Raw power harnessed

In danger: two thirds of the children injured on Germany's roads are hit by cars.

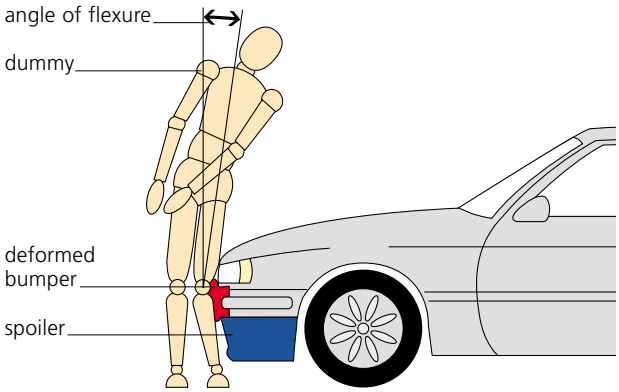
A thorough knowledge of plastics is becoming increasingly important for car designers. To ensure that pedestrians sustain as little damage as possible from car accidents, specialists from Bayer Polymers perform virtual crash simulations to find the right materials and the optimum design for car bumpers.

The number of traffic fatalities in Germany is constantly declining, thanks to the ever improved protection of the occupants through safety belts, head restraints and airbags. Nevertheless, more than 7,000 people still lose their lives every year on German roads. While the protection of car occupants has reached a relatively high level, the same unfortunately cannot be said about pedestrian protection. In Germany, pedestrians account for around 13 percent of all fatalities in traffic accidents. To further reduce the large number of accident victims, automakers are working on intelligent systems to assist the driver, but it will probably never be possible to completely eliminate accidents involving cyclists and pedestrians. However, to keep the consequences of an accident to a minimum, the automotive industry has undertaken to begin designing "pedestrian-friendlier" vehicles in 2005 – with fixed, annually increasing quotas. To comply with the set targets, the problem areas of the vehicles must be made safer, above all the front section with the bumper. In the event of a collision, it is the legs that are hit first, and in around 45 percent of all injuries resulting from accidents with pedestrians, the bumper is involved in some way. Formerly, shiny chrome bumpers used to dominate the front ends of our cars, but nowadays the integrated bumpers are made predominantly of plastic. Being one of the world's biggest suppliers of raw materials for bumpers, Bayer Polymers can call on a great deal of valuable know-how and expertise in this field.

Thorough knowledge of the relevant materials is vital because the design of a bumper can be varied enormously depending on the properties of the plastic and its layer structure. The characteristics of a plastic also depend much more on temperature than those of a metal: "Steel isn't bothered by heat," says plastics expert Jürgen Knaup from Bayer Polymers, Manager CAE, Injection Molding, Europe. A metal bumper will dent in shimmering heat in exactly the same way as it will in icy cold.

Right choice of materials will enhance safety considerably

A plastic, on the other hand, can be kneaded by hand when it is hot and can fracture like glass when it is cold. On top of that, most bumpers are made up of different plastics: polyurethane foams, produced in the mold from two liquid components, serve above all to



Softening the impact
In the tests carried out according to the Euro NCAP Directive, a dummy impacts the front of a vehicle at a speed of 40 kilometers per hour. The key data, according to which the safety is appraised, are the maximum force on impact and the angle of flexure of the leg. Through skillful design – for example, with a deformable bumper – pedestrian safety can be enhanced considerably.

Stars for safety

The transport ministers of the E.U. countries have issued a new directive on the safety of pedestrians. It prescribes tests with dummies to yield information on the weight of impact. The measurements are entered into an evaluation system that awards the tested car up to four stars according to its pedestrian safety. These tests are carried out institutes such as Euro NCAP (European New Car Assessment Program). However, since 2002 no vehicle at all has been awarded all four stars, and only twice have three stars been given: to the MG TF roadster and the Honda CR-V off-roader.

absorb impact energy. By contrast, thermoplastics are supplied as ready-to-use granules and injected as a hot, tough compound into the mold under high pressure. They cover the bumper system and, as part of the actual bodywork, contribute to the overall design of the car. If someone makes a mistake in the choice of the components for the bumper, he can easily end up with a component that is unable to absorb enough impact energy in the event of a collision. If he goes for the wrong design, a bumper impact could snap the legs of a pedestrian. If he gets it right, he can make an important contribution to pedestrian safety.

As a partner to the automotive industry, the plastics specialists at Bayer Polymers have taken up the challenge and offer a wide range of material and design services. In view of the large number of different models on the market, customized support is crucial. "After all, there's no such thing as a magic formula for all applications," says Klaus-W. Huland, team manager for Bayfill EA® at Bayer Polymers, Business Development.

Instead of carrying out time-consuming and expensive tests by replicating real collisions, the Bayer experts establish the optimum components by virtual means, simulating the crashes on a computer. To come up with a reliable prediction, the computer basically needs two kinds of input: the so-called material model and a three-dimensional design of the bumper (CAD model) that conforms to the customer's basic ideas.

The material model is nothing other than the mathematical description of the plastic properties. The data are obtained in a series of tests with specimen cubes having an edge length of about five centimeters. For example, a defined weight is dropped onto a block of plastic in a falling tower. How deeply the weight penetrates, how high and how fast it springs back, and how much the plastic is deformed as a result are all entered into the material model. Crash simulations as such are nothing new, but the models are becoming more and more realistic and the predictions are becoming increasingly reliable. And they still have not reached their limits: particularly the high-speed processes are being documented more accurately all the time.

With the aid of the drawing, the bumper is broken down into a grid made up of thousands of tiny simple geometric elements that can be mathematically calculated. Although the material model and the grid can only map reality to a limited extent, this approximation is quite adequate for predicting which polyurethane absorbs sufficient energy for a given design, how thick the outer cover must be to return the bumper to its original shape in the event of a minor impact, and whether or not an extra transversal rib should be incorporated to make the bumper stiffer.

Bayer's experts demonstrate on the company's website how a simulation of this kind actually works. If you want to produce a bag or rucksack with a spring catch made of plastic, you can enter the relevant data for the part you want, and you will be informed shortly afterwards by e-mail what sort of stresses the catch will be subjected to and where its weak points lie.

Virtual design: Jürgen Knaup studies a computer model of a bumper.

www.euroncap.com
Homepage of the EU transport ministries for car safety, with evaluations of individual car models.

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