painting of Automotive Bodies". The waste water treatment plant which processes organically contaminated waste water containing heavy metals for introduction into the municipal sewage treatment plant is subject to approval in accordance with the Water Resources Act (WHG). If more than a certain amount of waste subject to special monitoring is generated, a waste balance sheet must be drawn up in accordance with the Recycling Management and Waste Disposal ("Ecocycle") Act (KrW-/AbfG).

Production: Sequences and Processes

Achieving perfect corrosion resistance and a flawless finish calls for many processing steps. Only the right combination of primer, filler, base coat and clear coat will give the paintwork the desired properties. Prior to the actual painting, the bodies must be degreased, using the spraying and full immersion method, shavings and dirt residues from the mechanical processes must be removed, and a zinc phosphate coat must be applied to the bare metal before priming, as protection against corrosion and as an adhesion promoter. All surfaces and cavities are then primed, using the cataphoresis immersion painting method, and the paint layer is then stoved. For protection against stone impact and corrosion, the underbody and wheel-wells are coated with PVC, and the passenger compartment and luggage boot are sealed with PVC seams. To level uneven patches and for further protection against corrosion, a filler is applied to the body.

The filler coating is followed by evaporation and intermediate drying of the coating, and the basecoat is applied by the spray-coating method. The last layer to be sprayed on is the clear topcoat. Ancillary parts such as door handles, mirrors and trim strips are also painted with water-based paints in a separate process. For further protection against corrosion, the finished bodies undergo cavity flooding. The process, developed and patented by Audi, uses solvent-free wax.

Environmental Aspects

Air
Solvent emissions are created during painting and coating processes in particular. During overspraying, paint particles are released. Energy consumption is associated with carbon dioxide emissions. The operation of ventilation systems produces noise emissions.

Energy Consumption
Energy is required especially for drying processes and for the ventilation of clean-room areas.

Water
Water is necessary for all rinsing processes. In the paint shop, fairly large quantities of water-polluting substances, which are discharged into the waste water, are generated, primarily in the pre-treatment steps such as degreasing and phosphating.

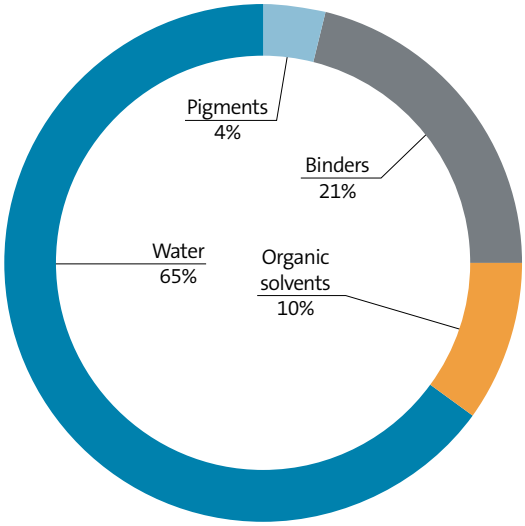
Waste
In the paint shop, waste requiring disposal and reutilisation is formed, including waste that demands particularly close monitoring, such as paint sludges and rinsing fluid residues.

Ground
Cleaning of the painting equipment by washing, and storage of the paint itself involves the risk of hazardous substances being released into the ground.

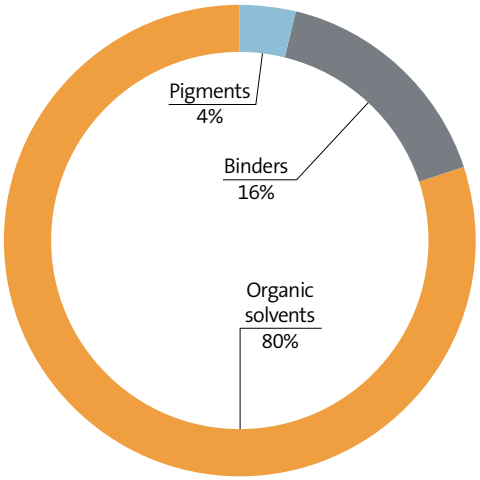
Product: Composition and Design

Modern paint applications systems such as those used in the new paint shop, are economically viable, environmentally friendly, and produce high-quality results. In the light of these aspects, the best technology available to date has been the use of pretreatment media free of chromium (VI) and water-dilutable paints. Over the last few years, it has proved possible almost totally to replace the organic solvents present in customary solvent-based paints, which evaporate during the painting process, with water. A new development, in the form of a two-component water-based clear paint Audi is currently working on, is set to achieve a further reduction of the solvent content. First trials in this area have already yielded promising results.

Composition of water-based paints



Composition of customary paints



Optimisation of the Process for Minimising Environmental Effects

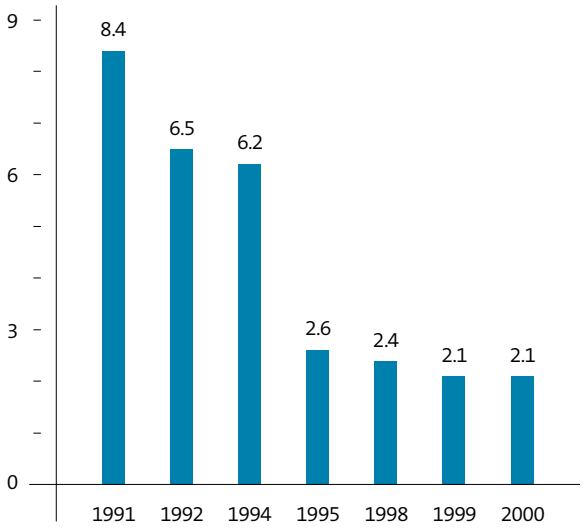
Air

Thanks to the reduction of the solvent content, emissions are so low that cleaning the exhaust air to meet legal limits is no longer necessary. Only the solvents released in the drying process need be subjected to separate additional cleaning or thermal incineration.

Energy Consumption

The use of environmentally compatible water-based paints increases the degree of drying required and, accordingly, also energy consumption – an aspect which was taken into account right from the planning of the paint shop. Heat recovery units for the plant and process waste air help minimise energy consumption. A new drying concept combines recirculated air with infrared radiation in a drying zone. This is performed by passing the hot air from the thermal post-combustion in twin pipes through the dryer. The residual heat is also utilised and serves to heat the fresh air by means of heat exchangers. Cold air and heat for ventilation are supplied by a local combined heat/power/cold unit (KWKK). Thanks to all these measures, it has been possible largely to offset the higher energy consumption associated with the use of water-based paints.

Emissions of organic solvents (in kilograms per vehicle)



Water

Closed water cycles ensure markedly lower water consumption during the painting process. The process waste water is cleaned either via the internal chemical/physical waste water treatment plant or fed into the municipal sewage system or reprocessed back to process water in a separate treatment plant and fed into the local process water network.

Waste

In the new paint shop, the actual painting is performed by process-control robots. Despite the most advanced spray technology, paint residues cannot be entirely avoided. Overspray is therefore collected, and the solid matter removed by flotation in pure form, for material or thermal reutilisation.

To reduce the amount of paint sludge and, accordingly, of special waste, an innovative plant for processing filler paint sludge has been installed at the Neckarsulm facility. The overspray formed during body painting is recovered using an ultrafiltration unit and reused for painting the body interior.

A special feature of the new paint shop is a colour-sorting store in which the bodies are combined into colour blocks before undergoing the further process steps. This process allows the rinsing of the paint application units necessary upon each change of colour to be minimised. To reduce the amount of cleaning required during a colour switch, the paint lines are cleaned mechanically using a so-called go-devil.

IPP Challenge: Use of Water-Based Paints Increases Energy Consumption

To reduce solvent emissions, water-based paints have been introduced over the last few years. Their stringent processing tolerances result in higher cooling and heating outlay . Since the increase in energy consumption can only be counteracted by high-efficiency recovery systems, simple conversion of the existing plants is ruled out. Moreover, spray equipment using water-based paints must be made of stainless steel to avoid corrosion. The switch to water-based paints thus inevitably calls for investment in new painting lines.

Ground

To protect groundwater and the subsoil, the entire floor of the paint shop consists of water-impermeable concrete. Additional protection in storage areas is provided by protective membranes integrated into the floor and by stainless steel collector sumps and pumps which in case of leaks prevent the ecologically hazardous substances from penetrating into the ground and groundwater.

In the paint shop, the car body is preheated in preparation for the hot-flooding process.

logistics

Logistics plays an important role in the life cycle of a product. Without transport, there is no procurement and no distribution: providing the production plants with a wide range of materials, raw materials and products as well as passing the finished products on to the customers are the basis of any production activity. Logistics embraces the organisation and the provision of transport, as well as loading and unloading.

Requirements and Regulations

Various prerequisites and requirements must be met when transporting goods. Thus, the laden vehicle must not exceed a certain total weight (EU Standard). The loading arrangement, load height and load securing must meet precise requirements. According to the Hazardous Goods Act (GGVS), trucks used for transporting hazardous goods must be equipped accordingly. Drivers must observe speed limits and driving time restrictions (night and holiday driving prohibitions, rest and recreation areas, 8-hour day). Tolls are levied on certain stretches of road (e.g. motorway, tunnel).

Optimisation of Logistics through Driver Training

Since the behaviour of the driver has a strong influence on the environmental compatibility of the transport operations, the Drive + Save Training offered by MAN teaches economical, sensible and safe driving. Familiarity with the performance characteristics of the vehicle in question allows gear changes to be reduced and the available power

Interfaces

Buyers/Vehicle owners

MAN Nutzfahrzeuge AG has opted to provide its customers with comprehensive advice, using, among other media, the computer programmes MANEX and MANTED. MANEX allows the subsequent construction of the vehicles to be adapted to the individual needs of the customers. Future routes are taken into account, as are the type, size and weight of the goods to be transported. The result of the computer-aided customer advice is a construction order containing detailed prerequisites on transmission, gearbox, engine performance or type of fuel. The computer programme MANTED assists MAN in its cooperation with bodywork manufacturers. It contains all technical information on the chassis, thus allowing ancillary body units, for example for fire appliances, to be precisely planned.

Head of Department

MAN holds logistics discussions to optimise the use of its transport vehicles. The aim of these is to reduce “no-load” trips, shorten idle times, improve utilisation of load capacity, through sensible route planning, and remove unnecessary heavy truck traffic from the road network and thus also reduce the environmental impact through the use of rail-borne “piggy-back” transport. Setting up city logistics warehouse centres also contributes to optimising the distribution traffic in the inner cities.

Drivers

There is a wide range of additional measures for avoiding accidents: one of the first successful measures was the “Tipptronics/Tippmatics system” (automation of mechanical gears and steering-column gear change units). This relieves the driver’s burden during gear changes, and ensures the engine operates efficiently, and thus in the environmentally compatible power range. Modern systems also help the driver to drive more safely. Thus, the ACC system (Adaptive Cruise Control) equipped with a radar distance sensor and integrated signal processing unit helps maintain a safe distance from other vehicles. A special driver aid eases of the “blind spot” problem when negotiating corners, and an automatic “keep-in-lane” system (effectively a sleep alarm) indicates to the driver if the vehicle veers close to the lane marking.

Maintenance/Repair

Easy-repair construction and a 24-hour spare parts supply service for original parts ensures that damaged vehicles can be put back into service within the shortest possible time. The proper disposal or return of components to the recycling cycle is ensured by certified workshops. The use of filter units of high technical quality allows engine oil to be used for longer. Greater intervals between oil changes reduce the consumption of fresh oil and thus also the amounts of used oil to be disposed of. The use of modern econometer systems contributes to improved recording of status data – the basis for preventive maintenance and repair work.

to be utilised more efficiently. By driving with foresight, unnecessary acceleration and braking operations can be avoided. At the same time, the stress on all running gear and drive components is reduced. This results in fewer repairs and reduced maintenance outlay – which thus also pays off from the economic standpoint.

Numerical data on Drive+Save Training

Fuel economy	–11.5 %
Increase in Speed	+4 %
Reduction in gear-changing operations	–45 %

Optimisation of Logistics through Time Savings

The optimisation of transport schedules serves to shorten non-transport operations (loading and unloading of vehicles, coupling and uncoupling). Electronically controlled air suspension (ECAS) allows the chassis to be both lowered and lifted from the driver's cab to receive swap bodies. The fact that this allows the operation to be carried out more quickly results in a reduction in the number of vehicles while maintaining the same transport volume.

Optimisation of Logistics through Increased Use of the Capacity of Trucks

There are two possible ways of increasing the capacity utilization of trucks: reducing the unladen weight and increasing the load capacity or increasing the loading volume. In both cases, the measures contribute to reducing fuel consumption.

Saving weight on the vehicle equipment – without cutting back on quality, safety and functionality – allows load capacity to be increased. Examples of increasing the loading capacity are the use of aluminium wheels instead of steel, and air reservoirs and tanks made of aluminium. The vehicle weight can be reduced by dispensing with one spare wheel and its bracket. More than 400 kilograms of unladen weight can be saved by these measures. This reduces the number of vehicles or transport operations required, while maintaining the same transport capacity.

The use of the full capacity of a vehicle in terms of volume can be optimised by double-floor loading, various close-coupling alternatives in articulated units, or by increasing load volume by means of the ECAS system and low-profile tyres.

The increased expectations of customers and the efforts of the competition have forced AUDI AG to concentrate increasingly on the quality and performance of the Audi partners. This includes the implementation of high performance standards and services in line with the high quality of the range of models offered. In order to increase customer satisfaction and customer orientation, the company continuously optimises its range of services offered.

Requirements and Regulations

Group Release Act

The Group Release Act expressly exempts the automobile industry from the EU anti-trust ban and thus grants it exclusive and selective distribution. This means that an automobile manufacturer can select its distribution partners and exclude other dealers from the supply system. This guarantees the safety of such a complex product as the automobile with a view to sustainability too. Since the Group Release Act lapses in 2002, its continuation is currently being discussed in the EU commission.

Interfaces

Dealers
The contracted dealers are included in the environmental and quality management system of the group. Contracted dealers and workshops must have established a quality management system according to DIN ISO 9000. Outlets that meet certain criteria are awarded the group's environmental seal-of-approval.

Customers
The Audi partners offer all services from sales to distribution, maintenance and repair from a single source. This brings various benefits for the customer, such as the offer of a pickup and delivery service, an emergency service and services within the mobility guarantee.

Disposal Firms
Contracted dealers must obtain certification as receiving point for end-of-life cars. They are incorporated into the Germany-wide network of the VW group for the reception and reutilisation of old cars which include, apart from the branches, 50 dismantling partners of MAS Callparts (formerly Preussag Recycling GmbH) and more than 800 certified recycling firms.

Personal Vehicle Collection

Some 25 per cent of the automobiles leaving the Audi factories in Ingolstadt and Neckarsulm every day are collected by the customers themselves. To ensure smooth functioning of this arrangement, the on-site customer centres receive precise details as to which vehicles must be available at what time. Thus, those Audi drivers who are pressed for time can leave with their new car within 30 minutes, although most customers spend far longer. Guided tours of the Ingolstadt and Neckarsulm locations are available, and to ensure the first trip in their new car is a memorable experience, the Ingolstadt site has prepared special scenic routes through the neighbouring Altmühltal for those with one or two days to spend familiarizing themselves with their new purchase.

Optimisation

Advisory Service "Environmental Protection"

Contract dealers of Audi AG receive a three-volume environmental handbook with information on laws, statutes and EU directives relevant to the environment and material data sheets and concrete tips on filling out the waste certificates. A handbook on hazardous substances provides information on hazardous substances used in automobiles, such as paints, paint thickeners and adhesives and contains lists of hazardous substances, data sheets and operating instructions. If required, the environmental representatives of the group also hold on-site advisory consultations. A further advantage is that the contract workshops can arrange for the group carry out their waste disposal at no cost.

Customer Information

The topic of environmental protection also plays an important role in the operating manuals for the vehicles. Here, the customers can find hints on fuel-saving driving methods and advice on the ecologically sound care and maintenance of their automobile. Those interested in mechanical matters can consult the brochure "What you should know about fuel consumption, exhaust gas and environment" where they can learn how to protect the environment and save money by driving economically. Those wishing to familiarize themselves with their own vehicle under expert guidance, can take part in the "Audi Economy Training".

Mobility Guarantee for Customers

Audi offers its customers a complete programme in the area of mobility services. In the case of a car breakdown, for example, the customer receives:

- a replacement car for up to five days,
- up to five nights' accommodation in a hotel for driver and co-driver,
- continuation of their journey by air or train,
- return of the repaired vehicle,
- reimbursement of taxi costs or parking charges.

Moreover, along with the extra peace-of-mind, Audi also offers important additional services such as recovery and tow services after an accident, or casualty evacuation if necessary as a result of a personal emergency. It is not only the buyers of new cars who can take advantage of the services of the mobility guarantee, since owners of used cars too, enjoy the same entitlements. Regardless of the age or mileage of the vehicle, the mobility guarantee is extended automatically upon each inspection until the next scheduled service date – the only condition being that the scheduled maintenance is performed by an authorised Audi partner.

Presentation and information: At the Audi Centers the customers learn everything they need to know about their new car.

traffic planning, environmental planning and city planning

The desire for mobility is a basic human need for movement and communication. Mobility is essential to the economic development of a country as well as offering the individual their own possibilities for personal development. Mobility is the basis of almost all entrepreneurial activities, whether the transport of goods and merchandise, the journey to work or the travelling necessary for the provision of services.

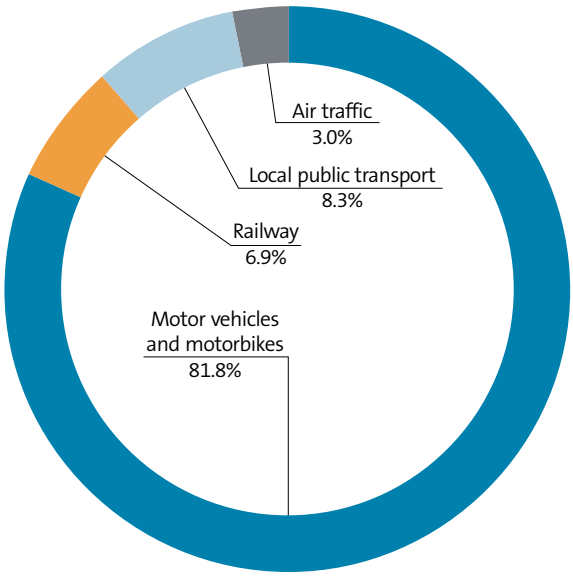
Modern man seeks the mutual compatibility of many things: to live in the country, to enjoy city life in the evening, to have a clean environment but also to travel comfortably by plane or car. These contradictory needs make the job of traffic planners a difficult one. Mobility has its price: accidents endanger the safety of the road users, the environment is polluted, thus ultimately limiting man's quality of life. It is no longer possible to solve these problems merely by building more roads. Therefore, the objective of traffic planning is to maintain the positive effects of mobility while reducing their negative effects. This is a task which concerns everyone: not only politicians, planners and car manufacturers but also the users of the product "Automobile".

Therefore, in designing for future mobility, the research world, industry and the political community must come up with coordinated measures which are acceptable to the people, social groups and companies. On this premise, the VDI Society for Vehicle and Traffic Technology (FVT) has outlined a vision of future mobility and officially approved in it in a "Memorandum on Transport and Mobility" at the World Engineers Conference in June 2000 [www.vdi.de/wit/memorandum/memorandum-mobilitaet.pdf]. Its central statement is that traffic concepts and systems must be planned and implemented in an interdisciplinary and compatible manner, unconstrained by national boundaries.

Determinants of Traffic

The volume of traffic depends on various factors: thus, the employment situation has a direct effect on the increase or decrease of the rush-hour traffic. Leisure and holiday traffic plays a more and more important role. Higher fuel prices are designed to encourage people to limit the use of their cars, or not to drive at all. However, long-term analyses have shown that increases in petrol prices bring about only a modest fall in the volume of traffic. The development of traffic is also affected by demographic factors. Thus, a shift in the age structure of the population results on the one hand in a decrease in rush-hour traffic since the proportion of the gainfully employed decreases. At the same time, it must be assumed that in the future there will be a further rise in the mobility needs of older people.

Proportion of transport operators involved in passenger traffic



Environmental Planning

A particularly important factor is traffic demand is the geographical expansion of the housing stock. Even with more or less stagnating population numbers, the population density will increase in the long run since the various land usage demands can only be satisfied by allocating additional development areas. This goes hand in hand with a more marked delineation of areas for commercial purposes, housing and shopping, which in turn results in an increase in traffic volume. The current trend towards smaller households will also continue into the future. The rising number of private households affects shopping and leisure traffic in particular.

Local authorities are important partners in the creation of housing structures and local amenities designed to reduce traffic levels, and the realisation of models for state and regional planning. In terms of avoiding traffic, state planning, environmental planning and communal building planning management are called for. Taking the "city of short distances " as the model for urban planning, the Bavarian State Development Programme (LEP) has called

for residential developments, workplaces and supply and leisure installations to be brought closer together. The industrial, housing and infrastructure development of Bavaria and its various regions is to focus on minimising the area of land occupied, without significantly impairing the natural fundamentals of life.

The following possibilities exist for reducing the area required for road construction projects:

- Economical sizing of traffic areas and other roadway elements,
- Land allocation designed to save traffic-related areas (e.g. living, working, resting),
- Minimizing the effects of parcelling up available land,
- Extension of existing roads instead of constructing new ones,
- Making full use of all options for minimising disturbance when constructing new roads.

City Planning

Traffic development plans give a detailed description of the objectives and strategies of city development planning in the traffic sector, including the measures important for the entire city, as well as of plans and programmes. They must take into account the interests of the population and industry in the city and in the region in accordance with the aims of city development and in coordination with the regional planning projects. The planning of traffic development is a continuous process which is subject to constant further development as a result of changing framework conditions caused by land utilisation plans, building measures or measures adopted by federal and state regulations.

Traffic Policy

Past experience has shown that isolated measures are hardly suitable for reducing traffic-related environmental pollution. What is needed are integrated overall concepts linking economic, ecological and social interests. This is why Bavaria has opted for a multi-track strategy: the primary goal is to avoid traffic, or at least to make it as environmentally compatible as possible. This is the purpose of switching road traffic to environmentally

Traffic Development Plan of the City of Munich

In the preliminary draft for the city of Munich's new traffic development plan 2000, the guideline "Preservation and Improvement of Mobility for all Road-Users – A City-friendly Approach to Traffic" was defined and specified by the following measures:

- To ensure mobility within Munich in a manner compatible with the city's interests, which is necessary for economic and social reasons, all measures for avoiding traffic and for switching traffic to environmentally compatible transport media should have the highest priority. This priority is a basic condition of the higher housing densities being planned, which can only be realised in a "city-friendly" manner if the local public transport facilities are attractive and offer the requisite capacity.
- In order to enhance the image of the economic region around Munich, it is essential to improve traffic conditions for commercial traffic. Apart from a sensible extension of the road network, the establishment of goods traffic and goods distribution centres and the cooperative implementation of a city logistics concept, extension of local public passenger transport is essential here too, especially with a view to switching unnecessary motor vehicle traffic.
- In order to minimise the impact of road traffic, the necessary motor vehicle traffic has to be organised in a "city-friendly" manner. This includes traffic-direction measures for interregional and inner city connections and the increased use of telematics for better traffic control as well as, for example, support for car-sharing projects, carpools or taxi traffic.

compatible and more efficient means of transport with less environmental impact and, in a further step, the efficient, environmentally and socially compatible design of transport methods and systems. Moreover, the Bavarian government supports improved operating conditions for railway goods traffic (which is not currently competitive), and the introduction of an emission-dependent road tax for two-wheeled motor traffic and an obligation to install catalytic converters.

A further focus of Bavarian traffic policy is the optimisation of vehicles and fuels. The aim is to reduce the emissions caused by diesel engines as successfully as in the case of petrol cars, where emissions have been reduced by means of regulations on catalytic converters. Bavarian companies have been working on the controlled diesel catalyst (GDK) which is primarily designed to reduce the NO_x content of exhaust gas. Since the sulphur content of fuels has an adverse effect on the efficiency of exhaust gas technologies, these have to be improved as well.

In parallel, the state of Bavaria is committed to alternative motive power systems. A current example of this is the world's first fuel cell-powered public bus service, which has gone into service in Oberstdorf as part of an initiative of the Ministry of the Environment.

A particular challenge is the protection of the population against traffic noise, which has been set down in the Bavarian government programme as a new focus of technical environmental protection. In this area, the advances made in the reduction of mechanical noise have been offset in the past few years by a sharp increase in traffic. However, it should be taken into account that noise generation depends to a large extent on the state of roads.

Every year the southbound motorways near Munich turn into a bottleneck for holidaymakers.

The essential aspects of changes in society are greater individualism and an increase in mobility. The negative consequences of this development on road traffic are particularly noticeable in conurbations.

The example of Munich: the inhabitants of the Bavarian capital use their car on average for about 40 per cent of all journeys, public transport for 27 per cent, while 22 per cent of all journeys are made on foot and 10 per cent by cycle. Even though this result looks fairly positive compared with other conurbations, in Munich it is nevertheless essential to handle the volume of traffic more efficiently. Every day 950,000 cars cross the city limits, with an additional 1.3 million car journeys undertaken in the city. This situation creates traffic jams on the approach roads, parking problems in the residential areas and high levels of air pollution. At the same time, the Munich Traffic Development Plan predicts an increase in jobs and population for the city and its environs, which is likely to lead to more commuter traffic.

Since the limits of the existing infrastructure have been reached, any additional traffic which is not kept flowing smoothly will impair the quality of life and the development of the economy and prosperity. To solve these problems, in 1995 the Bavarian capital joined forces with BMW to create the initiative "Joint Solutions to Traffic Problems". The participants include the municipal authority, BMW, the Chamber of Industry and Commerce (IHK), the Trade Corporation, the General German Automobile Club (ADAC), the Munich Transport Authority (MVV), the Planning Association for the Economic Region of Outer Munich, the Association of Bavarian Retail Businesses and representatives from the parliamentary parties in the city council. In joint sessions, projects for the optimisation of the traffic situation were developed and studied. In this context, the IHK has assumed the sponsorship for the project "Parking Space Management".

Optimisation Projects

MOBINET

The initiative described laid the foundation for MOBINET: 25 institutions participated in this research project, which was one of five projects to be sponsored by the German Ministry of Education and Research (BMBF) within their invitation to tenders "Traffic in Conurbations". The project focuses on traffic optimisation within the main road network of the city of Munich and ways of influencing the selection of means of transport in the surrounding region. Provision such as city/regional trains, suburban trains, Park+Ride and an improved shuttle system are intended to shift commuter traffic from the road to the railway. At the same time, the objective is to ensure that the remaining motor and public traffic runs smoothly, by means of an optimised network of main roads. More use is to be made of the existing infrastructure, including car parks, using telematics, IT, guidance and control systems, so that traffic as a whole flows more smoothly.

Telematic control processes are to be used at four levels typical of conurbations: the regional information system is intended to direct through traffic towards motorways, at the transition to the city network changing direction signs and an adjustable traffic light control system directs traffic towards the city. The ring control system directs traffic on the Middle Ring Road and its approach roads, via dynamic traffic information, while in the inner-city quarters, too, light signal control is intended to open new routes. Finally, according to the report by the Association of German Engineers (VDI), making traffic run more smoothly not only reduces traffic jams but also cuts accidents on motorways by 30 per cent. In parallel, MOBINET is investigating the possibilities of multimedia information services. Here the key objective is to provide and combine individualized mobility-related information on traffic, tourism, environment and leisure. In this way, the Personal Travel Assistance Service (PTA) gives the users the opportunity of selecting service and leisure offerings according to location, time and means of transport. The investigation of mobility behaviour and of new mobility patterns should provide additional indicators.

Car-Sharing

Not everybody who occasionally needs a car necessarily has to buy one: this is the basic idea behind car sharing which at the same time is designed to decrease car traffic. Individuals who share a car with others will only use it when absolutely necessary, and will more often look for alternatives. Munich has two car-sharing organisations with a total of 46 stations distributed throughout the entire city. Members pay a deposit and a modest monthly charge, and can book the car of their choice, at any time, for a period of hours, days or even months. For each community car, there are 15 members who, at 3,000 kilometres a year, drive much less than the average German citizen. At the same time, according to a survey by the Munich Transport Authority (MVV), an average of five

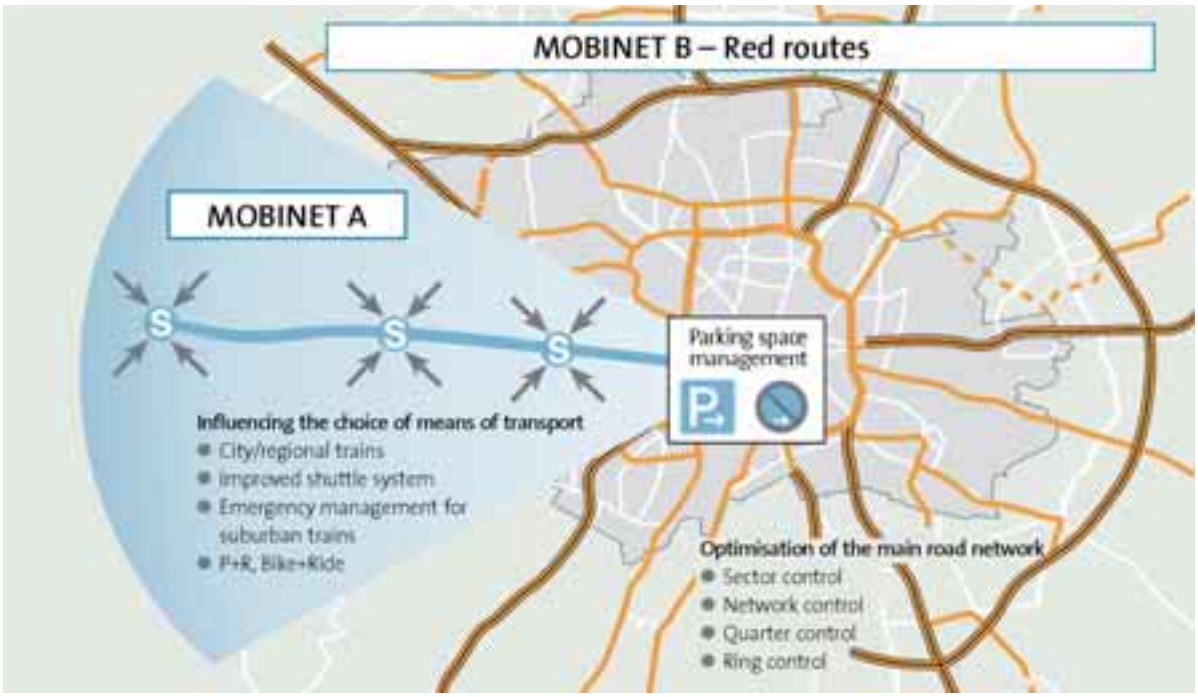
passenger cars are eliminated for each car in the scheme. Through the German Car-Sharing Society reg. Soc. (bcs) [www.carsharing.de] and the European Car-Sharing Society (ecs) [www.carsharing.org], the use of cars in other cities is also available to the members of the car-sharing organisations. Some 1,800 cars are now available in a total of 200 cities all over Germany.

Local Public Passenger Transport

The draft of the new traffic development plan for the city of Munich plans a further extension of the local public passenger transport (ÖPNV): the underground network will be extended in the next few years to a total of 108 kilometres. In parallel, it is planned significantly to extend the tramway system and to promote the extension of "fast-track" lines. The suburban railway system, for which the state of Bavaria and the Bavarian Railway Company (BEG) are the competent authorities, is also to receive new lines and stations. Park+Ride and Bike+Ride are essential elements of a combination of ÖPNV and individual transport for commuters and visitors. In Munich, four large car parks with more than 1,000 parking spaces each, located at the outskirts of the city, and with direct connection to the ÖPNV form the cornerstones of the Park+Ride concept. This is supplemented by inner city facilities to cater for local demand. The Bike+Ride concept includes the extension of the bike parking spaces at railway stations and roofing over these facilities. In order to make the use of ÖPNV as reliable and simple as possible, the Munich Transport Authority (MVV) offers a detailed timetable on CD-Rom and on the Internet [www.mvv-muenchen.de], while the timetables for other Bavarian cities and regions are available on "Bayerninfo" [www.bayerninfo.de].

IPP Challenge: Despite the Reduction in Specific Fuel Consumption, Consumption in Absolute Terms Increases

The great advances made in the development of fuel-saving engines have led to decreasing fleet consumption. However, these positive effects are offset by a steady increase in the motor vehicle population and in mileage. Consequently, changes towards a sustainable development cannot be controlled on the supply side alone, but also demand effort on the demand side too.



operation

The average service life of a motor vehicle is about ten to twelve years. During this time, the user is the only one responsible for the environmental compatibility and safety of the product "Automobile" and thus bears a very personal responsibility. Depending on how he behaves, the environment will be more or less polluted, for example through low petrol consumption or recycling of the wash water. Apart from the driving speed and the type of vehicle, a decisive factor for the emission of noise and hazardous substances is driving performance. The main emission sources of a motor vehicle are the engine, the fuel tank ventilation and running gear (tyres, brakes). In order to handle the car "properly" and to observe the rules of the Road Traffic Act, the vehicle owners need broad knowledge. As a group representing the interests of car drivers, the General German Automobile Club (ADAC) reg.Soc. provides a wide range of information on various aspects of car ownership such as, for example, test reports or documentation on travel planning. In Bavaria alone, the ADAC has more than two million members.

Laws and Regulations

The car is one of the few products whose use is regulated by law. This also includes environmental aspects, which must be taken into account right from the early stages of product development. Thus, cars without catalytic converters can no longer be licensed, and the stipulated exhaust gas limits must be observed. Moreover, the vehicle owner must submit his car to regular exhaust gas tests.

Interfaces

Technical Inspection
The technical roadworthiness of an automobile is checked regularly by the Technischer Überwachungsverein e.V. (Technical Inspectorate), DEKRA or other experts. Vehicles which are no longer safe to drive are removed from circulation.

Driving Schools
Before taking the wheel, all car drivers have to learn to drive safely and properly at a driving school. Only after passing the driving test are they authorised to become a road user. The German Union of Driving Instructor Associations reg. Soc. has published, in cooperation with Volkswagen AG, "Curricular Guidelines for the Practical Training in the Use of Passenger Cars". Apart from the technical requirements of handling a car, environmentally compatible driving techniques have also been integrated into overall driving training. In addition, the "Instructions on Environmentally Compatible Driving" reiterate to every learner driver the benefits of using a car with minimum ecological impact.

Workshops
At some time, every car has to go to a workshop, either for maintenance and servicing or for repair. Workshop tests are provided by ADAC.

Infrastructure (roads, petrol stations, car washes and rest areas)
In its brochure "Motorway Rest Areas with Minimum Ecological Impact", ADAC provides tips and assistance on switching to a mode of operation with minimum ecological impact. A unique ADAC campaign was the "Quality Seal of-Approval for Environmentally Friendly Petrol Stations" mounted at a time when gas recirculation systems were not yet a legal obligation. Currently, the association checks that the suction devices for petrol vapours at petrol stations function properly. Those drivers wishing to clean their car in an environmentally compatible manner need only look for the "Blue Angel" symbol, which identifies car washes that reprocess dirty water and use it again.

Manufacturers
Manufacturers provide their customers with information on the technical aspects of the car in users' manuals. The services covered by warranty, supply of spare parts, especially via contracted workshops, and take-back guarantees show that automobile producers stand by their responsibility during the entire life cycle of the vehicle.

Product Requirements and Product Design

As regards the purchase of automobiles, customers in Germany may be seen as fairly demanding. There is total agreement that cars must be as safe as possible. Apart from this, their wishes differ quite markedly. Many buyers seek a particularly fast and high-powered car, for others space and comfort are important, others again look for low petrol consumption or even for a favourable price/performance ratio. ADAC informs its members on new models and their advantages and drawbacks through car tests in the magazine "motorwelt". In the ADAC practical test, it is club members and the readers of the magazine who assess comfort, user friendliness, and other aspects of the cars concerned. The Test Reports also provide information on consumption and emission values, recyclability and service life. Moreover, they include comparisons of acquisition and running costs, resale values and outlay on maintenance and repair. The test results published have some influence on purchasing behaviour and thus also affect manufacturers, as reflected in design modifications or improvements in handling and ease-of-repair.

Product Use

ADAC not only offers its members information on proper behaviour in road traffic and on safe driving (on slippery roads, with winter tyres, etc.) but also active road traffic assistance, for example through its breakdown service and its road patrol service.

Information on car-related environmental issues encourages car owners to drive in an environmentally compatible manner. The ADAC also promotes raises its members' awareness of their individual responsibility for environmentally compatible disposal.

With its statements on traffic policy, road construction, speed limits, 30 km/h zones, legal framework conditions, or its comments on fiscal policy decisions (infrastructure, taxes, petrol prices, etc.), ADAC influences policies on behalf of car drivers.

Optimisation

An essential factor of influencing the petrol consumption of a vehicle is individual driving behaviour. Those who always drive at high revs need to refuel far more often than someone who selects fourth or even fifth gear when driving at 50 km/h. In order to promote responsible driving with low ecological impact, ADAC has drawn up a three-stage training concept. For beginners who have only just received their driving licence, ADAC initiated the "Drive and Be Smart" campaign, in cooperation with the TÜV Süddeutschland (Technical Inspectorate for Southern Germany) and in coordination with the Ministry of Education and the Arts and the Ministry of the Environment. Initial investigations have shown that driving in an environmentally compatible manner is an important issue for teenagers too, provided it is communicated vividly and humorously. Senior students are addressed by the ADAC "Fuel-Saving School" campaign, and encouraged to drive without "putting their foot down", to drive at low revs, switch off the engine during lengthy stops, constantly

monitor fuel consumption adjustment, change air filters and spark plugs regularly, change the oil at petrol stations and check their tyre pressure regularly. The third stage involves driver training sessions, which are currently being piloted, and are intended for companies with large vehicle fleets, whether cars, vans, trucks or buses.

Since there is nothing more environmentally friendly than foregoing the use of your car for a while, ADAC recommends more discrimination and flexibility in choosing the means of transport, and in this connection particularly promotes the Park+Ride concept: in the morning commuters should park their cars on the outskirts of the city at the special car parks, and switch to suburban or underground trains for the last few kilometres to their workplace in the centre. Additionally, ADAC in Ingolstadt, in collaboration with the local transport association (INVG), offers its members an annual ticket reduced by 200 deutschmarks under the "Drive smart + save" banner.

Drive and Save Training

The programme "Safe Driving and Saving – Safe, Economical and Environmentally Friendly Driving" jointly mounted by the trade associations and the German Council on Traffic Safety reg. Soc. provides information for safety experts, and recommends actions within the trade associations' education and adult education programmes. This training programme is designed to encourage better behaviour in road traffic, reduce damage and accidents on journeys on work and official business and lower exhaust gas emissions and fuel consumption, at the same time as reducing wear and tear on gears, tyres and brakes. Address: German Council on Traffic Safety reg. Soc. (Verkehrssicherheitsrat e.V).: Phone: +49 228 4 00 01-0, Fax +49 228 4 00 01-67, [**dvr-bonn@t-online.de**].

All major automobile manufacturers also offer their customers so-called Eco-Training, which, however, has generated very little response so far – even free courses offered by car dealers have not been taken up, even though fuel consumption can easily be lowered by up to 25 per cent through improved driving techniques. This means that the car users first have to be made aware of environmentally compatible driving behaviour.

fuel production

A car alone does not confer mobility, but requires fuel to power it. Until now, most vehicles have run on petrol or diesel fuel. A few cars use rapeseed methyl ester (also referred to as biodiesel), natural gas, electric current or hydrogen. About 57 million tonnes of petrol were consumed in Germany in 1998. Fuels are produced by mineral oil companies in refineries.

Production

Conventional fuels are essentially based on crude oil, which in turn consists of a number of hydrocarbons. Many production steps are necessary in producing the end product, petrol. The basic process at the refinery is to carry out distillation by heating the crude oil. The rule is that more heating produces a lighter end product. This is why the production of petrol especially, in contrast, for example, to the heavier heating fuel, is very energy-intensive. To ensure that fuels comply with legal requirements and the quality demands of the automotive industry, further treatment, such as the use of additives, is necessary. This removes unwanted components such as sulphur and improves the ecological properties of the product.

Optimisation

To reduce pollutant emissions due to motorway traffic, a European Auto Oil Programme has been created with the aim of reducing the sulphur content of fuels. German mineral oil companies have been offering grade Super Plus petrol with a maximum sulphur content of 50 ppm (parts per million) since January 1st 2000, five years earlier than required by the European Union.

German lawmakers adopted an environmental tax reform with the aim of cutting down consumption by an increase in prices. Mineral oil tax will thus be raised step by step.

At the mineral oil refineries, most process and cooling water flows are recirculated. Vapour recovery equipment contributes to reduced hydrocarbon emissions.

IPP Challenge: The Pros and Cons of Low-Sulphur Fuels

The reduction in the sulphur content of diesel fuel to 50 ppm will lower SO_2 emissions from motor vehicles by 50,000 tonnes/year. However, greater technical effort at the refineries is necessary to produce this fuel grade. Moreover, higher energy consumption during production would generate an additional CO_2 emission of 550,000 tonnes/year over the same period of time.

In order fully to exploit the fuel-saving potential of direct-injection internal combustion engines while maintaining low exhaust gas values and thus reduce CO_2 emissions from traffic, the mineral oil companies have to make sulphur-free fuel (sulphur content <10 ppm) available.

petrol stations

Fuels are available at more than 16,000 filling stations in Germany. In addition to petrol, they offer oil change and car wash service, and often also carry out repairs. However, the growing range of food, newspapers and gifts on offer at the filling stations accounts for more profit than the sale of fuels itself. Most petrol stations are integrated into the distribution network of the large mineral oil companies by lease and purchase contracts, but there are also "free" petrol stations working independently.

Optimisation

Vapour recovery systems containing suction tubes prevent hydrocarbons from being released into the atmosphere during refuelling. By means of the gas suction tube, the petrol nozzle sucks in fuel fumes and returns them to the underground tank through an internal tube. The hard-standing around the fuel pumps is impermeable to liquids to ensure that spilled fuel does not seep into the ground, and the underground storage tanks are double walled and provided with safety and alarm systems in the event of leakages. In addition, many filling stations have set up closed-loop systems for car wash water. They carry the Blue Angel eco-label.

The used-oil directive of 1986 gives recycling into secondary mineral oil products priority over incineration, for example in cement factories. Filling stations must have a collection point for used oil and take back used motor oil and lubricants equivalent to the amount of fresh oil sold and forward them to a recycling or disposal facility. Empty oil cans are also collected and recycled.

The great majority of petrol stations have now installed gas recovery systems. So-called suction tubes prevent fuel vapours from being released into the air during the refuelling of vehicles.

repair/shops

An important objective of ecological product design is a long service life of cars. Maintenance and repair play an important role in achieving this goal. The Motor Vehicle Association for Munich and Upper Bavaria represents some 2,000 car dealerships and repair shops in the district of Upper Bavaria. Some 55 per cent of these businesses specialise in particular brands and are part of the selective sales and distribution system practised by car manufacturers and dealers. The 900 or so repair shops that are not tied to a specific make of car are mostly family-run small businesses and employ fewer than 10 people.

Interfaces

Manufacturers
Car manufacturers and garages tied to a specific make of car work closely together. Sales and service staff are always kept up to date on the latest technical developments, ensuring a consistently high level of safety in the event that car manufacturers have to initiate a recall campaign.

Dealerships
Sales outlets owned by the car manufacturers as well as authorised dealerships and service centres within the selective brand-specific distribution network maximise customer benefit in terms of their vehicle's service life: the necessary spare parts are always in stock, thus allowing the car to be back on the road within a short period of time. Vehicle owners can rely on a nationwide network of dealers and garages who work closely together with the corresponding car manufacturer.

Customers
The customer benefits from a closely-meshed pan-European network of dealerships and service centres which also carry adequate stocks of spare parts.

Disposal of End-of-Life Vehicles
The motor trade has established a nationwide system for the environmentally compatible disposal of end-of-life vehicles. There are currently about 500 receiving stations for old cars, which are certified to the end-of-life vehicle ordinance. These companies, whose compliance with established environmental standards is certified in advance, work together with recycling companies which are also certified to the end-of-life vehicle ordinance and which issue complete documentation on the whereabouts of parts and materials (see chapter 4.6 "Recycling").

Requirements and Regulations

All companies are required to conduct their business in accordance with environmental requirements. They are encouraged to use water and energy sparingly and handle consumables and hazardous substances in a responsible manner. Working together with the Bavarian Ministry of the Environment, the Bavarian branch of the German Association of the Automotive Industry and other Bavarian motor vehicle associations, the Motor Vehicle Association for Munich and Upper Bavaria have drawn up a manual titled "Der umweltbewußte Kfz-Betrieb" ("The Environmentally Conscious Motor Vehicle Shop").

Manual "The Environmentally Conscious Motor Vehicle Shop"

The manual offers businesses practical guidance on environmentally compatible management, ranging from cost and environmental aspects to waste prevention and proper disposal, energy and water consumption and purchasing. In addition to technical information, the manual also offers advice and checklists for all environmentally relevant business areas. For a copy write to Bayerisches Staatsministerium für Entwicklung und Wirtschaft (Bavarian Ministry of Development and Economic Affairs), Rosenkavalierplatz 2, D-81925 Munich, phone: +49 89 92 14-0.

Sequences and Processes

Dealerships and workshops linked into the support system created by the motor vehicle association guarantee that cars keep functioning optimally during their entire life cycle. Regular inspections are carried out on cars, and defective parts are replaced or repaired. The service centres also check at regular intervals whether the emission limits prescribed by law are observed.

Partslife

Instead of operating a costly take-back system, the manufacturers and dealers in automotive parts can use a joint disposal system. As a self-help organisation created by independent spare part businesses, Partslife handles the environmentally compatible disposal and recycling of spare parts. The focus of the organisation's work is on coordinating the disposal of used spare parts from independent repair shops and on giving support in all matters relating to disposal. At more than 100 locations all over Germany, Partslife currently offers a comprehensive disposal and recycling network for a wide range of products. In addition, the organisation checks on the reliability and quality of the disposal facilities bound by contract. They must be certified and observe certain maximum price limits [**www.partslife.de**].

All parties involved are currently striving to establish a functional spare part market so that older car models can be repaired at a reasonable cost. However, much work still needs to be put in on convincing the customer, since vehicle owners are often sceptical about the use of used spare parts, especially in insurance cases. It is therefore important that used spare parts are accompanied by a warranty and that the car manufacturer's unconditional guarantee remains valid if a vehicle is repaired with used spare parts. However, at present used spare parts are not yet available in sufficient numbers.

Optimisation

The Bavarian Association of Automotive Mechanics has drawn up a list of voluntary environmental services. Businesses meeting the requirements of the checklist or those who participate actively in Agenda 21 activities of the local communities are entitled to join the Environmental Agreement for Bavaria.

For member businesses not tied to a specific make of car, the vehicle association offers training programmes for mechanics who want to take the master craftsman's examination, technical training and computer classes at the association's own training centre. The schedules for these activities are listed in the magazine "kfz-betrieb".

dismantling

An automobile is not easy to dismantle. After all, it comprises up to 10,000 different parts. Complete dismantling is not economically feasible, ecologically useful or technologically necessary. In order to use end-of-life vehicles as a raw material source, it is sufficient to segregate the different materials. Scrap cars are always used as a source of spare parts before they are materially recycled. Intact parts are used for to repair older cars. Repair at reasonable cost saves raw materials and energy, as new spare parts would otherwise have to be produced. The Munich end-of-life vehicle recycling company Schindelar [www.schindelar.de] has a permanent stock of 40,000 items, 90 per cent of which come from dismantled end-of-life vehicles or vehicles which have been involved in accidents. Used or new parts are then built into the vehicles of private customers in Schindelar's own repair shop.

Interfaces

Customers
Functional spare parts are sold to garages in Germany and abroad, as well as to reprocessing companies and private users. Used spare parts may be returned to Schindelar or exchanged within four weeks after purchase. If necessary, the customers are provided with data sheets and information on the environmentally compatible use of the parts they have purchased.

Suppliers
End-of-life vehicles are delivered either by private individuals, car dealers, or breakdown services.

Partners
Schindelar is linked into the network of decentralised, qualified, accredited recycling plants set up by car manufacturers to ensure the recycling of metals and plastics. Most car manufacturers publish manuals with detailed information on the environmentally appropriate recycling of their products. In addition, there are recycling training sessions on new developments in vehicle recycling. As a partner in the MAS Callparts system (formerly Preussag recycling system), Schindelar also buys test cars from automobile manufacturers and recycles them.

Requirements and Regulations

Scrap cars are dismantled in accordance with the ordinance on end-of-life vehicle management. Suppliers are, of course, bound by law to observe all relevant statutory regulations when delivering end-of-life vehicles. Complex parts are tested to check whether they are still in working order. A "Procedural Instruction on Dismantling" describes how proper, environmentally friendly dismantling has to be carried out. In addition, Schindelar has prepared a manual with work instructions.

Instruments

For dismantling, the IDIS database of the European Automobile Manufacturers is used (see chapter "Recycling concepts", page 73).

Dismantling: Sequences and Processes

Firstly, end-of-life vehicles are pre-treated. The battery and all operating fluids such as fuel, lubricants, brake fluid, cooling agents, shock absorber fluid, windscreen washer fluid and antifreeze are removed and pyrotechnical components such as airbags and seatbelt tensioners are taken out. To prevent soil and groundwater from being contaminated, this work is carried out on concrete hard-standings. Only then does the dismantling process itself begin, during which functional engines, transmissions, axles, alternators, wheel rims, body parts, etc. are removed. Operating fluids and unusable parts and materials are properly stored before being forwarded to accredited disposal plants.

Residual materials for which no means of recycling is available are flattened and crushed to save costs, before they are sent on to shredder plants. To avoid a further increase in road traffic, scrap is transported by rail.

Optimisation

Schindelar has already established a high-quality recycling system. The company separates up to 40 different materials, ensuring especially that plastics, glass, expanded foam and metals are segregated. Major progress has been made recently now that it is possible to regulate the direct use of remanufactured components. For example, used engines are checked and resold with a warranty.

End-of-life vehicles are dismantled according to the manufacturers' instructions by trained staff who are aware of the environmental relevance of their work. Regular training and information about new developments contribute to this.

shredding

Shredding allows steel and iron to be almost completely recycled and returned to the production process. This is also true to a great extent for non-ferrous metals such as aluminium, zinc, copper and lead. The business activities of the Munich recycling company Taxer Schrott- und Metallgroßhandel GmbH are quite different from the work of a traditional scrap yard. Taxer recycles 30 per cent of end-of-life vehicles and 70 per cent of collected scrap.

Requirements and Regulations

Shredder plants must be approved under the Federal Pollution Protection Act and have to fulfil a series of stringent requirements. Moreover, they must comply with the ordinance on accredited recycling plants, the end-of-life vehicle ordinance and the requirements of the plant permit. The rules staff must observe are laid down in a manual.

Steel works require that shredded scrap have a purity of 99 per cent of iron. Most importantly, the scrap must not contain more than 0.3 per cent copper to ensure satisfactory melting results. In addition, the apparent density of shredded scrap should be high.

Instruments

Taxer is a member of the National Association of Steel Recycling and Disposal Companies reg. Soc. and participates in the expert "Shredder" group, which seeks to improve the recycling of shredder fluff.

Dismantling: Sequences and Processes

First, random samples are taken of the scrap cars to ensure that they are completely drained of fluids. They then go to a shredder plant where they are cut up into pieces about 10 to 15 cm in size. The pieces go through a multi-stage sorting plant, where they are separated according to type, weight and size by means of a wind sifter. A reverse current ventilator then removes lightweight non-metallic particles such as textile residues, fluff, foam or carpet residues (so-called shredder fluff). Finally, separation of the remaining shredder heavy fraction into a magnetic (steel, iron) and a non-magnetic fraction (non-ferrous metals, glass and stones) is performed in a magnetic drum.

Interfaces

Customers
To meet the customers' quality requirements and comply with environmental regulations, regular audits are held from the inspection of incoming materials to the final inspection of goods leaving the yard. As an accredited recycling company, Taxer GmbH is also certified to quality standard ISO 9002 and the end-of-life vehicle ordinance.

Suppliers
Taxer buys scrap cars only from accredited vehicle recyclers, either in compressed form or in containers. The fact that the suppliers are certified to the end-of-life vehicle ordinance guarantees the smooth running of Taxer's operations, good product quality and a minimum amount of shredder fluff.

Partners
Taxer is a member of the German Recycling Association for Steel and Non-Ferrous Metals (ESN) and participates in their information and training system.

Optimisation

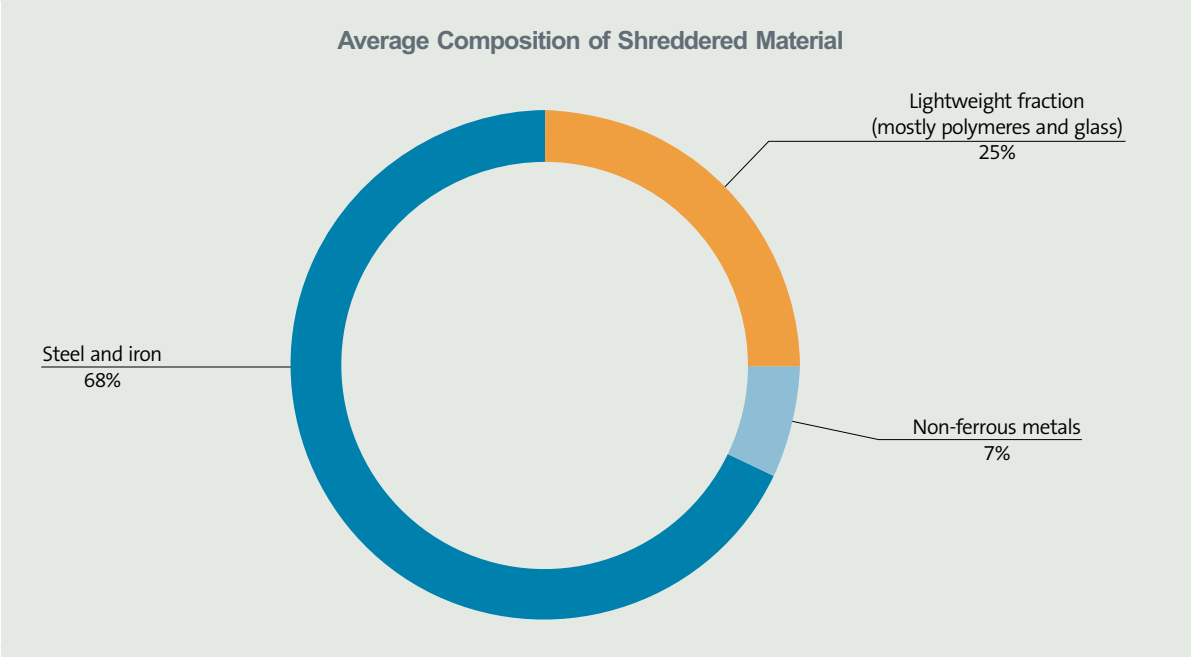
A conveyor belt takes the magnetic fraction to a sorting station. Here it is sorted manually to remove copper coils with iron cores, which are often contained in shredded scrap as electric motors are increasingly being used in cars. Other impurities such as cable residues, safety belts with iron buckles or metal-reinforced tyre pieces must also be removed manually. Once the required purity level is achieved, the shredded scrap is sent to steel works by train, where it is used as a secondary raw material. The lightweight fraction is compressed by two waste compactors and used as fuel in heating power stations.

The non-magnetic fraction is separated by sieves into a fine-grained and a large-grained portion and delivered to specialised disposal plants where the remaining metals are sorted out by combined filtration and flotation and impact crushers. The metals go to foundries to be used as secondary raw materials, while the remaining waste is incinerated with recovery of energy or used for back-filling stopes in mining.

Fuel residues in the tanks of end-of-life vehicles may cause small detonations during the shredding process. This is why shredder plants are equipped with devices for absorbing impact, and fire extinguishers.

An adjustable system maintaining consistent flow conditions in the cleaning channel has been installed to make it easier to separate lightweight insulating materials. The dust extraction unit ensures a fine dust content of less than 30 mg/m^3.

In the future, further improvements will be made on the separation of rubber and cable residues. Glass, textiles and plastics contained in shredder fluff are still difficult to sort and recycle.



recycling concepts

The car manufacturers' responsibility does not end the moment the vehicle is delivered to the customer. It extends over the whole product life cycle – from production to disposal. The recycling concepts of car manufacturers are aimed at closing material loops to allow the materials and substances used to make cars to be utilised as long and as efficiently as possible.

Requirements and Regulations

BMW makes provisions for recycling already at the design stage (see chapter on "Product Design", page 43).

Recycling Process: Sequences and Processes

The recycling system ensures that each vehicle component is handled in an environmentally sound manner and at a reasonable cost. The recycling process is divided into the following steps:

>> Pretreatment: Removal of batteries and operating fluids such as lubricants, coolant, brake fluid, fuel and cooling agent from air conditioning units, treatment of pyrotechnical components.

>> Dismantling of components and materials: Functional used parts such as engine, transmission and alternator are removed and resold, ensuring recycling of a consistently high standard. Plastics, glass, tyres and metals are dismantled and sorted, and the resulting materials are recycled and resold. Thanks to the dismantling of recyclable spare parts and materials it has become possible to reduce shredder fluff from on average 250 kg to about 150 kg per end-of-life vehicle.

>> Shredding: Ferrous and non-ferrous metals (e.g. copper, zinc, aluminium) and organic and inorganic residues (shredder residues and fluff) are separated by a mechanical process.

>> Shredder fluff is incinerated with energy recovery.

Optimisation

To fulfil the automotive industry's pledge, BMW and its qualified partners have set up a nationwide network of nearly 100 accredited recycling plants with about 200 receiving stations. The environment-friendly disposal of scrap parts from repairs is ensured by an independent repair shop disposal system which 90 per cent of BMW dealers have joined to date.

The national recycling network is the basis for the international joint venture "Together for Recycling" which BMW has set up with Rover in the UK, Renault in France and FIAT in Italy. The partners have agreed to encourage the further organisation and qualification of accredited recycling plants and make it available to their respective partners. For example, the German recycling network is also open to ELV of the brands Fiat, Renault and Rover and vice versa. In addition, BMW offers its extensive recycling network to partners in Sweden, Austria and The Netherlands. The first recycling plants have already been accredited in the US and Japan.

Interfaces

Recycling Plants
Consistent requirements and the inspection and certification to the end-of-life vehicle ordinance of receiving stations and recycling plants by independent auditors are to ensure high environmental standards and the observance of statutory regulations.

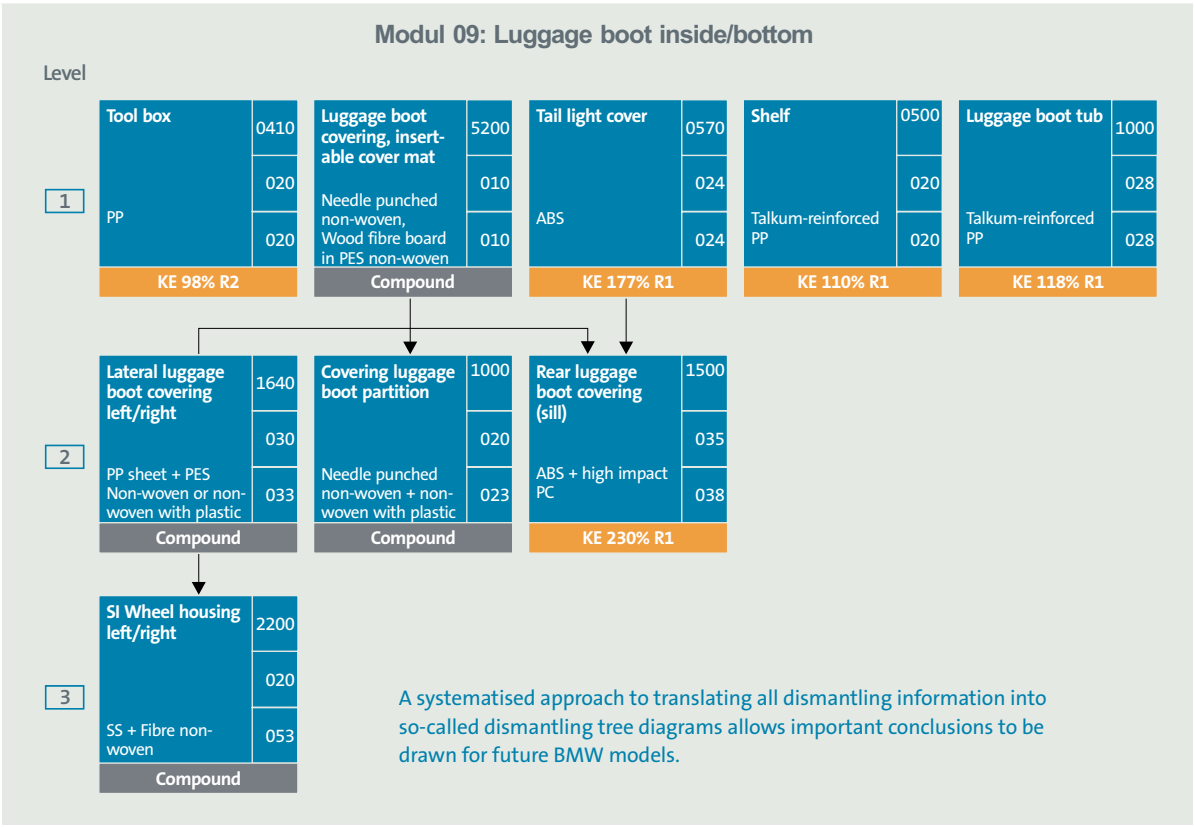
Users/Customers
The last owner is obliged to take his end-of-life vehicle to an accredited recycling plant or a receiving station. A hot-line has been set up to inform vehicle owners of suitable disposal plants within easy reach.

[ELV hot-line in Germany: (0180) 5 00 21 26]

Instruments

A cornerstone of BMW's recycling activities is the Recycling and Dismantling Centre (RDZ) the company has set up. It allows end-of-life vehicles to be recycled at a reasonable cost and in an environmentally responsible manner. As a platform for research and development, it makes a significant contribution to further improving the recycling properties of future generations of cars. The RDZ regularly carries out "dismantling analyses" simulating the dismantling of the various modules of a car, such as windows, doors, seats, or engine compartment. The knowledge gained from these tests flows straight back into the computer programme IDIS (International Dismantling Information System). A continuous exchange of information between the RDZ, the international BMW sales and distribution organisation and the BMW recycling network guarantees that the recycling concept is consistently implemented. The RDZ is available to the recycling partners for training and advice.

To date, 20 automobile manufacturers have supplied information on 350 car models to the IDIS database. Components suitable for material recycling are described in detail, along with material information, dismantling recommendations, weight, dismantling times and drawings of the structures of the individual modules. IDIS is available in 8 languages and has been distributed in the form of a CD-ROM free of charge to more than 2,500 recycling companies in Europe [www.idis2.com].

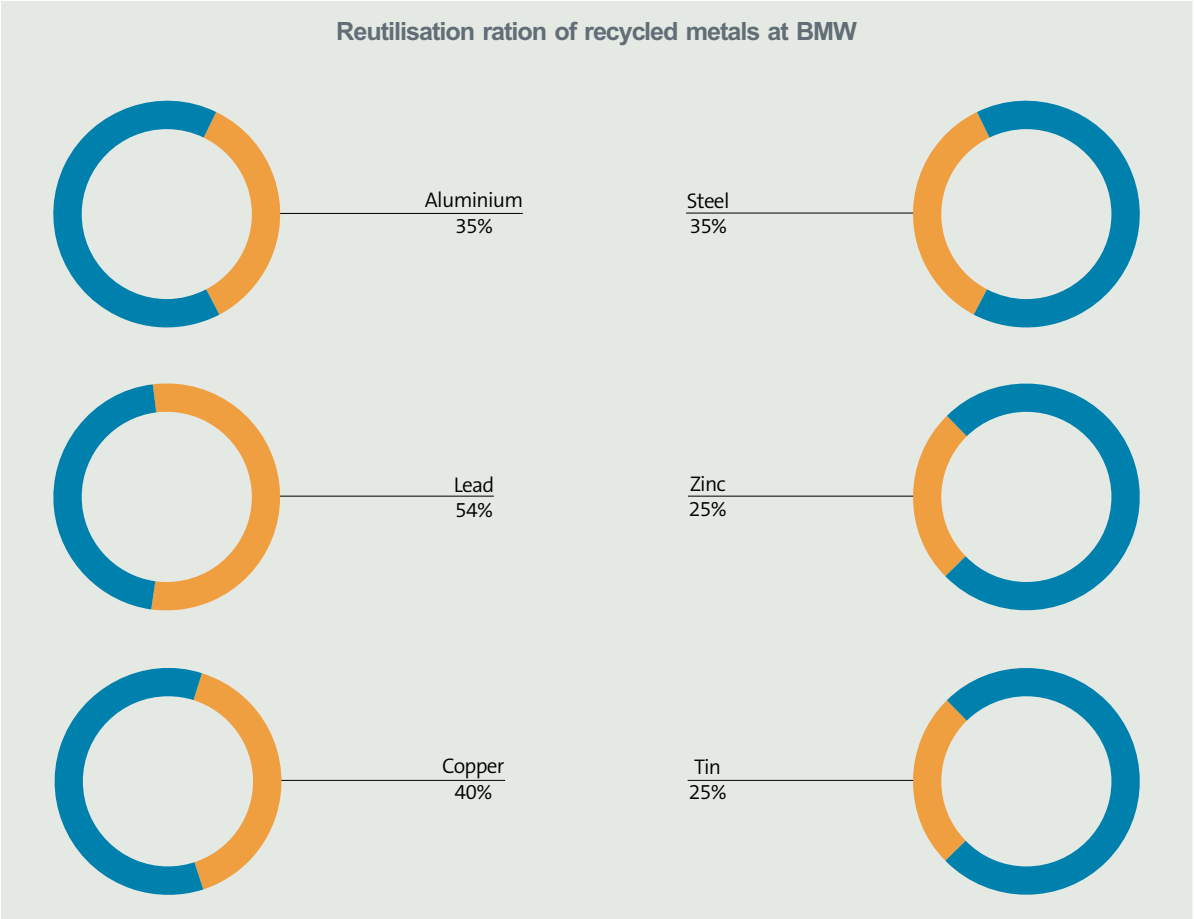


A systematised approach to translating all dismantling information into so-called dismantling tree diagrams allows important conclusions to be drawn for future BMW models.

utilisation as a secondary raw material

The materials used in automotive construction make cars a “raw material resource on wheels”. For some time now, it has been possible to recycle about 75 per cent of the total weight of an end-of-life vehicle and use the resulting materials as fresh raw materials. This applies mainly to segregated materials which can be made into quality-controlled secondary raw materials as per specification. Today, secondary materials cover a good proportion of the overall demand in Germany.

In contrast to metals, the recycling of plastics or polymer materials from end-of-life vehicles is still in its infancy. At present, only 10 per cent by weight of a new plastic part can be made from recycled materials. Car manufacturers



Interfaces

Dismantling plants
This is where recyclable used parts are dismantled and segregated and sent on to recycling plants.

Recycling plants
Working with partners from the plastics and textile industries, BMW has developed an innovative single material concept including new methods for the processing of polyurethane.

are currently only using a small proportion of recycled materials, the majority originating from recycled production residues. BMW intends to approve and use recycled materials so as to stimulate demand. The overriding aim is to close the material loop for plastics as has already been done successfully with some thermoplastics and duromers.

Requirements and Regulations

As more and more demanding requirements are made on cars in terms of fuel economy, there is a strong trend towards lightweight construction, which is leading to a shift in the composition of materials. Traditional materials such as steel are increasingly being replaced by lightweight metals and plastics, with the result that the proportion of plastics per vehicle has more than doubled over the last 20 years to up to 160 kg.

Instruments

The Recycling and Dismantling Centre (RDZ) was described in detail in the chapter on “Recycling concepts”, page 73 and the construction suitable for recycling under “Product Design”, page 45.

Recycling Process: Sequences and Processes

Designers choose the plastics to be used in cars in accordance with their dismantling and recycling properties. For example, the instrument panel carrier of the BMW 3 series is made of a thermoplastic SMA GF-10 base layer with semi-rigid expanded PUR filler and a sprayed PUR top coat. After being removed from end-of-life vehicles, the instrument panels are crushed together with rejects and stamping waste from production, then rid of metal residues by means of a metal separator and finally ground. The ground material is then separated into its individual components by a dry mechanical process.

The largest fraction of the resulting materials, at about 60 per cent, comprises thermoplastic SMA which can be recovered with a purity of 99.5 per cent for use in hot-air ducts for instrument panels. The remaining ground decorative and expanded foam fractions are mixed with binders and made into marketable sheets or building components.

Optimisation

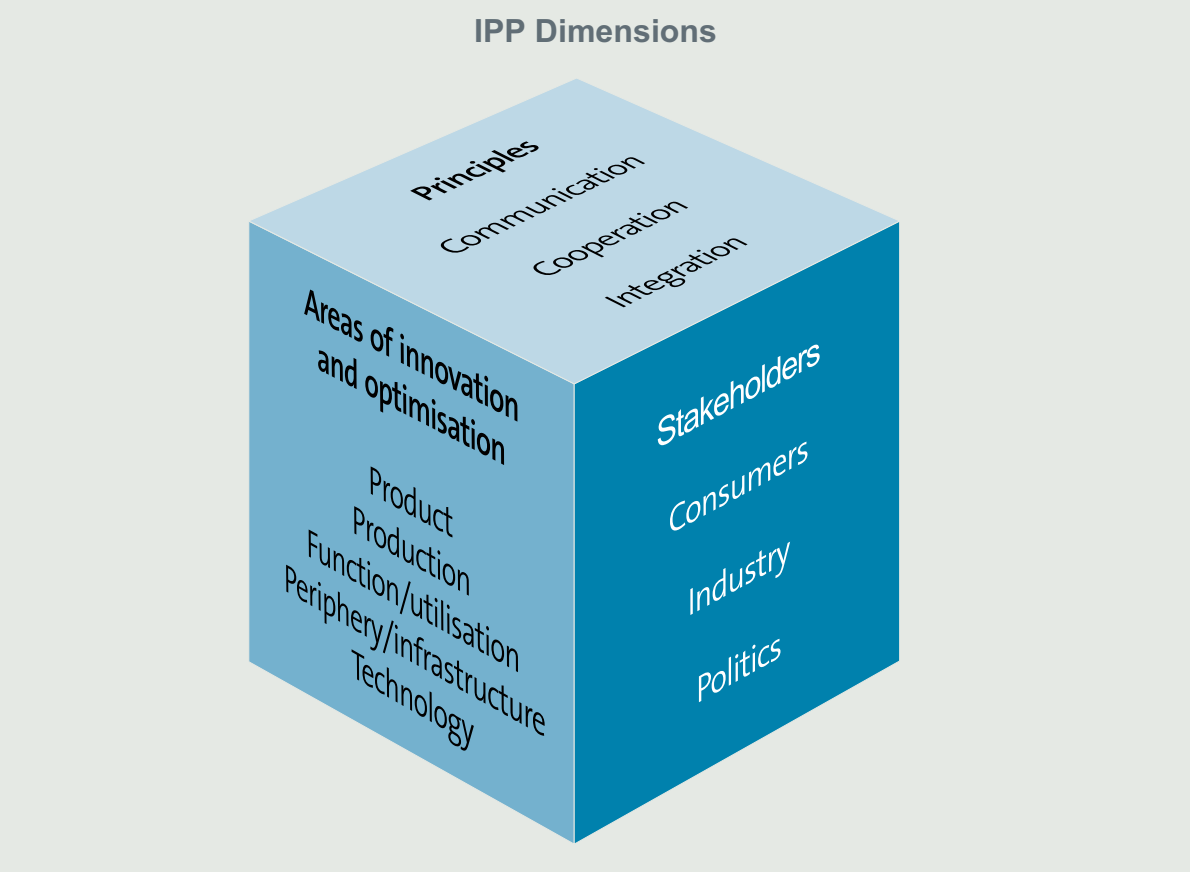
The end-of-life vehicles currently being delivered for disposal are older models containing plastic components that are – in contrast to new models – not coded. BMW’s Recycling and Dismantling Centre (RDZ) has therefore developed a new system for the identification of plastics (KIS) based on the principle that different materials will reflect radiation from the surface differently. Using medium infrared spectroscopy, it is possible to identify and segregate plastic materials within seconds.

5. stakeholders, instruments and principles: ipp tool kit

In the present guidelines, the sectors involved in the product system "Automobile" have described sequences and activities, instruments and successful optimisations which are already being implemented in the various stages of the product life cycle. The examples clearly show that IPP is already being widely used on an individual basis. However, they also point to the interfaces which, with a view to a consistent application of IPP, need to be examined more closely. For further improvement of product-related environmental protection, it is not only the selective measures which are the responsibility of each individual stakeholder that are important. Rather, the important matter is to improve teamwork among the stakeholders by including and taking full account, at each stage, of requirements, desires, needs and economic as well as ecological necessities. This is why communication and cooperation are essential to the degree of integration being striven for.

The examples also show that for many approaches to the problems and requirements relevant to IPP suitable instruments already exist and are being used. This means that the IPP tool kit is, as it were, already very well equipped. What is needed now is for it to be applied consistently. In order to structure the various dimensions of action for all participants, a closed-door session of the IPP project group in Kreuth devised what is known as the "Kreuth Cube", which provides a good overview of the different strands of action to be linked together, and the fields of action to be completed.

Explanatory notes: It is assumed that IPP innovation and optimisation potential exists not only in the product but also in its preparation, that is, in its production, in the technologies used for this production (whose development is often independent thereof), and in the way in which the product is used. Using the product system "Automobile" as an example, it also becomes perfectly clear that if examined in its entirety by means of IPP, the periphery and infrastructure (roads, fuel supply, etc.) must not be ignored. If it is to do full justice to IPP, any action must therefore embrace all innovation and optimisation areas too.



Sample Activities in the IPP Fields of Action (Tool Kit)

Areas of innovation and optimisation

related to	Principles of Action: Communication	Cooperation	Integration
Product	■ Product brochures and safety data sheets (Moulding Sand Binder and Aluminium Casting, p. 26) ■ Comparative assessment by eco-indices (Lamps, p. 39) ■ Material data base (Lamps, p. 39) ■ Achievement of comprehensive product quality by Total Quality Management (Non-wovens, p. 30)	■ Optimisation of pre-production: tanning and dyeing processes (Leather Covers, p. 28) ■ Development of a single material concept with external partners (use of secondary raw material, p. 74) ■ Simultaneous Engineering (Product Design, p. 42)	■ Company standard on environmentally compatible product design (Electronic Components, p. 32) ■ Eco-Analyses along the entire life cycle (Lamps, p. 39) ■ Research and development centre as platform (Product Design, p. 42)
Production	■ Training of employees (Raw Material Extraction of Bentonite as an Example, p. 24) ■ Environmental Management Handbook (Chain Drive Systems, p. 36) ■ Internal exchange of experience (Product Design, p. 42) ■ Optimised recycling through plastics identification system (Utilisation as Secondary Raw Material, p. 75) ■ Preparation of environmental statements according to EMAS (Production, p. 46)	■ Cooperation with other companies for optimisation of production (Engine Elements, p. 40) ■ Integration of different environmental aspects e.g. through power-heat-cold coupling unit (Production, p. 48)	■ Parallel project groups at the manufacturer and supplier (Chain Drive Systems, p. 36) ■ Integrated management system (Paint Thickeners, p. 27)
Function/ Utilisation	■ Advisory consultations (Moulding Sand Binder and Aluminium Castings, p. 26) ■ Elaboration of the customer desires in "product clinics" (Product Design, p. 43) ■ Environmental handbook for dealers (Distribution and Sales, p. 54) ■ Comparative test reports for consumers (Operation, p. 65) ■ Product label "Blue Angel" for car washes (Operation, p. 65) ■ Taking into account individual customer requirements by computer assisted customer advice (Logistics, p. 52) ■ Running of driving training for customers (Logistics, p. 52)	■ Exchange system for used clutches (Clutch, p. 35) ■ Research cooperation for improved product function (Chain Drive Systems, p. 37) ■ Participation in car sharing models (Mobility, p. 59)	■ Advantage for the user: manufacture, maintenance, distribution and repair come from a single source through selective distribution system (Distribution and Sales, p. 54) ■ Combination of local public passenger transport and motorised individual traffic through Park+Ride concepts (Mobility, p. 60) ■ Innovative financing models, e.g. job tickets, member tickets (Operation, p. 63)
Periphery/ Infrastructure	■ Guidelines "The environmentally conscious motor vehicle shop" (Repair/Shops, p. 66) ■ Hot-line for car owners providing information on reprocessing factories (Recycling, p. 72) ■ Participation in the Environmental Agreement for Bavaria (Repair/Shops, p. 67)	■ Initiative "joint solution of traffic problems" (Mobility, p. 59) ■ Voluntary self-regulation of the automobile sector (Self-Regulation Measures, p. 17) ■ Joint disposal system: Parts life (Repair/Shops, p. 67) ■ Cooperation of sectors "Together for Recycling" (Recycling, p. 72)	■ Research project MOBINET on traffic in conurbations (Mobility, p. 59) ■ Preparation of traffic development plans taking into account the interests of industry, population, city and region (City Planning, p. 57) ■ Recycling and dismantling centre/ exchange of experience along the product chain (Recycling, p. 73)
Technology	■ Database of the European automobile manufacturers on dismantling (Recycling, p. 73)	■ Pilot project with suppliers on renewable resources (Non-woven materials, p. 31) ■ State initiative on the use of fuel cell technology in local public passenger transport (Traffic policy, p. 58)	■ Development of water-based paints (Painting, p. 50)

6. results and recommendations: together we can succeed

Integrated Product Policy (IPP) is an important focus of the "Environmental Agreement for Bavaria – sustainable Economic Activity in the 21st Century" concluded in October 2000. Its goal is continuously to improve products and services with respect to their effects on man and environment along the entire product life cycle.

Integrated Product Policy in the Environmental Agreement for Bavaria

In order effectively to support this goal, model projects have also been carried out within the Environmental Agreement and a common stance of state and industry has been drawn up. Below are summarised some contributions made by the partners in the Environmental Agreement for Bavaria relating to the objective of IPP goal:

- The Bavarian government and Bavarian industry form a study group for continuous dialogue on IPP-related approaches, initiatives and developments on a national and international level.
- Bavarian industry aims to develop IPP-oriented communication structures between the individual stages along the product life cycle and to an increasing degree to inform the users of products and services about the environmentally relevant effects thereof.
- The Bavarian government intends to set up and sponsor a "Bavarian Development Network for Innovative Technologies" (BEnefiT) at the University of Erlangen-Nürnberg, with funding of 2.5 million deutschmarks, which Bavarian industry will support, especially with respect to the practical implementation of IPP guidelines.

Position of the IPP Study Group

The Environmental Agreement for Bavaria defines IPP as follows: "Integrated product policy promotes and aims for the continuous improvement of products and services with respect to their effects on man and environment along the entire product life cycle".

Moreover, the Environmental Agreement states that for the successful implementation of IPP the three principles of integration, cooperation and communication must be regarded as the decisive factors for success.

In order to use the IPP definition as the basis for recommended actions within the Environmental Agreement for Bavaria, the IPP study group has discussed them in detail and agreed on a common basic understanding which extends the definition of the environmental agreement as follows:

- Regarding "products and services", the IPP study group formulates an extended perception of the product in the sense that the product system also includes product-related services.
- "Continuous improvement", as understood by the IPP study group, also includes innovation.
- "Effects on man and the environment" means that ecological, economic and social effects are always to be regarded as having the same standing in the pursuit of sustainable development.
- The "entire product life cycle" also comprises product development which plays a key role for IPP.
- "Promotes and aims for" means for industry in particular "to work actively towards".
- "Communication" relates to the stakeholders and refers to the provision and exchange of information on results and tools between industry, politicians and consumers.
- "Cooperation" relates to the stakeholders and means the cooperation and exchange of experience between development partners and system providers, but also including consumers and the state or administration, with the aim of improving their relationship.
- "Integration" relates to the stakeholders, life cycles, environmental media and the sustainability aspects of economics, ecology and social affairs.

Conclusions

The following basic findings can be derived from the pilot project work on the product system "Automobile":

IPP is based on principle of cooperation between all stakeholders: all bear responsibility for sustainable development in their sphere of influence and in their target-oriented cooperation.

IPP is not a new instrument: its new aspect is the systematic, transparent, target-oriented and conscious use of the existing instruments throughout all product life cycle stages.

IPP formulates sustainable actions in concrete terms: as a matter of principle, ecological, economic and social aspects are to be treated on equal terms.

There are no IPP-compatible products, only IPP-compatible actions: as a result of different framework conditions and the demand for continuous optimisation, a product per se cannot be compatible with IPP. The decisive factor is the manner in which all stakeholders act.

IPP creates confidence: through information on instruments and procedures, the actions, including those in the area of tension between industry and the state, become transparent and can be understood by all stakeholders, and especially by consumers too.

IPP also means risk management: wherever IPP, through preventive, transparent and cooperative actions, avoids product-related risks, or renders them controllable, the state does not need to establish product prohibitions.

Recommended Actions

To make IPP a success, the economy must

- >> make IPP instruments an integral element of entrepreneurial actions,
- >> increasingly provide consumer-friendly and traceable information on product properties relevant to IPP,
- >> further develop and use IPP tools on its own initiative, and cooperate within industry on a comprehensive basis,
- >> formulate IPP-relevant goals for the sector, and use self-regulation as an instrument,
- >> comprehensively integrate all decisions, sequences and management systems throughout the economic and ecological product life cycle.

To actively promote IPP, the political world should

- >> create reliable framework conditions in line with market requirements,
- >> limit itself to setting out the framework and allow sufficient scope for voluntary agreements and self-regulation of industry,
- >> not interfere in product planning,
- >> take the opportunity to examine the provisions of existing state legislation and formulate an environmental law comprising all environmental aspects,
- >> commit itself to international harmonisation,
- >> prepare and support society at large in terms of environmental education and training,
- >> provide incentives for the introduction of environmentally compatible products.

IPP can only be successful if the consumer

- >> actively demands information from manufacturers and service providers,
- >> also seeks information on the sustainability aspects of a product system,
- >> through his decision to buy, requires the development and preparation of products with minimum environmental impact,
- >> is ready in individual cases to pay more for products with low environmental impact,
- >> assumes environmental responsibility during the usage stage.

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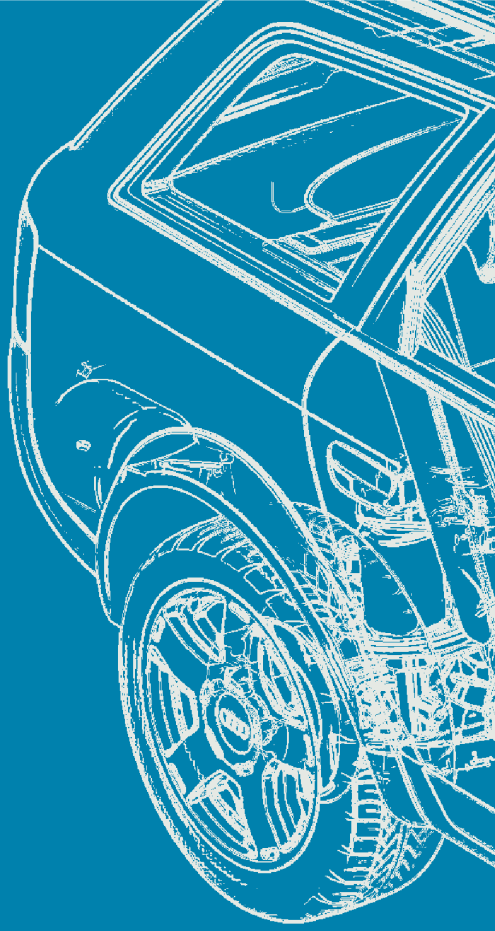

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