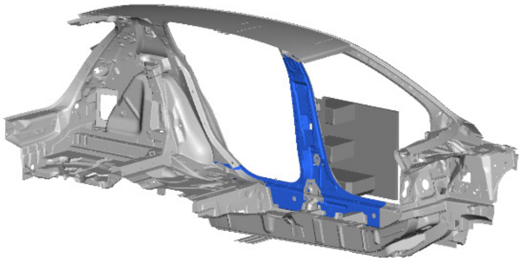
FRACTURE PREDICTION IN CRASH & SAFETY SIMULATION

Fracture prediction remains a barrier in the design of safe vehicles. In response, Cray, Altair and the PSA Groupe teamed up to investigate the modeling and compute requirements for capturing metal fracture in a side-impact crash. Using Altair® RADIOSS® on a Cray® XC40™ supercomputer, they ran a 50-million-element side-impact "B-pillar" model, using primarily solid elements, in less than 24 hours. Their work shows that fracture simulation and prediction can be a practical part of the design process.

Problem

With today's high-fidelity crash and safety simulations, vehicle — and passenger — safety have improved dramatically. But even so, crash tests still fail. Designs go back to the drawing board, projects get cancelled, and hundreds of millions of dollars can be lost in the process.



Manufacturers need as much insight into the design as possible. And one key area where typical crash simulations fail is in modeling how metal is going to tear or fracture. Since a metal fracture dramatically changes a vehicle's structural integrity, predicting where and how these tears will happen is absolutely critical in the design process.

But there's a problem. Capturing structural cracks requires a level of model fidelity that's possible only with mesoscale modeling. Such models are an order of magnitude, or more, larger than the typical crash simulation. Running a model of this size is impractical in typical compute environments.

> Knowing where and how structural fractures will happen can prevent prototype failures.

Solution

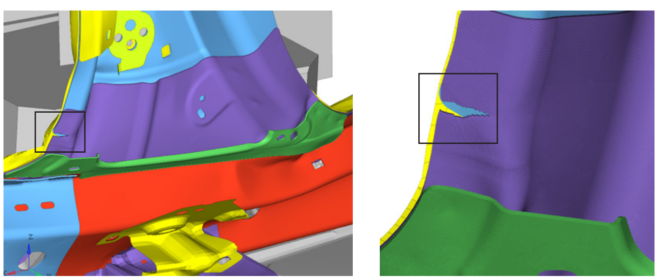
Understanding that material fracture prediction is critical to the design process, software vendor Altair, auto manufacturer PSA and supercomputer maker Cray teamed up to investigate the modeling and compute requirements for capturing metal fracture in a side-impact crash. Could the physics, application and compute performance come together to make fracture prediction a practical solution?

For the project, the team used a mesoscale mesh modeling of a B-pillar impact on a PSA car using RADIOSS on a Cray® XC™ supercomputer. The model consisted of 50 million elements, primarily solids. These solid elements had a 0.3mm mesh density with three to four elements through the thickness.

To put the model size in context, a typical crash simulation of an entire vehicle might consist of 5 million to 10 million shell elements.

Results

Running RADIOSS on the Cray XC system, the team completed an entire 50-million-element simulation in less than 24 hours. The simulation results predicted the crack formation at the base of the B-pillar and ultimate component failure with excellent correlation to the physical test results.



ACCURATE PREDICTION: *The simulation results predicted the crack formation at the base of the B-pillar and ultimate component failure with excellent correlation to the physical test results.*

The team found that with a model of this size the compute must be scaled up to deliver an acceptable turnaround time. To achieve the sub-24-hour run, they scaled to 14,000 cores — well within the power and scaling capabilities of the Cray XC system but impossible with a traditional crash simulation compute environment.

Notably, the team used production, not R&D tools — a standard version of RADIOSS and a production-ready XC system — underscoring the point that fracture prediction can be an immediate and practical part of the design process.

Overall, the team confirmed that using the right tools — RADIOSS and Cray supercomputing power — manufacturers can readily reduce the risk of failing a crash test through the use of material failure simulation.

TECHNICAL OVERVIEW

Side-impact simulation

50-milion-element model

Solid elements used for B-pillar:

- 0.3mm mesh density
- 3-4 elements through the thickness

80ms simulation time (2.7 million iterations)

Simulation completed in less than 24 hours

COMPUTE SOLUTION

Cray® XC™ supercomputer

Up to 384 nodes with two Intel® Xeon® E5-2695 V4 @ 2.1 GHz per node

128 GB memory per node

Cray Aries™ high-speed interconnect

Cray Inc.
901 Fifth Avenue, Suite 1000
Seattle, WA 98164
Tel: 206.701.2000
Fax: 206.701.2500
WWW.CRAY.COM