Reduce Costs and Development Time of an Automotive Project with MD Nastran

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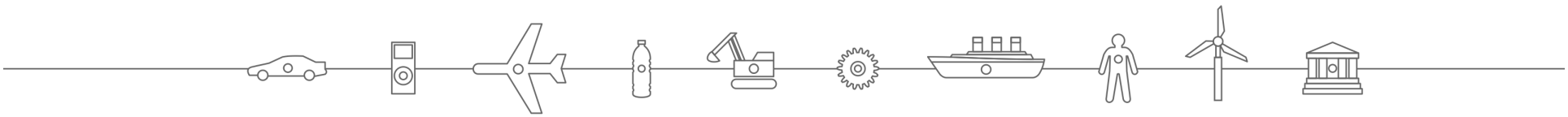

Background

- PSA Peugeot Citroën is a French manufacturer of automobiles and motorcycles sold under the Peugeot and Citroën brands.

- PSA is the second largest automaker based in Europe and the number six in the world.

- The mission of PSA Peugeot Citroën production facilities is to manufacture, each day, vehicles that meet both the design teams' expectations and customer requirements while complying with cost targets and delivery deadlines.

- Research and innovation constitute a major priority for PSA Peugeot Citroën. Today, more than 18,000 engineers and technicians - in the four R&D centers in France - participate in the R&D projects with the conception of future organs and vehicles Peugeot and Citroën.

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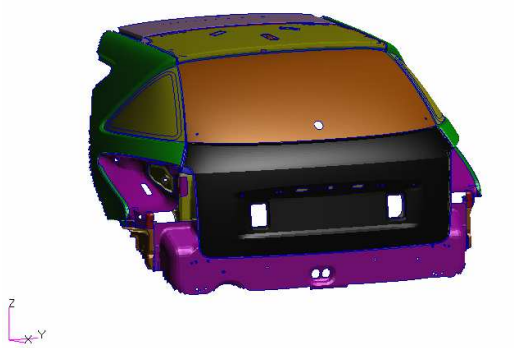
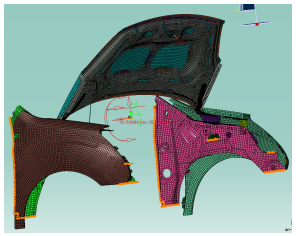
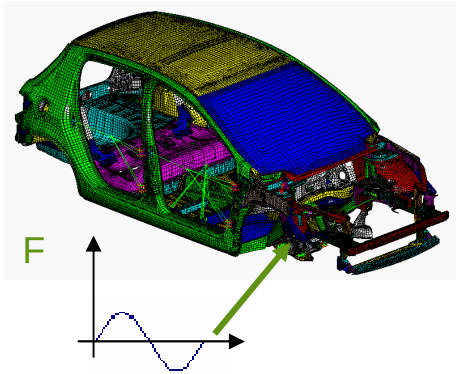
Scope and challenge

- Scope:
  - Simulation on body structure:
    - Body parts
    - Attachment points
    - Closures : doors, hood, boot lid…
  - Studied load cases:
    - Exceptional loads (strength)
    - Fatigue and durability
    - Structural rigidity







- Challenge:
  - Reduce costs and development time of the automotive project by improving the simulation process :
    - Reduce the number of models
    - Reduce the pre-processing steps
    - Optimize the training course for the new users
    - Improve the traceability, as few models as possible
  - Standardize exchange format for the body models between the different departments

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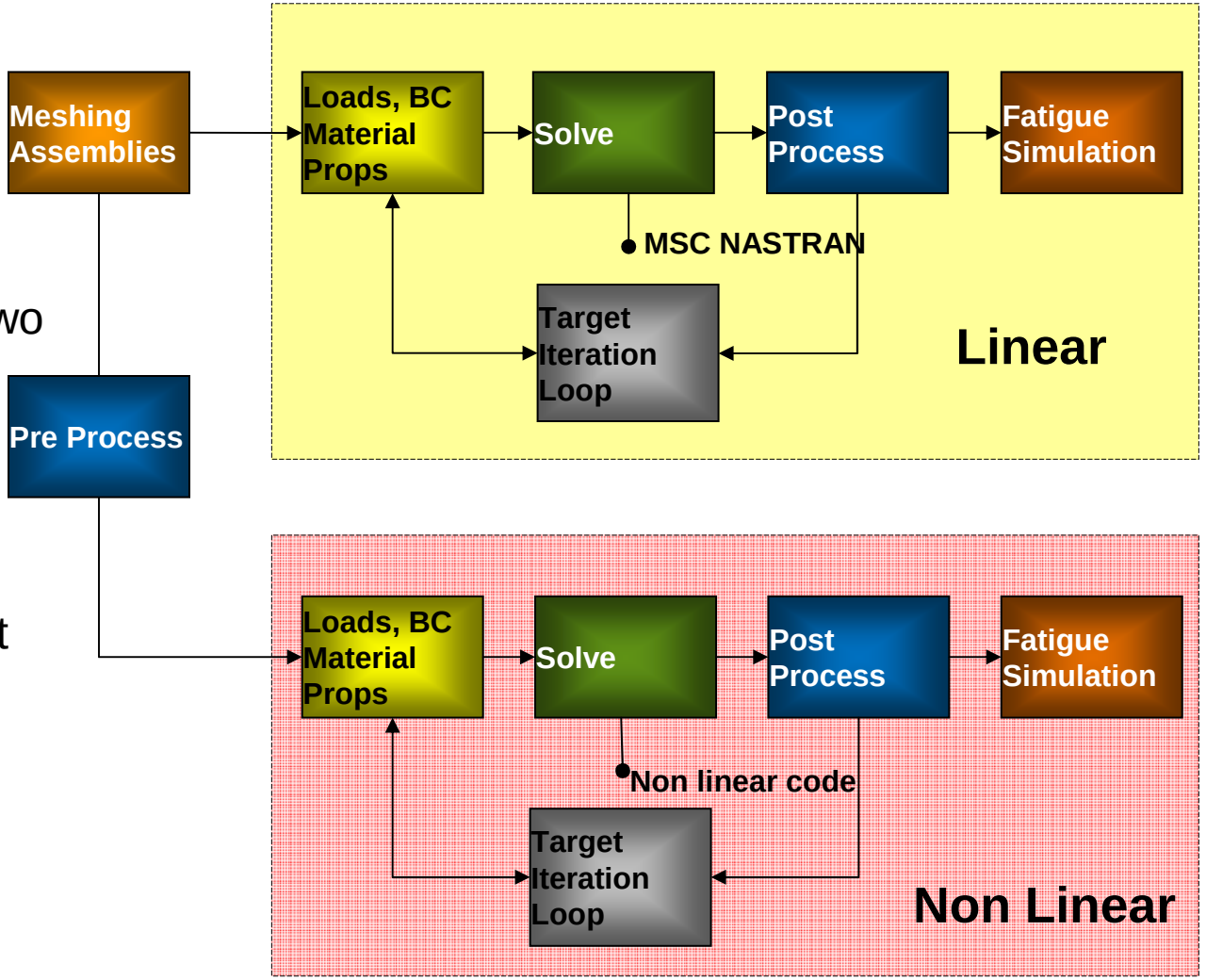
Automotive Use Case

As Is Process

- Weak communication between groups
- Rework to assemble two models
- Sequential process resulting in more iterations
- Delays in development cycle



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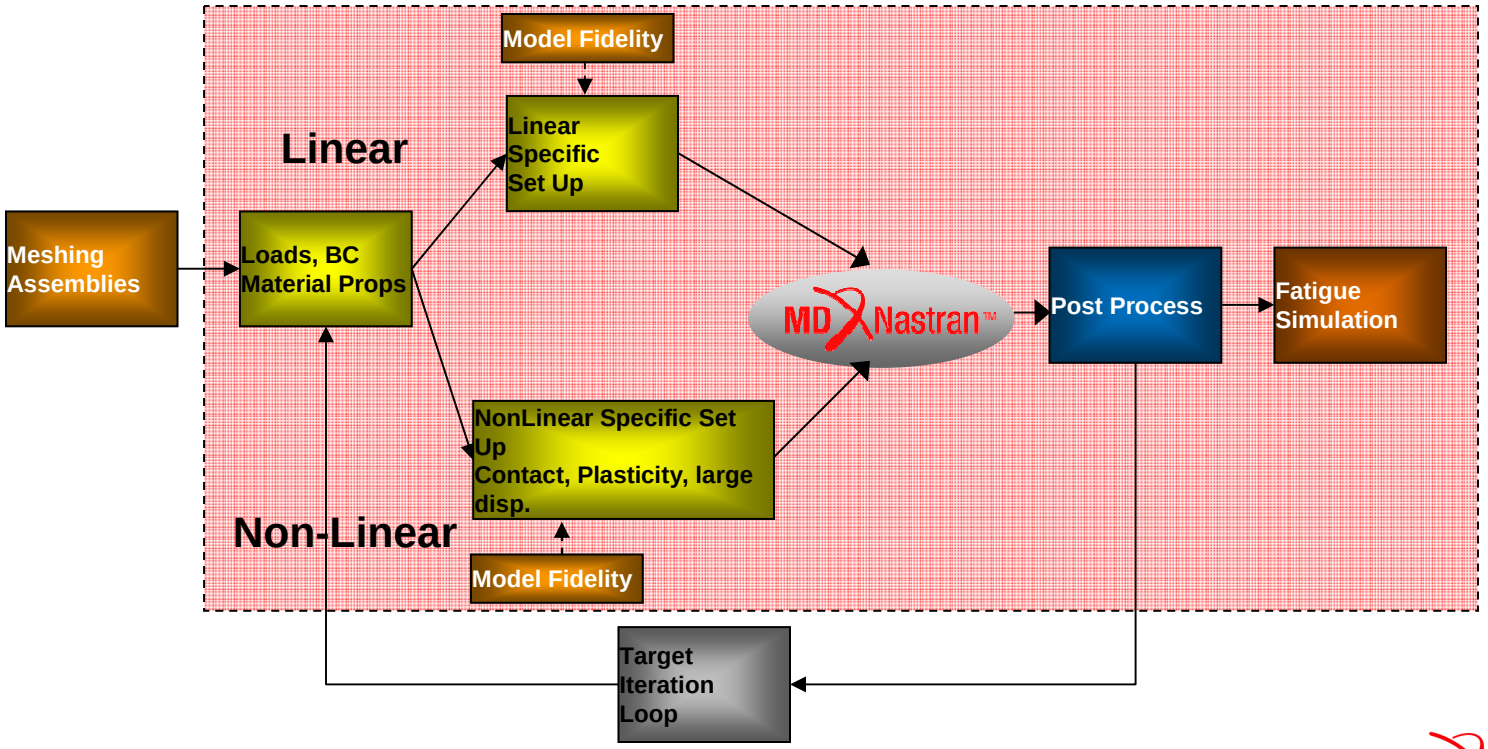
MD Automotive Use Case

MD Value

- Common data model
- Single simulation environment that reduces error
- Increased communications between groups
- Shortened simulation cycle
- Easier validation of design changes



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Evaluation strategy

- Selection of 6 typical use cases (input from users)
- The benchmarks must be validated for:
  - Keys results (in comparison with the nonlinear code and test)
  - Performance

		Nonlinear criteria			
		Contact	Plasticity	Large displ. Large rotation	Performance
Benchmarks	Door sag	■	■	■	■
	Welded specimen		■	■	■
	Jack bracket	■	■	■	■
	Load customer on hood	■	■	■	■
	Towing hook	■	■	■	■
	BIW interface	■	■		■

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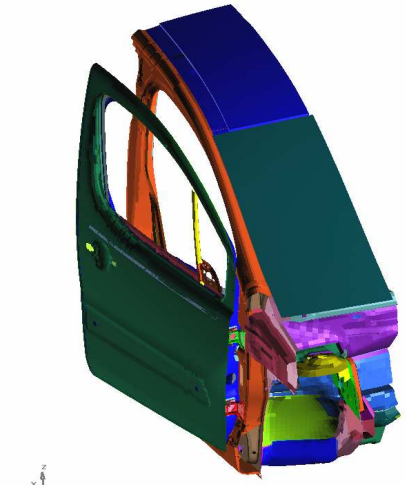
Door Sag Model description

Performance validation of the door / body interface under exceptional load

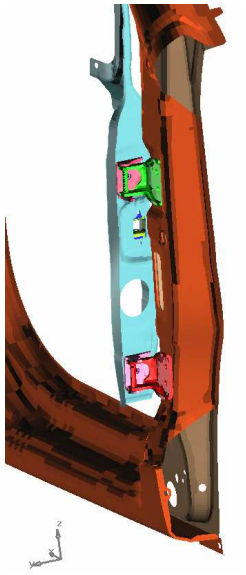


Model description

- 2D elements
- 3D elements for the hinge parts
- 118 141 nodes / 115 405 elements

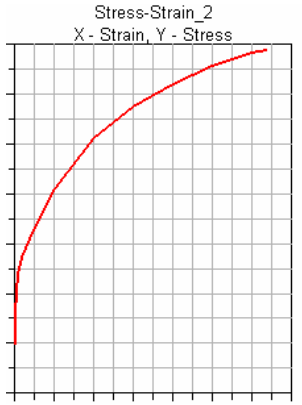
Non-linearity :

- Contact : 17 contact zones constructed with whole body contact declarations.
- Large displacement
- Plasticity : Defined by stress – plastic strain curves



Loading & BC :

- 3 load cases applied to the door :
  - Gravity / Gravity + Load / Unload



Post-processing :

- Maximum displacement
- Von Mises stress
- Plastic deformation
- Remaining displacement in z-direction

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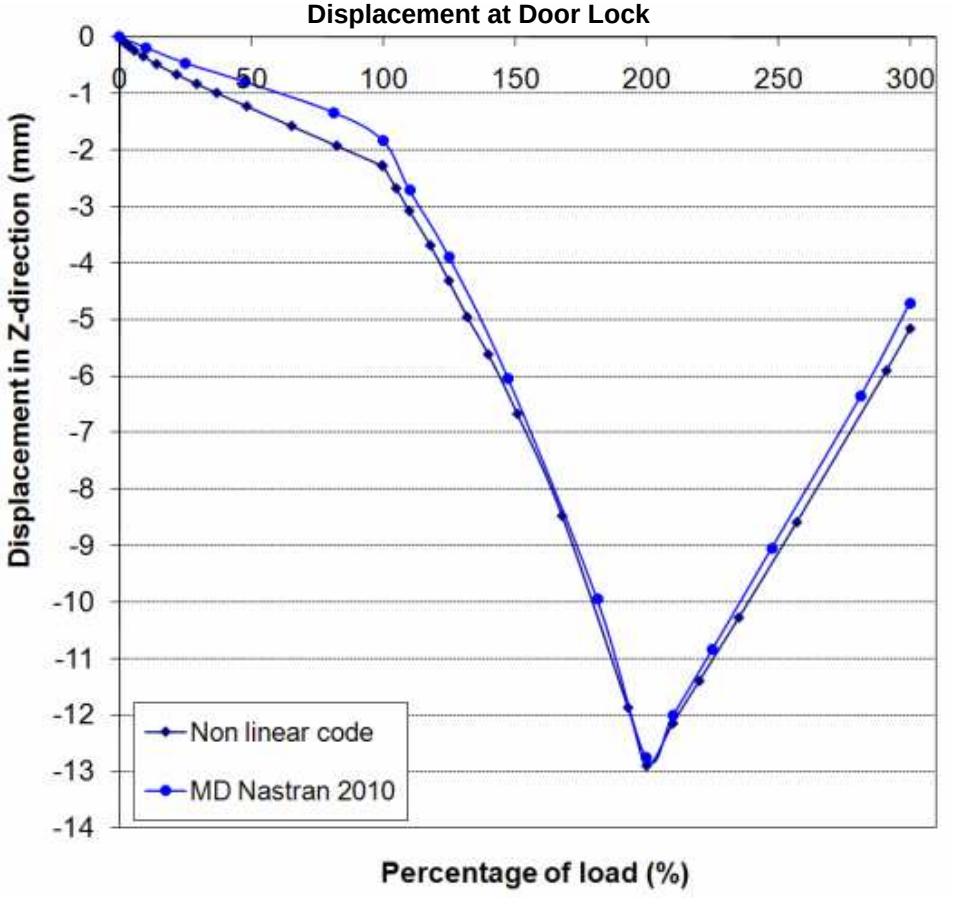
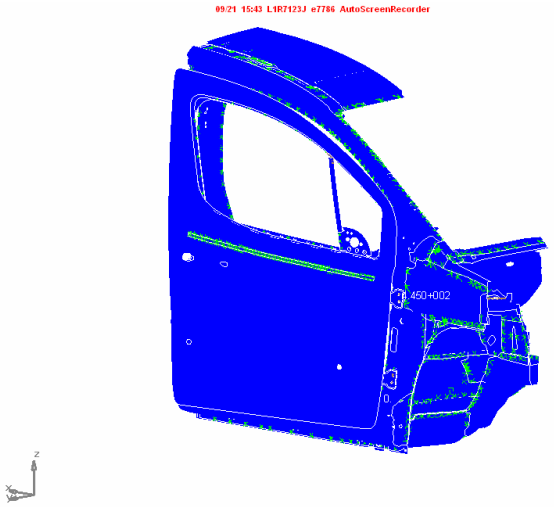
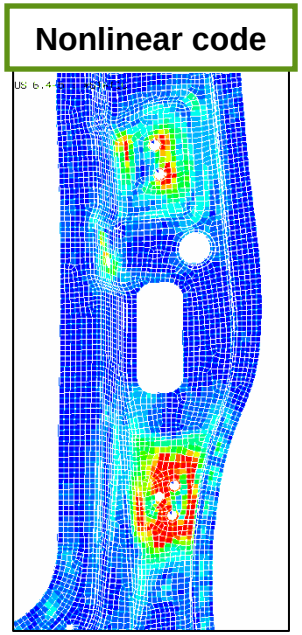
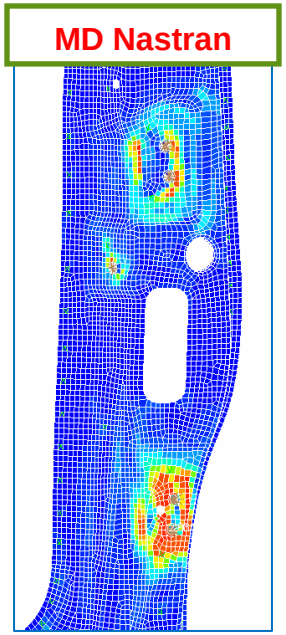
Door Sag Model Results





	Maximum Von-Mises Stress		
	Nonlinear code	MD 2010	Δ
A-Pillar reinforcement	310	308	-1%
Hinge reinforcement	315	322	2%





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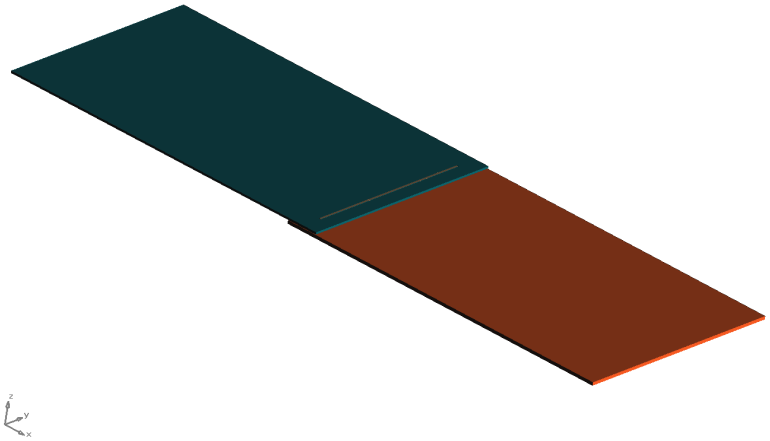
Welded Specimen Model description

Large Rotation Analysis of a welded model for test correlation

Model description:

- 3D elements
- 2D elements for the skin (postprocessing only)
- 256 075 nodes / 329 700 elements



Two analysis for validation:

- Large displacement, large rotation
- Plasticity and Large displacement, large rotation
- One load case applied in the X-direction at the extremity of the specimen

Post-processing :

- Maximum and minimum principal stresses in specific zones
- Comparison with test data

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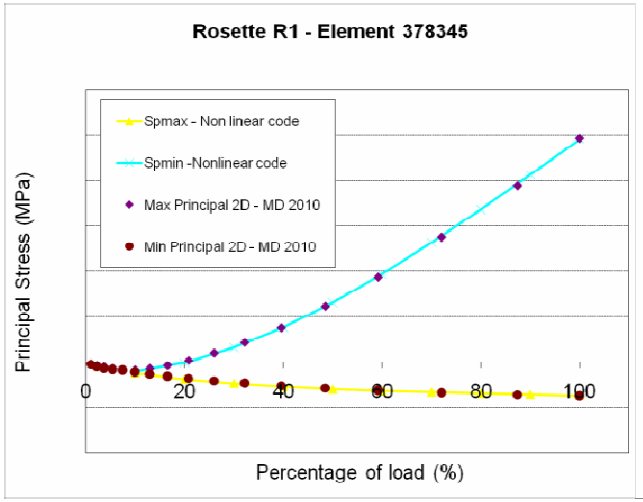
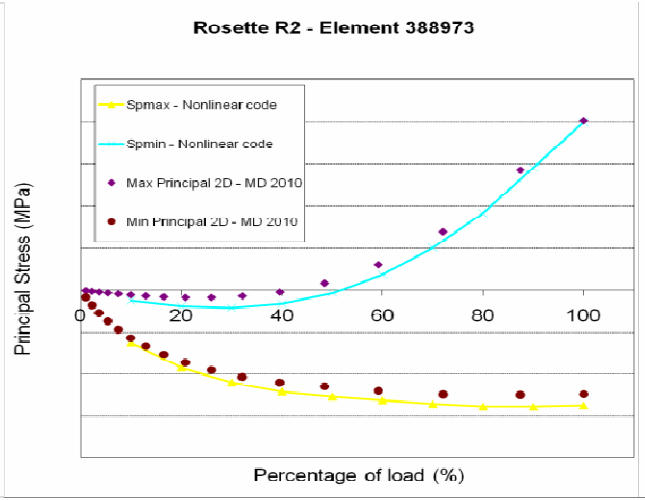
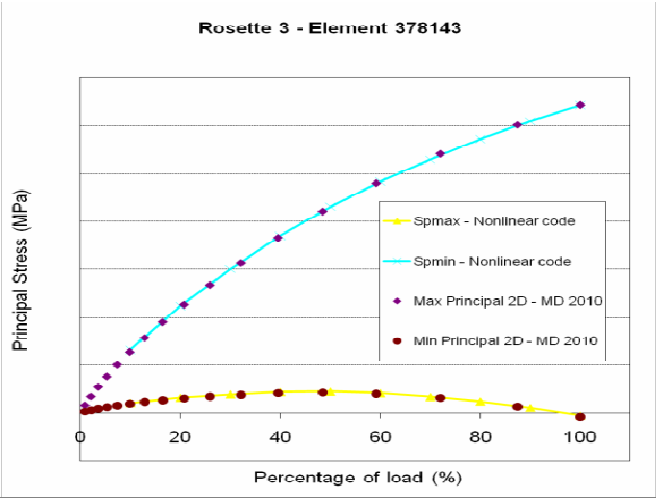
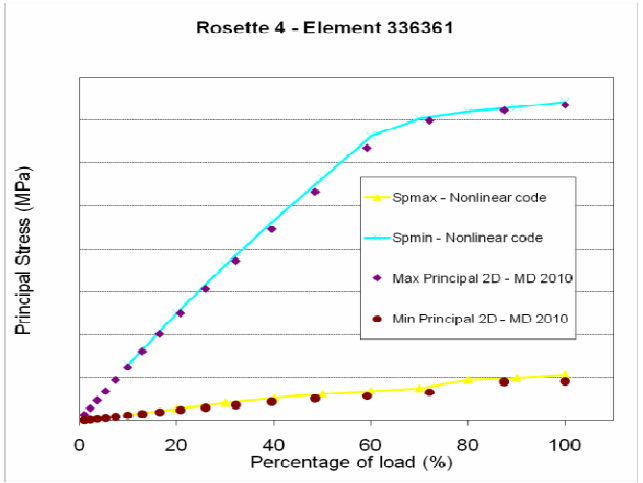
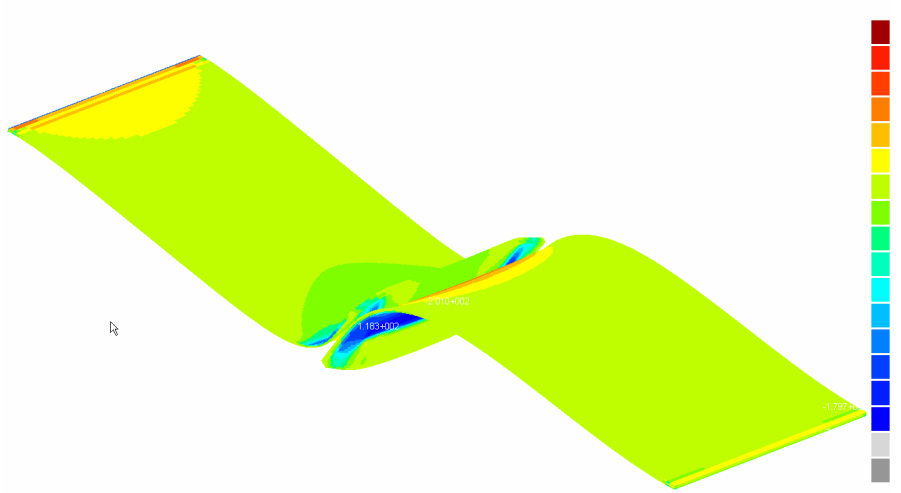
Welded specimen Model Results











Magnified displacement

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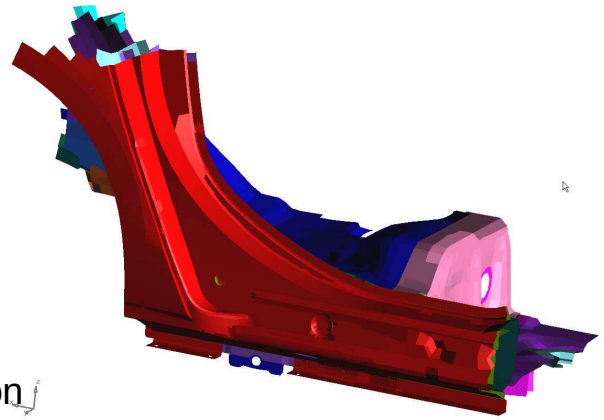
Jack bracket Model description

Validation of the structure rigidity around the jack bracket

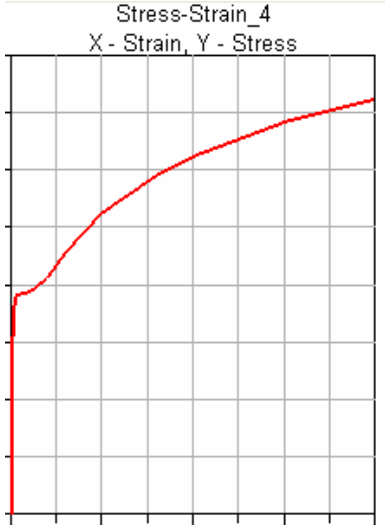


Model description:

- 2D and 3D elements
- 21 938 nodes / 22 189 elements

Non-linearity :

- Contact : 21 contact zones defined by specific contact surface selection
- Large displacement
- Plasticity
- Buckling



Loading & BC:

- 1 Load applied on the jack bracket.

Post-processing :

- Maximum displacement
- Von Mises stress
- Plastic deformation
- Comparison with the test data

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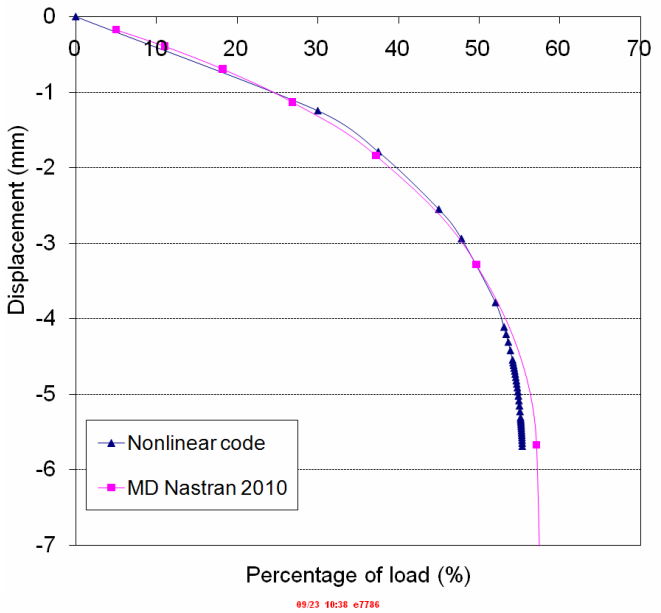
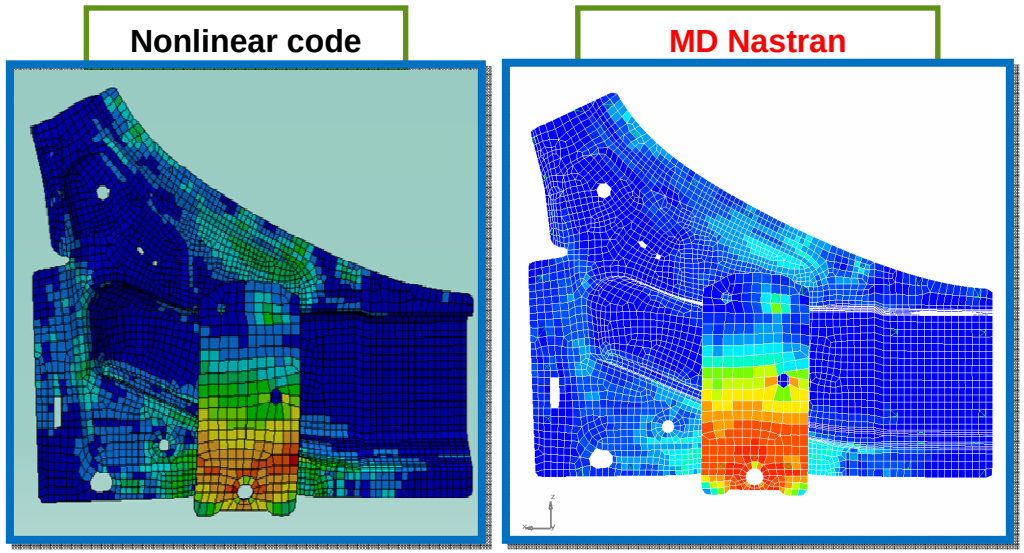
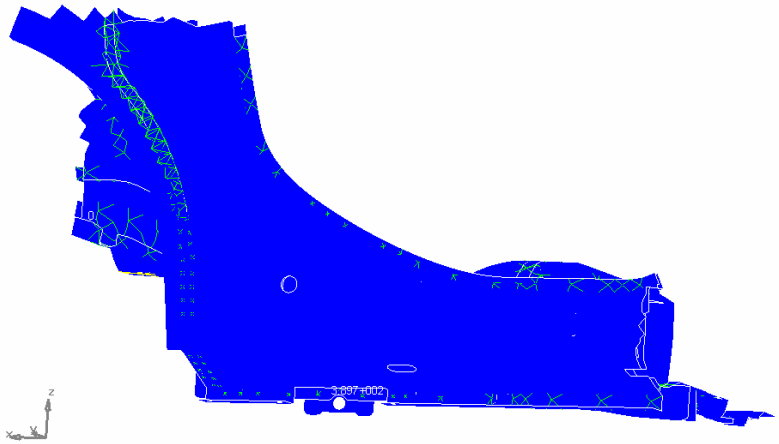
Jack bracket Model Results



	Nonlinear code	MD 2010	Δ
Maximum Von-Mises Stress	368	374	2%
Maximum Strain	0.008999	0.00911	1%





The divergence in the simulation corresponds to the buckling phenomenon observed during the test.

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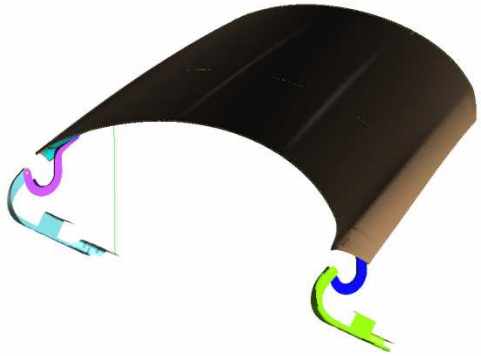
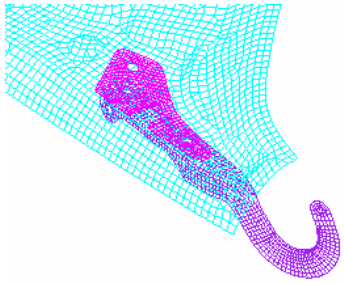
Customer loading on a hood

Performance validation of the hood under exceptional load



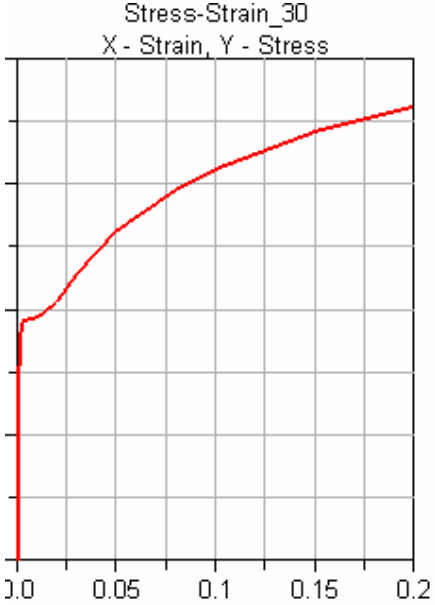
Model description

- 2D and 3D elements
- 35 392 nodes / 38 610 elements



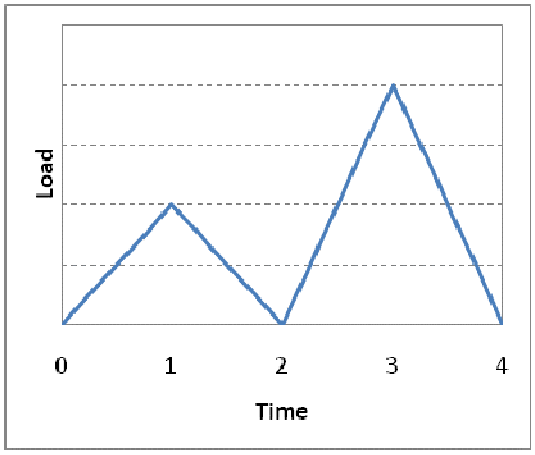
Non-linearity :

- Contact : 5 contact zones constructed with whole body contact declarations.
- Large displacement
- Plasticity
- Management of large initial penetration



Loading & BC:

- 4 load cases applied to the hood



Post-processing :

- Maximum displacement
- Von Mises stress
- Plastic deformation
- Displacement

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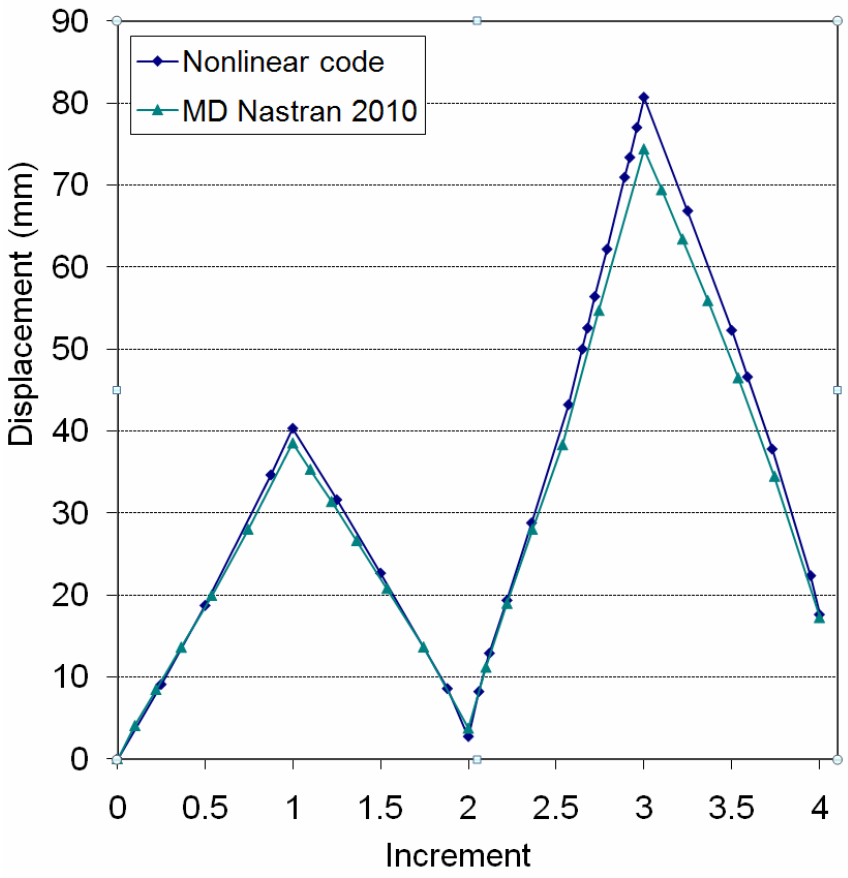
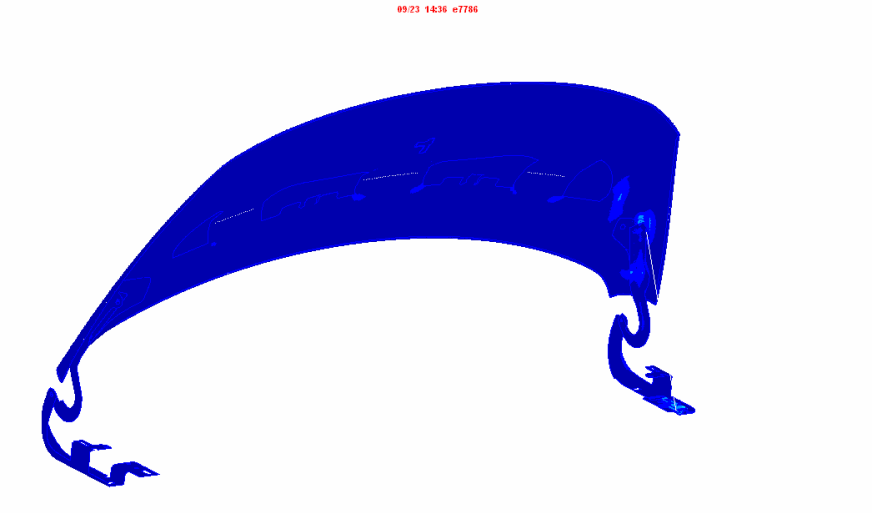
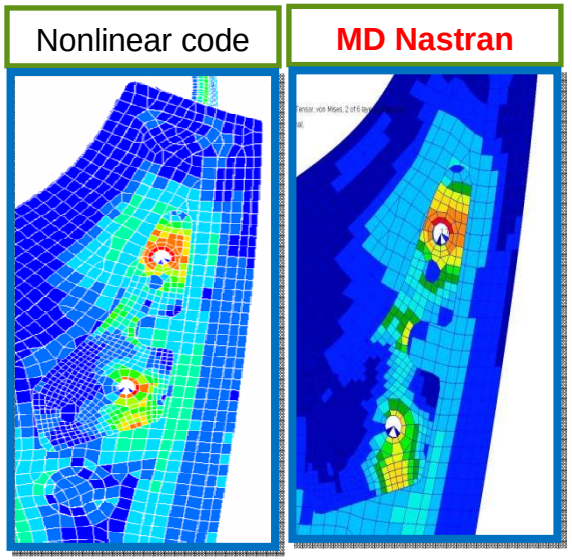
Customer loading on a hood – Results







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Towing - Model description

Design of the front bumper for towing

Model description:

- 2D and 3D elements
- 26 259 nodes / 26 217 elements

Non-linearity:

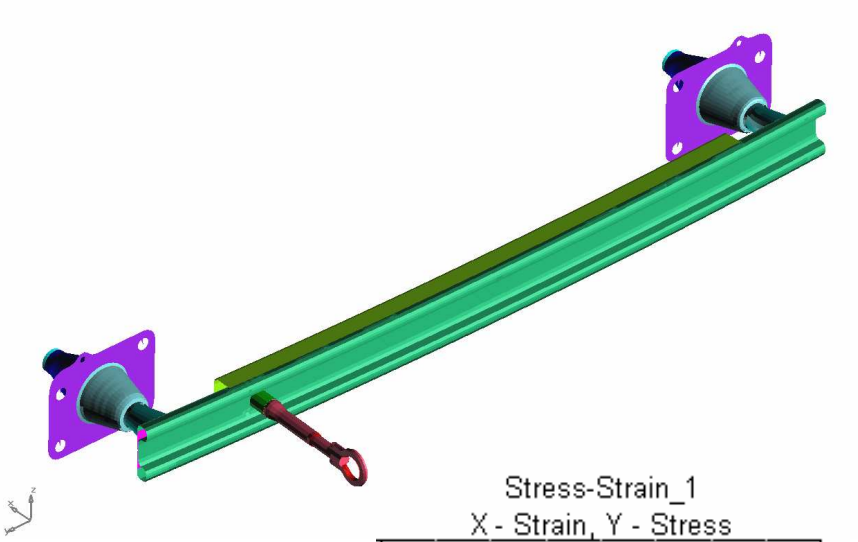
- Contact
- Large displacement
- Plasticity

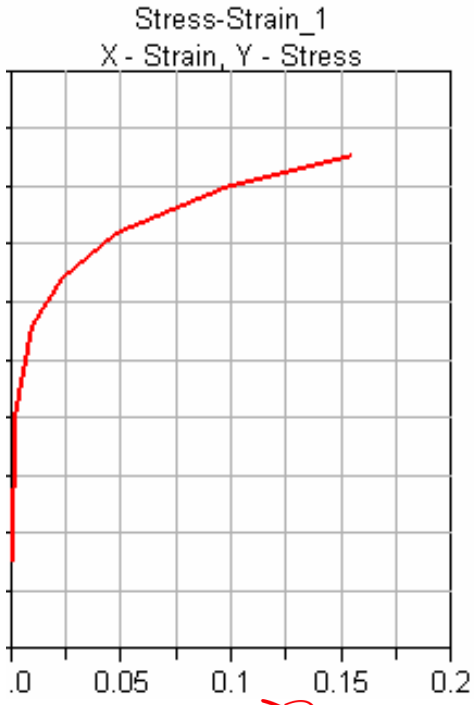
Loading & BC:

- 2 load cases : Load and unload of the hook

Post-processing :

- Maximum displacement
- Von Mises stress
- Plastic deformation





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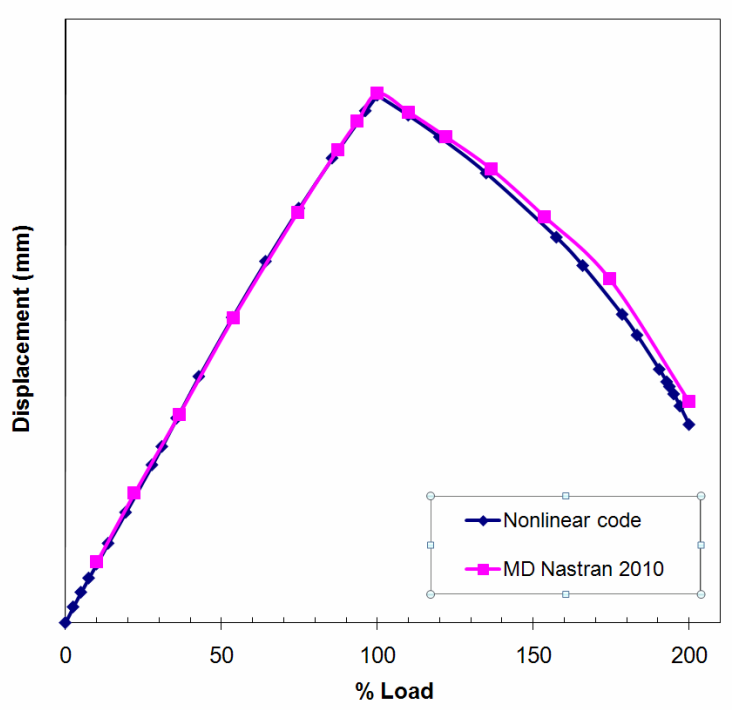
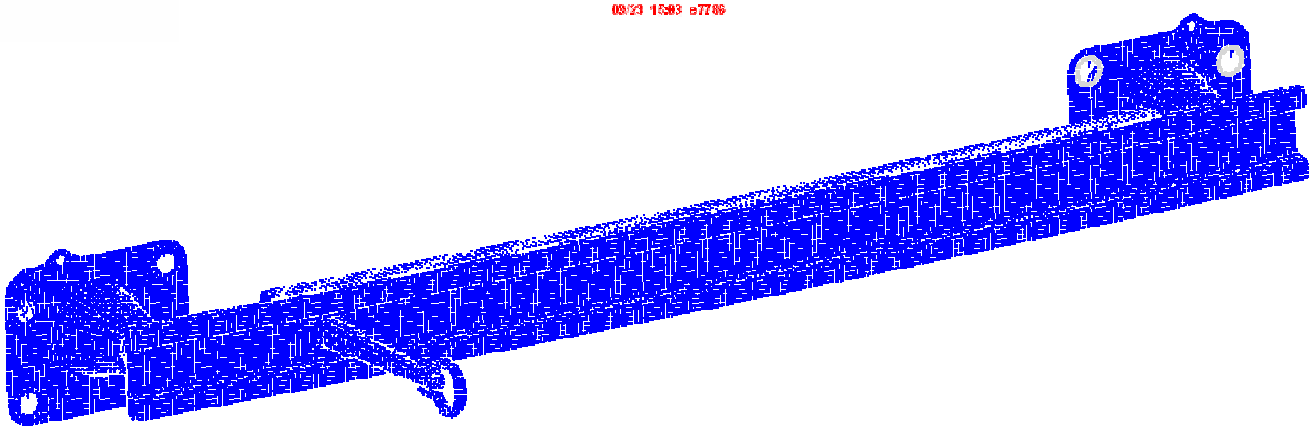
Towing hook - Results



	Nonlinear code	MD 2010	Δ
Maximum Von-Mises Stress	1400	1450	4%
Maximum Strain	0.0979	0.0888	-9%



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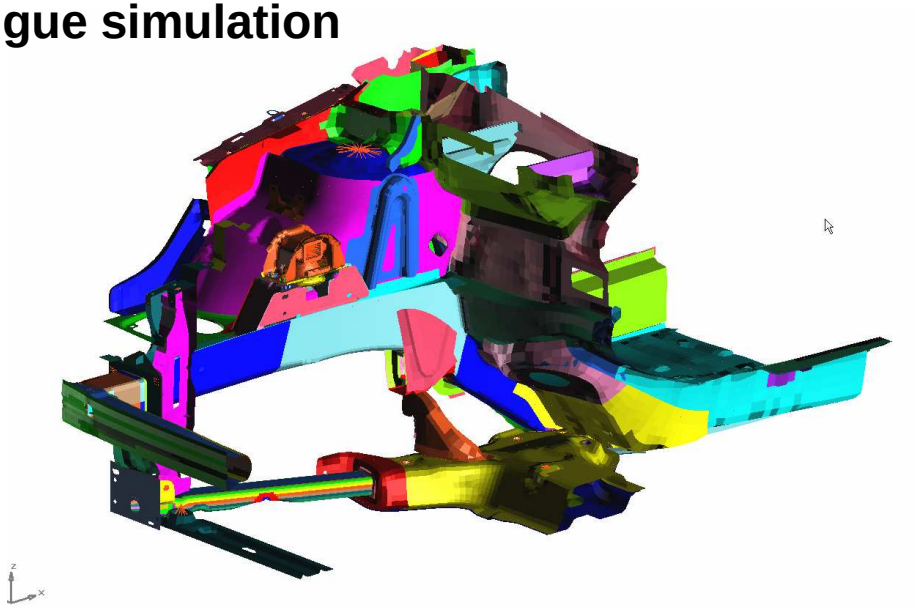
Body in white interface

Stress calculation for subsequent fatigue simulation



Model description:

- 2D and 3D elements
- 79297 nodes / 88302 elements

Non-linearity :

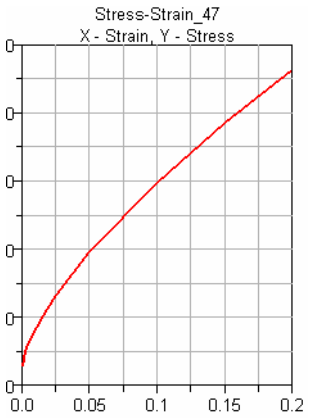
- Contact
- Plasticity
- Management of large penetration

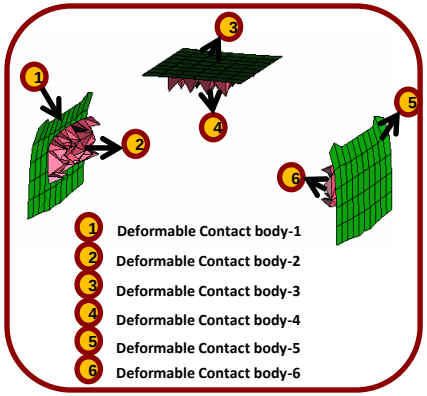
Loading & BC:

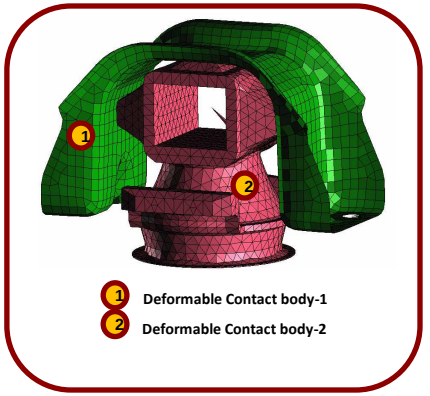
- 1 load case : Force applied to the engine mount

Post-processing:

- Von Mises stress
- Stress in the CBAR







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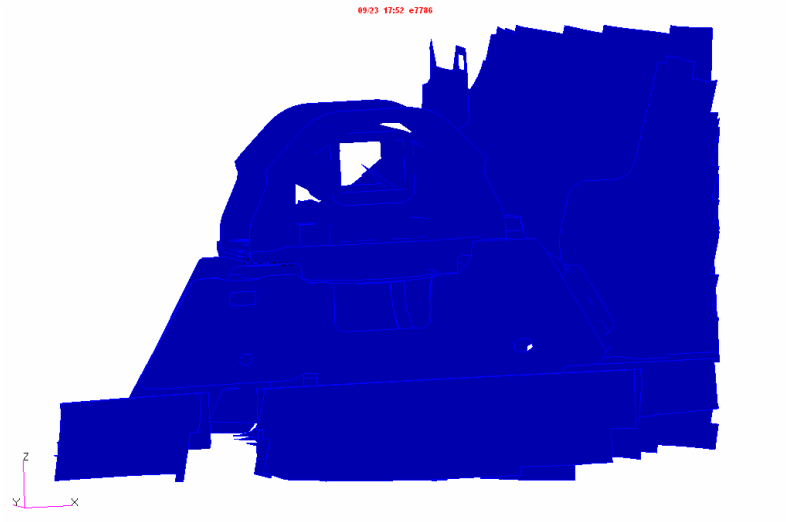
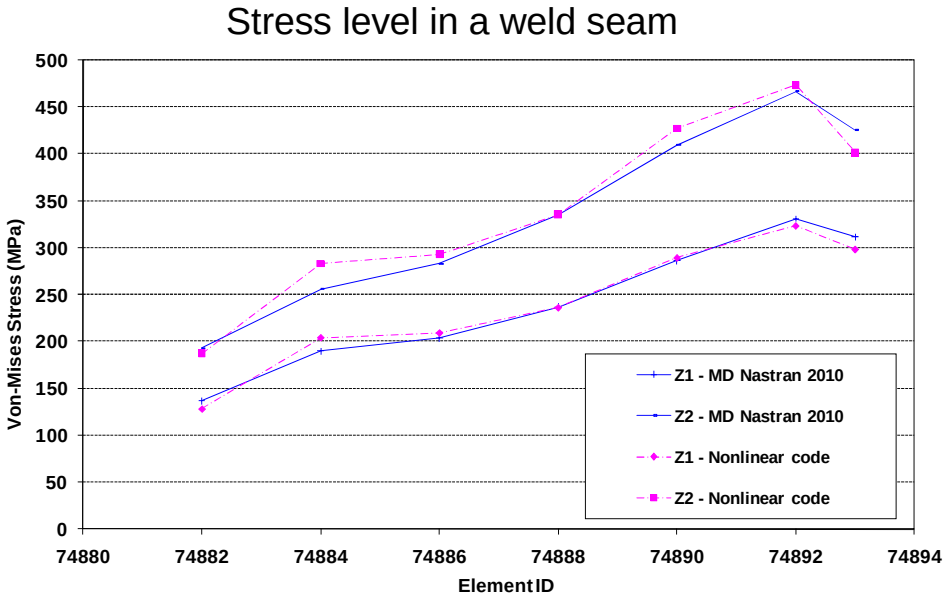
Body in white interface - Results





- Stabilization of the model not necessary because of the initial contact table of MD Nastran
  - Rigid links needed in the non-linear code
- Management of large initial penetration:
  - Offset
  - Contact interference
  - Stress-free initial contact

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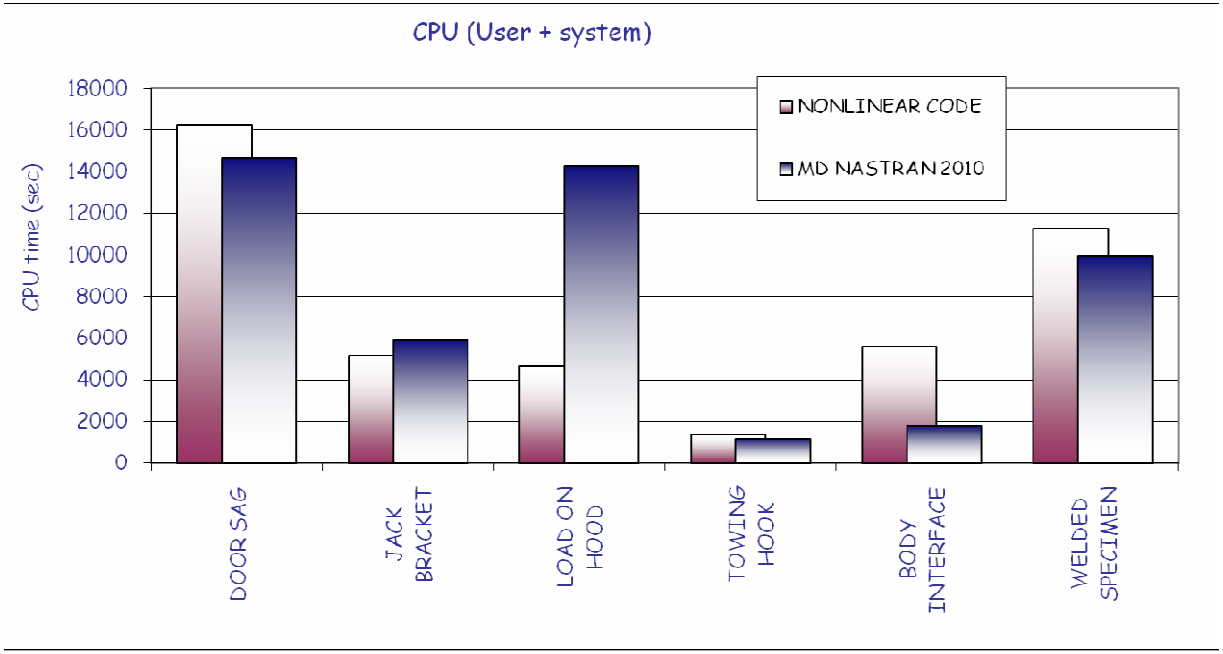
Performance



- Results obtained on Windows
- Welded specimen :
  - CASI solver (element based iterative solver) is used
- The “Jack bracket” model is diverging (buckling phenomena).
  - The MD Nastran 2010 model starts the divergence process later than the other nonlinear code.
- The “Customer Load on Hood” is a problematic model.
  - This model was analyzed by the product development, and the issue is identified and will be corrected in the next release of MD Nastran in order to obtain the same performance.

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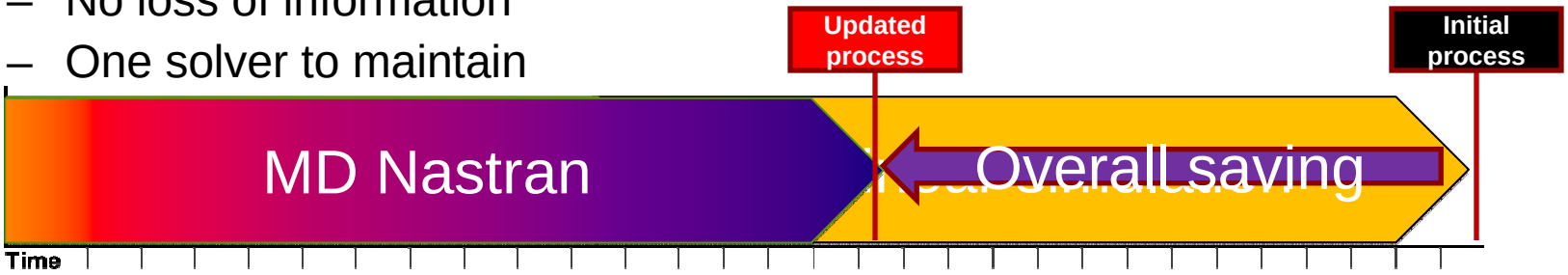
Summary

- MD Nastran 2010 meets PSA expectations regarding results accuracy and performance for body structure simulation.

- MD Nastran 2010 provides improvement for contact modeling (intuitive contact body definition, improved initial penetration management)

- The simulation process is improved :
  - Unique reference model for simulation on body structure
  - Reduction of the pre-processing steps
  - No loss of information
  - One solver to maintain



- Pilot project starts at the end of September
- 24 engineers were trained by MSC Software

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Thank You

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