Concrete example --

From the drawing board to the road.

Sustainability begins long before series production.

The fifth generation of BMW 3 Series automobiles, launched in the spring of 2005, continues the tradition of the BMW Group's most successful model series over the last three decades. During the five-year development process involving countless individual decisions, a vehicle was created that not only arouses the enthusiasm of drivers and is economically successful, but also takes account of environmental aspects and ensures a high level of motoring safety.

Five years before the beginning of series production. The first design sketches of the new BMW 3 Series are ready. The engineers use these to make a first shell, which gives a rough idea of the new vehicle. Vehicle specifications, such as dimensions and performance, are determined – and so decisions are also made in respect of sustainability. Fuel consumption, emissions and recycling properties are all firmly anchored in the specifications for the new BMW 3 Series.

Six months later. The finished characteristic profile of the BMW 3 Series is passed on to the concept development team. In the next twelve to 18 months, the vehicle takes concrete shape. At this early stage, the design engineers already pay attention to such requirements as environmentally compatible product design. Thus, they lay the foundations for the increasing use of recyclates (raw materials recovered by recycling). In the new BMW 3 Series, the proportion of plastic parts made from recyclates increased to more than 15 percent.

For the first time, engineers constantly use a central, virtual working platform to develop the new BMW 3 Series. This virtual vehicle consists of components constructed on the computer. Since all project members have access to the current state of development at all times, components can be developed simultaneously. This saves valuable development time. It also conserves resources as far fewer test parts and vehicles are needed up to the time the car is ready for series production.

Environmentally compatible product design also includes a suitable lightweight engineering concept. Should the body be made of aluminium, a composite aluminium/steel structure or sheet steel? Life cycle assessment case studies compiled for other vehicle projects showed the weight advantage of an aluminium body, but extra work is involved in aluminium extraction and processing. This finding supported the decision in favour of a body made of strong and extra-strong steels.

This not only reduces weight significantly. The strong and extra-strong steels, as well as strut structures as reinforcements also ensure optimum body rigidity and thus greater safety. "Despite larger dimensions and greater crash safety, we have achieved 25 percent more body rigidity without extra weight. In fact, after deducting the weight of equipment, we have reduced the weight of the body by almost 30 kilograms," says Dr. Wolfgang Epple, Project Director responsible for the new BMW 3 Series. Increased body rigidity helps the new BMW 3 Series to pass the hardest crash tests worldwide and offers occupants an outstanding level of safety.

In addition to analysing alternative materials, the engineers of the BMW Group are inspired by nature in the field of lightweight automotive engineering. So-called bionics show research engineers new approaches to solutions that enhance the fuel con-

01

02

01 -- Designer Joji Nagashima works on the design of the new BMW 3 Series.
02 -- The clay model is prepared.
03 -- The future vehicle takes shape.

03

sumption, safety and dynamics of new vehicles. A vivid example of this is the production technology used for the lightweight structure of the instrument panel of the BMW 3 Series: the engineers were guided by the bone structure of mammals to develop the process technology required. In the case of moulded integral foams, solid material is used only in areas under great strain, in other parts the structure is full of tiny air pockets like a foam. The result: a component that is 20 percent lighter in weight.

50 months before series production begins. At the same time as developing the new BMW 3 Series, the engineers work in top gear on the development of a new six-cylinder engine concept and on the enhancement of the four-cylinder engines. Long before the first power unit goes into operation, the combustion processes in the engine are simulated in complex models in order to fully exhaust potentials for improvement in fuel consumption and emissions. For within the entire life cycle, vehicle use has the strongest impact on the environment. Despite a significant increase in output, the BMW Group manages to noticeably reduce fuel consumption with a new concept for the six-cylinder petrol engines. A whole bundle of measures makes this possible. They range from innovative components such as the composite magnesium/aluminium crankcase, through an electric water pump to newly optimised VALVETRONIC technology.

December 2004. Production of the new BMW 3 Series begins in the Munich plant. The BMW plants in Regensburg, Leipzig and Rosslyn, South Africa, follow at the beginning of 2005. In vehicle production, the BMW Group sets great store by energy-optimised production and heat recovery systems as well as the use of waste heat. As a result, energy consumption per unit produced fell by 21.8 percent in the last eight years. CO_2 emissions from production sank by almost 20 percent in the same period.

Water is used carefully in production. Closed cooling cycles have long been common practice in production processes. These systems are extremely efficient. For example, the volume of wastewater per vehicle has decreased by almost 35 percent since 1997. In the last four years alone, water consumption in the production process has fallen by almost 22 percent. Innovative technologies in the paint shops reduce not only water consumption, but also emissions of volatile organic compounds (VOC). These have been significantly reduced due to the application of water-based and powder-based painting technology. In the BMW plant in Regensburg alone, the use of powder-based painting technology saves more than 140 tons of VOC a year.

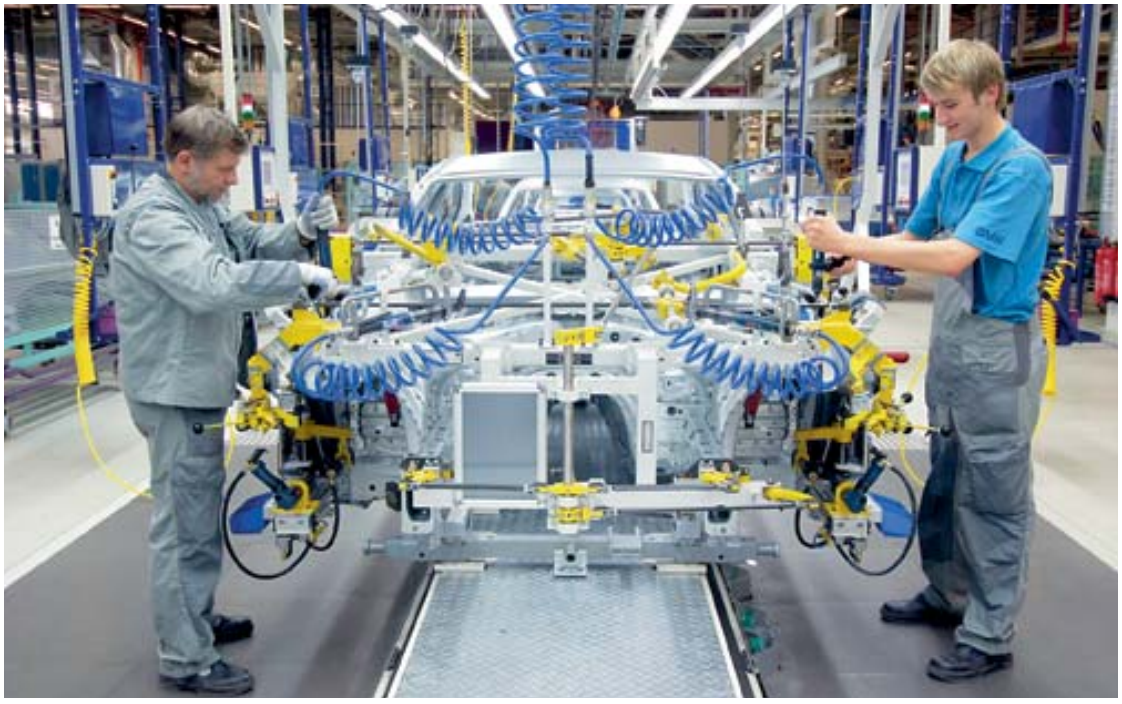
Spring 2005. The first customers take delivery of their new BMW 3 Series automobiles. Dynamics and sustainability have been coordinated convincingly. Although new models of the BMW Group are increasingly safe, comfortable, spacious and powerful, fuel consumption and emissions of noxious substances continue to decrease significantly. For example, the BMW 3 Series: despite increased output of 20 kW, at 8.7 litres a BMW 330i* needs 0.4 litres less petrol than the previous model. A further indication of efficient dynamics is that the BMW 320d** has 10 kW more output (120 kW/163 bhp) but emits only 153 grams of CO_2 per kilometre with fuel consumption of 5.7 litres.

A comparison between the first BMW 320 (1975) and the current BMW 320i*** shows how much progress has been made in the last three decades. Despite an increase in output of 30 kW/41 bhp and far more dynamics, comfort and safety, the new model's fuel consumption has been

* Fuel consumption of the BMW 330i Sedan and Touring (manual and automatic transmission): urban from 12.7 to 13.3 l/100 km, extra-urban from 6.4 to 7.0 l/100 km, combined from 8.7 to 9.3 l/100 km, CO_2 emissions from 210 to 224 g/km

** Fuel consumption of the BMW 320d Sedan and Touring (manual and automatic transmission): urban from 7.8 to 9.4 l/100 km, extra-urban from 4.5 to 5.5 l/100 km, combined from 5.7 to 6.9 l/100 km, CO_2 emissions from 153 to 184 g/km

*** Fuel consumption of the BMW 320i Sedan und Touring (manual and automatic transmission): urban from 10.7 to 11.3 l/100 km, extra-urban from 5.6 to 6.3 l/100 km, combined from 7.4 to 8.1 l/100 km, CO_2 emissions from 178 to 196 g/km



01 -- Employees on the body assembly line **01**
02 -- Cathodic dip painting in the BMW plant in Leipzig
03 -- Exhaust assembly: example of an ergonomic working environment

02

03

reduced by around 26 percent to 7.4 litres. As a result of this progress and other features, all BMW 3 Series models comply with the EU4 emission standard, which requires that emissions be reduced by half compared with the EU3 standard applicable until the end of 2004.

First service. Fuel consumption and emissions are not the only environmental impacts of vehicle use. That is why the engineers designing the new BMW 3 Series also paid special attention to minimising maintenance and maximising the life of wearing parts. In the new BMW 3 Series, for example, oils in the transmission and rear axle as well the ribbed V belts for the engine's auxiliary equipment no longer have to be changed. Nor is it necessary to change spark plugs, air filters or diesel fuel filters in the first 100,000 kilometres or so. With the service and maintenance concept known as Condition Based Service (CBS), wearing parts are no longer replaced at rigid intervals, but only when they really need renewing. This saves resources and reduces environmental impacts significantly.

At the end of the life cycle. Coming full circle, solutions for the environmentally equitable recycling of end-of-life vehicles, which were already considered in the development phase, now come into play. Fluid-carrying components that have to be emptied are quick and easy to access and pyrotechnic components, such as airbags, can be neutralised safely and simply. Thus, the vehicles can be recycled in an environmentally equitable and economically efficient way.

With the new BMW 3 Series, the BMW Group has created a vehicle that meets the standards of sustainability in many respects. This is confirmed, for example, by the Öko-Trend Auto-Umwelt Ranking 2005. Each year the environmental institute Öko-Trend assesses all the automobiles on the German market according to criteria such as fuel consumption and emissions of noxious substances, as well as conservation of resources, environmental management and recycling. In addition to a first in its category for the BMW 320d and outstanding ratings for other vehicles of the BMW Group, the Company takes first place in the manufacturer's ranking.

01

02

01 -- Testing gap dimensions is part of quality management.
02 -- The fuel-tank filling robot operates without emissions.
03 -- Dynamic performance and sustainability are compatible with one another.

03