Crashes which don’t leave any dents

Before a car even reaches the prototype stage it is crashed 100 times – in BMW’s new Virtual Reality Centre

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Point of impact: *on the Powerwall, Touraj Gholami watches a BMW crash into a concrete block*

A blue 5 Series BMW slams against a concrete wall at 56 kilometres an hour (35 mph) without braking. Although the driver is wearing a seatbelt, he lurches forward into the airbag that has inflated in a matter of a split-second. The bonnet on the driver's side heaves upwards and is crushed almost as far as the windscreen. The car's a write-off.

Touraj Gholami reaches for his mouse and "cuts" right through the car, opening up a view of the interior with the driver. "As you can see, the footwell has remained intact despite the impact," he explains, pointing at the screen. "It's what we have come to expect of a car nowadays."

Before a new model is even assembled by BMW, Touraj Gholami and his team have already smashed it up a hundred times in the most diverse ways. Not for real, though: only in cyberspace. "Colleagues provide us with the design data, and on the computer we add the chassis, engine and interior fittings," explains Gholami, a dark-haired Iranian wearing yellow Harry Potter glasses. "Our calculations take into consideration everything that is relevant to a crash – which more or less boils down to the entire car, except for cables and ducts."

Armed with this data, he and his colleagues proceed to carry out the first of the crash tests. Driving the virtual car into the wall just once involves two to four days' work for the computer. During this time it works around the clock, breaking down the tenth of a second of the impact into millisecond stages. This elaborate procedure eventually produces footage showing the car moving towards the obstacle millimetre by millimetre, and then being deformed as gently as if it were made of putty.

At least that's what it looks like afterwards when Gholami and his fellow-testers watch the crash on a screen in the form of a slow-motion 3D movie. "Virtual Reality, or VR as we call it, is a very important tool for us," he says. "Without this three-dimensional visual representation, the data wouldn't be any use to us."

Here in the virtual reality studio, in front of the 16-metre-square Powerwall, is where the actual work takes place. The specialists have donned their 3D glasses and are assessing the crash down to the minutest detail. Together they devise recommendations for making improvements to the planned car. Driver safety, after all, is the top priority.

"We launched the first virtual crash tests ten years ago," Gholami recalls. "Before then, you had to crash several real cars to obtain the same data." That was an expensive business, with a prototype costing up to 1.5 million marks. On the computer, by contrast, even with the lengthy computing time involved, a crash amounts to no more than 800 marks in costs.

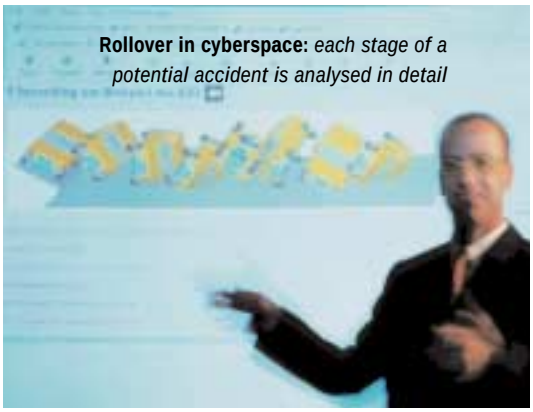
Of course you can't simulate everything, which is why these virtual crashes are followed up by a few genuine impacts. Legislation demands it for one thing, but for the technicians it is also important to keep comparing their simulations with the real thing. Obviously a computer simulation is only valid if it reliably reflects reality.

Teamwork in the VR Centre: *technicians at the control panel call up 3D images*

The latest ultra-high-speed computers enable almost any vehicle component and its behaviour to be simulated. This opens up whole new dimensions: technicians are now turning to cyberspace to investigate the interplay between man and machine long before a car even materialises in prototype form. Virtual crash tests are used to assess possible injury to occupants, while production-line simulations can verify whether mechanics will be able to assemble all the components without difficulty. In their electronic "Cave", the testers then set about checking whether the planned car delivers the requisite levels of comfort, safety and convenience.

"In the new VR Centre at BMW's Research & Development Centre the experts are also testing various alternatives for the interior design of cars," explains Antonino Gomes de Sá, who is in charge of the studio. Here they evaluate which materials look best, whether all the switches and dials are within easy reach and whether the cockpit instruments are clearly readable. "While doing this we can vary the levels of illumination, in other words simulate daylight or night-time conditions."

In all this the surfaces of the metals, plastics and leather feel perfectly genuine to the touch, and even reflections can be made out. For example, you would immediately notice if a piece of white paper on the dashboard was being reflected in the windscreen and distracting the driver.



Rollover in cyberspace: *each stage of a potential accident is analysed in detail*

In the test department for add-on components, experts are concerned with ease of operation. How much energy is needed to shut the roof of a convertible, for example? What happens if you slam the boot shut really hard? How difficult is it to open a door? Dr Wolfgang Neureiter and his team simu-

Roof up, roof down: *the computer works out how much energy it takes*

Hot outside, cool inside: *even the temperature inside the car can be accurately simulated*

late all these components on the computer and run through every conceivable situation. "Even if somebody loses their temper and slams the boot shut with tremendous force, there should be no consequences," stresses engineer Josef Hetzenecker. And so he continues to close the virtual bootlid time and again, with varying degrees of force, carefully assessing how the metal is deformed in the process.

Sight and touch strongly influence our attitude towards a car, but hearing is also part of the equation. "The very first encounter a customer has with a BMW is the moment they reach for the doorhandle and open the door," says Dr Albin Dirndorfer, who is responsible for testing bodywork components. "It's an important moment in which the decision in favour of or against purchasing the car may already be gelling in the subconscious." It may explain why the technicians were in for a bit of a shock last year when they opened the door of a brand-new model and heard a quiet, high-pitched, metallic "plink" that sounded somehow "cheap, makeshift and tinny".

A team of specialists instantly set about investigating this noise in the door lock and soon discovered that the problem lay with the catch. "It was then a question of modifying it so that it no longer resonated, but nevertheless remained as reliable as before," explains Christian Mühldorfer, who set up a computer simulation of the problem. "We altered the shape slightly and tested our virtual door lock to see whether it would still work as well as before – and to see how it sounded." After just a few trial run-throughs they had found the solution: the door lock now had a full, rounded sound. What would previously have involved months of work on the test bench had been accomplished in a matter of days.

A car's acoustics depend on innumerable components. "A car is made up of around 20,000 parts which are all linked to each other. At least 500 of them can play acoustic tricks on us," says Dr Raymond Freymann, Head of Vehicle Research. But it is precisely in this area – not least thanks to computer simulation – that the results are there for everyone to hear: 20 of today's BMW 7 Series taken together, says Dr Helmut Spannheimer, "produce no more external noise than a single model from the year 1970". n

In the next issue:
Where you can work as a test driver even if your blood alcohol level is 150 milligrams per 100 millilitres