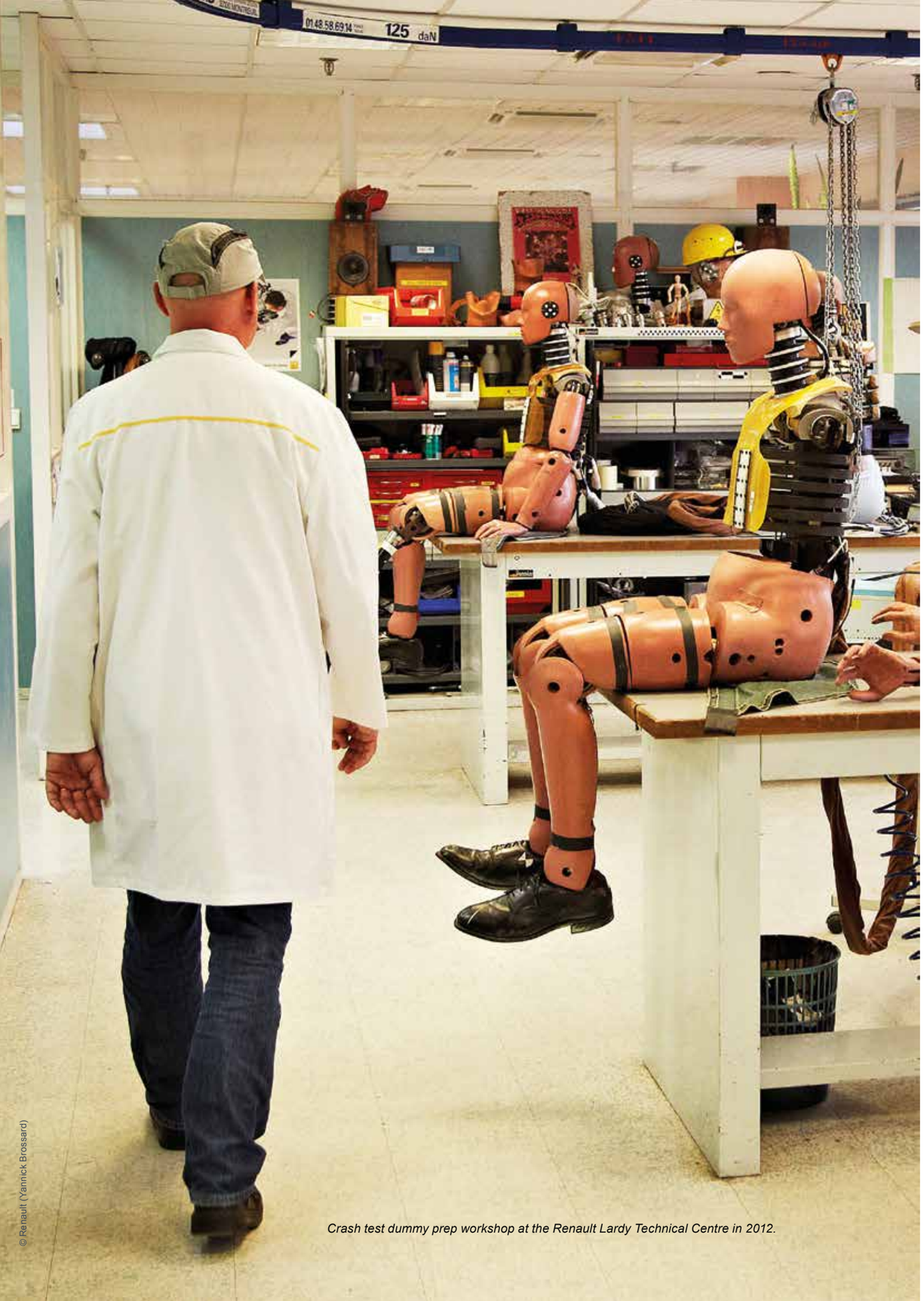

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Crash test dummy prep workshop at the Renault Lardy Technical Centre in 2012.

Designing Safer Cars with Accurate Crash Test Simulations

A project conducted by Renault, ESI Group and two French universities, aims to achieve more accurate crash test results with better optimization. Supercomputers will allow the team to study twice as many parameters compared to previous tests, in a much shorter timeframe than before.

Renault has conducted car crash simulations for over twenty years and optimization for ten years.

"We are currently in the process of changing our car crash model to be used on CURIE-supercomputer. The project, as such, is only getting started as we speak", **Marc Pariente**, the Research Engineer at Renault SAS, explains.

The French PRACE project "FMOC – Fast Multi-physics Optimization of a Car" is headed by Pariente, Two companies and two universities are involved in the project: the car manufacturer Renault SAS, ESI Group, a leading provider of virtual prototyping, the Ecole Centrale de Lyon and the Ecole nationale supérieure des mines de Saint-Etienne.

"ESI Group brings their car crash simulation and modelling expertise to the project, while the universities, on the other hand, add their specialization in optimization and mathematical know-how. At Renault, we are experts in car design, applied mathematics, crash simulation and optimization. We are very interested in seeing what results this kind of cooperation can produce", Pariente says.

More accurate and larger models for safer cars

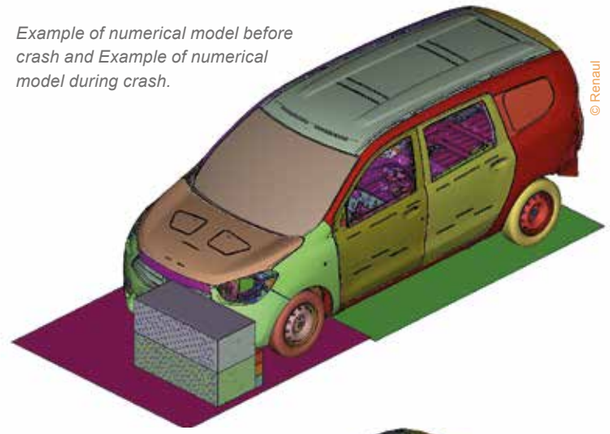
All engineering at Renault is focused on improving car safety and the company has for some time been working on improving its numerical simulations. Renault has implemented several optimization phases in their standard car design process, in which a standard model of three million finite elements is used.

"We have done a lot of optimization studies at Renault, but this PRACE project will allow us to be much more precise. Accessing to a supercomputer like CURIE is a great opportunity for benefitting from its processing capacity to improve our optimisation algorithms. The car crash model used in our PRACE project is ten times larger than the models used in this type of research before", Pariente says.

The PRACE project's aims are clear and practical.

"Our primary aim is to improve the crash simulations and achieve more precise results. Secondly, we want to improve our optimization methods and tools. The PRACE project allows Renault to use tools that we don't currently have in-house. We also benefit from our project partners' specialized knowledge. Working with PhD students from the applied mathematics departments from the two universities will improve the algorithms significantly."

Example of numerical model before crash and Example of numerical model during crash.



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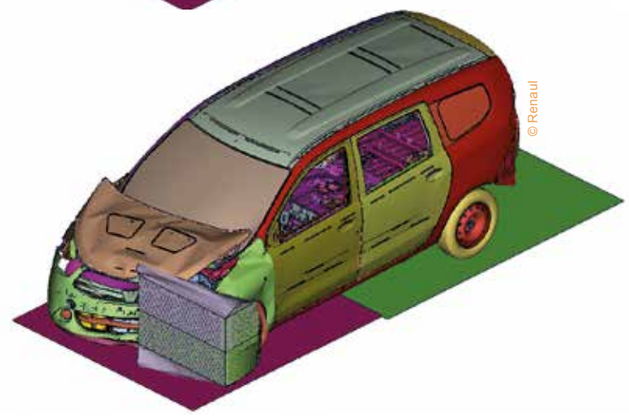

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Up to 200 parameters and 512 cores in a single simulation

The project was allocated 42 million core hours on the thin nodes partition of the CURIE supercomputer. Compared to research conducted on car crash simulations elsewhere, the project is unique, as it combines optimization and topic modelling.

"It is one of the first times that we are conducting an optimization study on a car with more than two hundred parameters and with such a big model of up to 20 millions finite elements. To date our studies have been done with fewer than a hundred parameters on up to 3 millions finite elements!"

Road safety is one of the cornerstones of Renault's corporate culture and draws on fifty years of research and development. Crash test in 2012 on New Renault Clio.

This level of detail is unheard of in the automotive industry and entails a lot of research, for example, on optimization algorithms and data management.

"We want to be part of developing what optimization will be in five years time. Running such big models require access to very big HPC configurations, but the PRACE facilities allow us to complete the calculations much faster than in the past with 512 cores instead of 48. Today, a single optimization phase can take up to a month, but we are hoping to reduce the time used to one week with the help of supercomputers."

The possibility to use the CURIE supercomputer through PRACE Open R&D calls provides to the researchers a unique opportunity to improve optimization methodology and tools.

"We are asking ourselves whether it would be better to run a single simulation on a large number of cores, as opposed to running many simulations simultaneously on a smaller number of cores. On our PRACE project we will be able to study the impact of the number of cores per simulation with regards the total time taken by the optimization phase. The goal is to complete the optimization phase in one week", Pariente says.

"Some of the results of the research regarding Renault car design, materials and some geometrical aspects of the cars will remain confidential, but the optimization results will be included in scientific publications. All the results of the research conducted at the universities in this project will also be made public", Pariente says.

The crash models will later be expanded, for example, with the introduction of a new biomechanical simulation of drivers and passengers and car to car models. These phenomena could be studied in a future PRACE project.

Päivi Brink

Each year, the Renault Group invests nearly €100 million in safety research and development. Some 600 employees work directly on this topic, which involves all sectors of the business. Crash test in 2012 on New Renault Clio at the Aubevoye Technical Centre.

Large car model with big data technology

The researchers are building a large car model (more than 20 million finite elements) that includes many physical phenomena that have not commonly been taken into consideration before:

- Iron sheet cracking
- Welding point cracking
- Failure of screw body
- Wheel rim deformation
- Windshield cracking
- Crash and stamping coupling

The researchers will use big data technology to extract more information from the simulations and improve the accuracy of the statistical models.

MORE INFORMATION:

- ***http://www.renault.com/en/innovation***
- ***http://www.prace-ri.eu/PRACE-6thRegular-Call***

Xcelerit Unleashes the Power of Many-Core Hardware

PRACE chose an Irish software company, Xcelerit, specializing in cross-platform acceleration tool as the winner of the "Most innovative Industrial HPC Solution in Europe" prize. The company's products enable engineers and scientists with no knowledge of parallel computing to access the raw power of hardware accelerators in their applications. Xcelerit's products broaden the use of HPC within European industry.

The company's core product – the Xcelerit SDK – has achieved success in multiple industries including financial services as well as research and science. It has been used to boost compute intensive algorithms such as Monte-Carlo simulations, Finite-difference schemes, Spectral methods, and Lattice-based schemes.

Programmers in HPC have long relied on Moore's law to consistently deliver major increases in processing power that allow new and more complex problems to be tackled. Although Moore's law is still alive and well, these speed increases can no longer be efficiently delivered by increasing the speed of a single processor, but rather are achieved by employing many simpler cores in parallel.

Programming is the Bottleneck

Hicham Lahlou, CEO of Xcelerit, has watched the evolution of these new many-core high performance systems for several years now. "We saw that great increases in performance were possible, but the complex multi-core architectures forced programmers to retrain, acquiring new skills and requiring major re-work of their software to take advantage of these new architectures".

Nowhere is this more true than in the case of Graphic Processing Units or GPUs. These devices have evolved out of chips designed to deliver blazingly fast computer games performance, but can equally well be applied to many demanding numerical examples. NVIDIA's new Kepler series