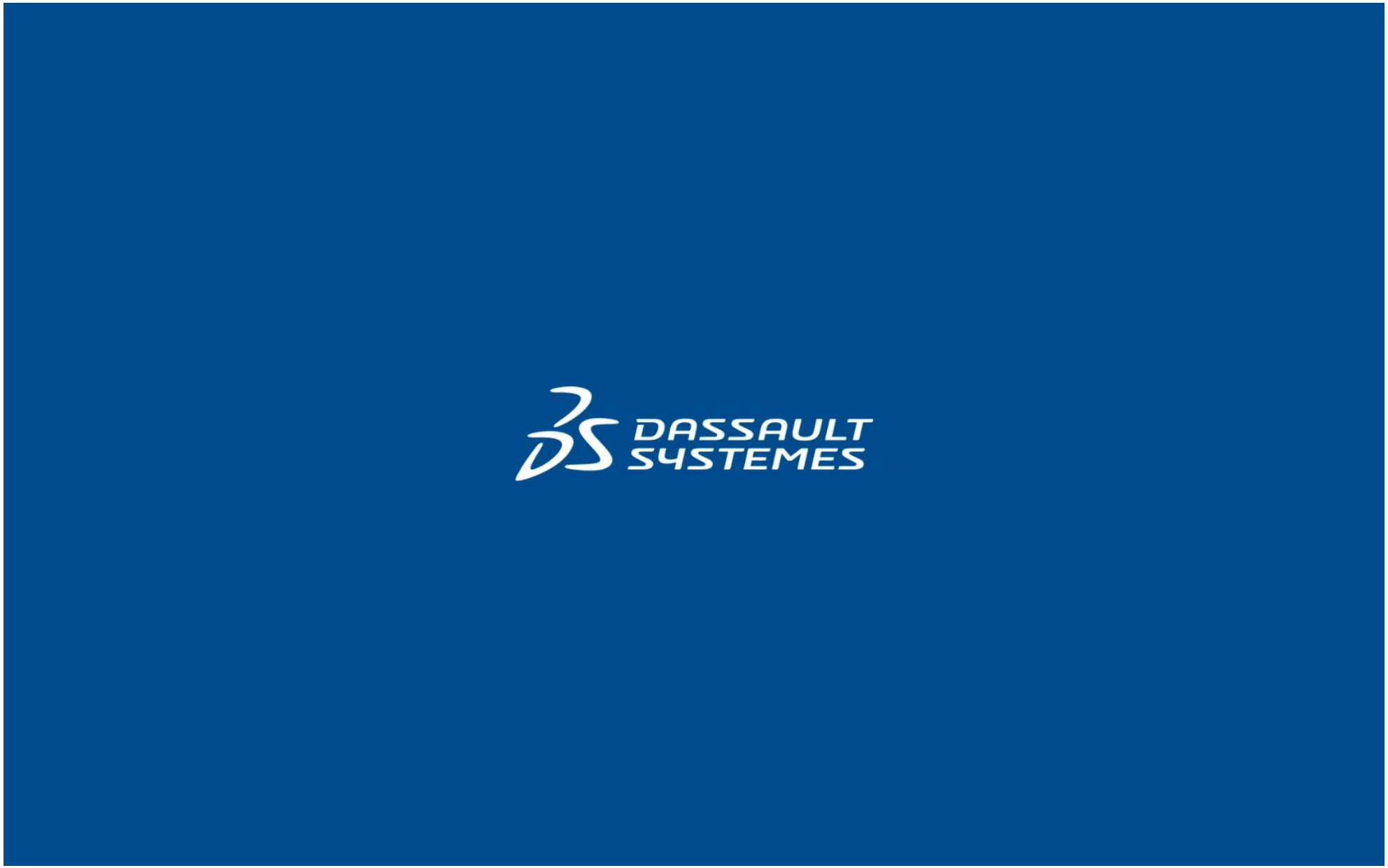
automotive CAE GRAND CHALLENGE

Parametric Design and Structural Optimization for Early Design Exploration

Dr. Tayeb Zeguer
Goup leader – Advanced CAE, MDO Jaguar Landrover

Stefan Mertz
Senior Industry Process Consultant
Dassault Systemès



Conceptual Design – Modelling and Simulation MODSIM

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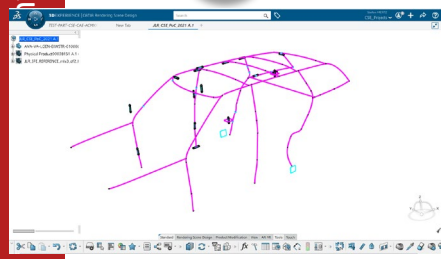

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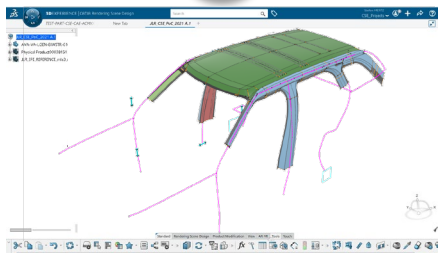

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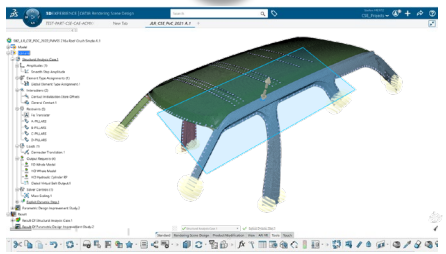

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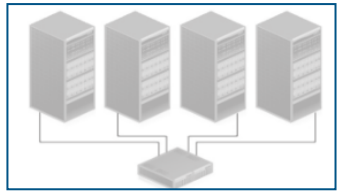

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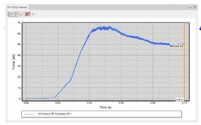

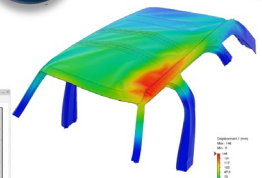

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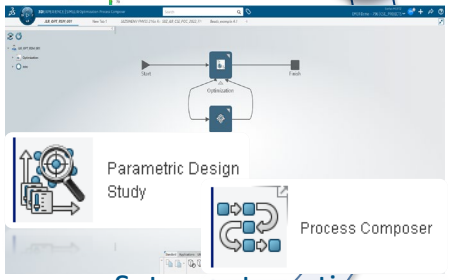

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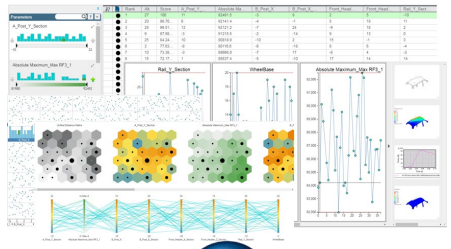

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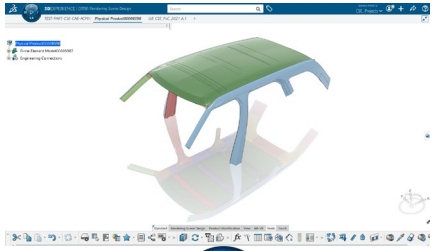

Feed-back concept geometry recommendations to AVA

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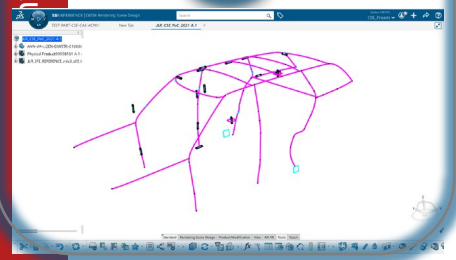

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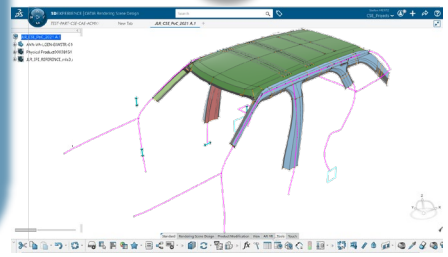

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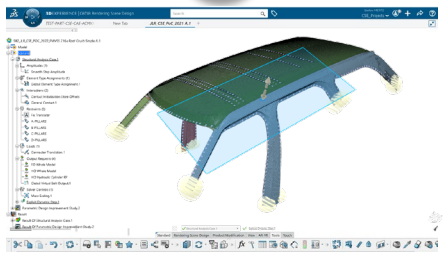

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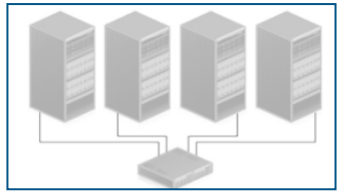

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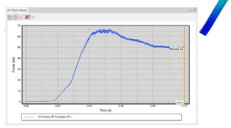

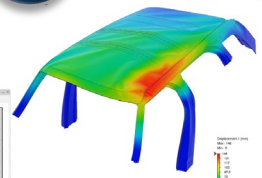

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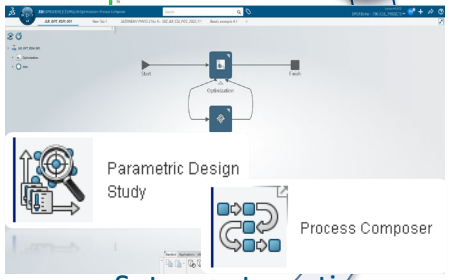

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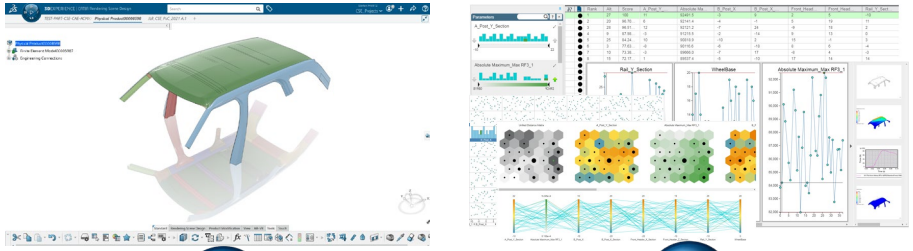

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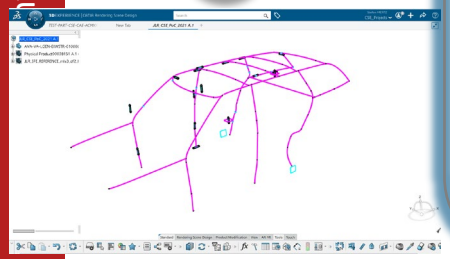

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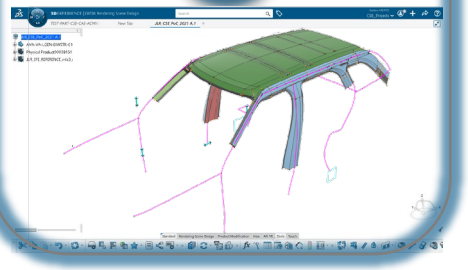

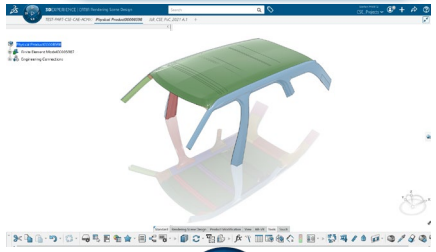

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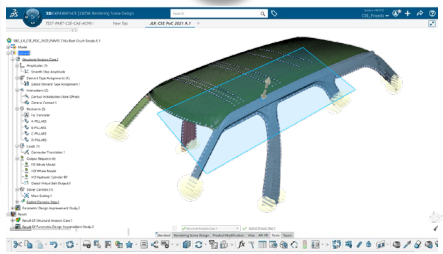

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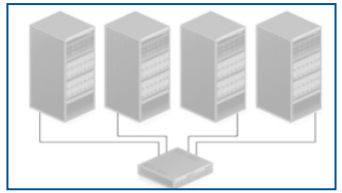

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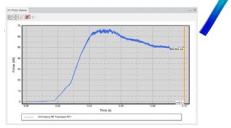

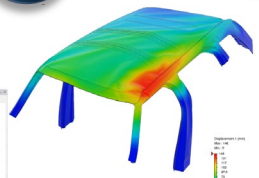

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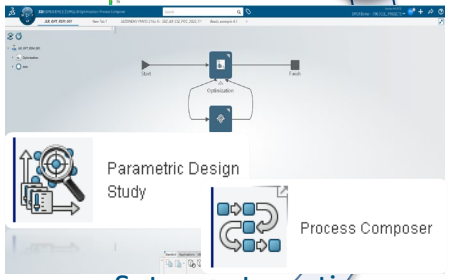

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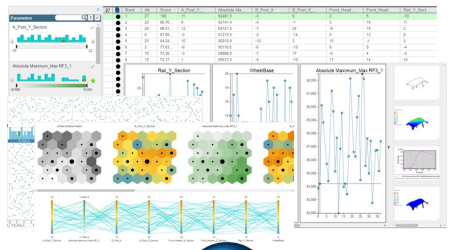

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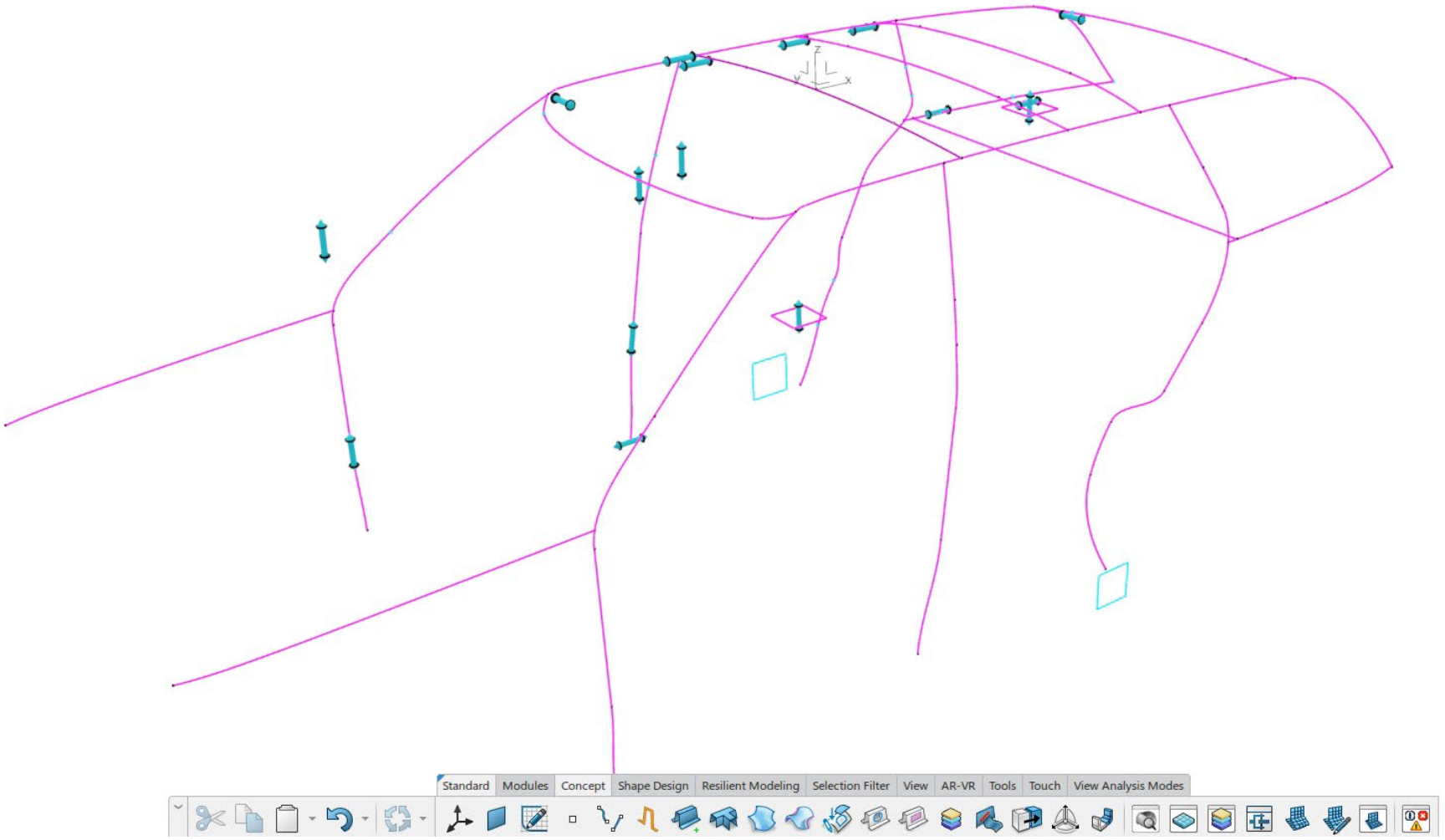
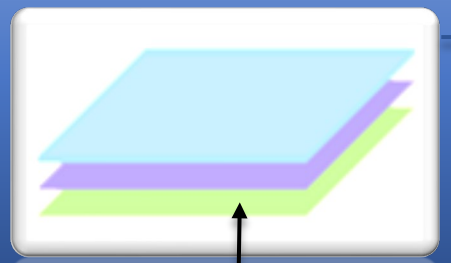
Create Associative CONCEPT STRUCTURE MODEL



Associative CONCEPT STRUCTURE MODEL

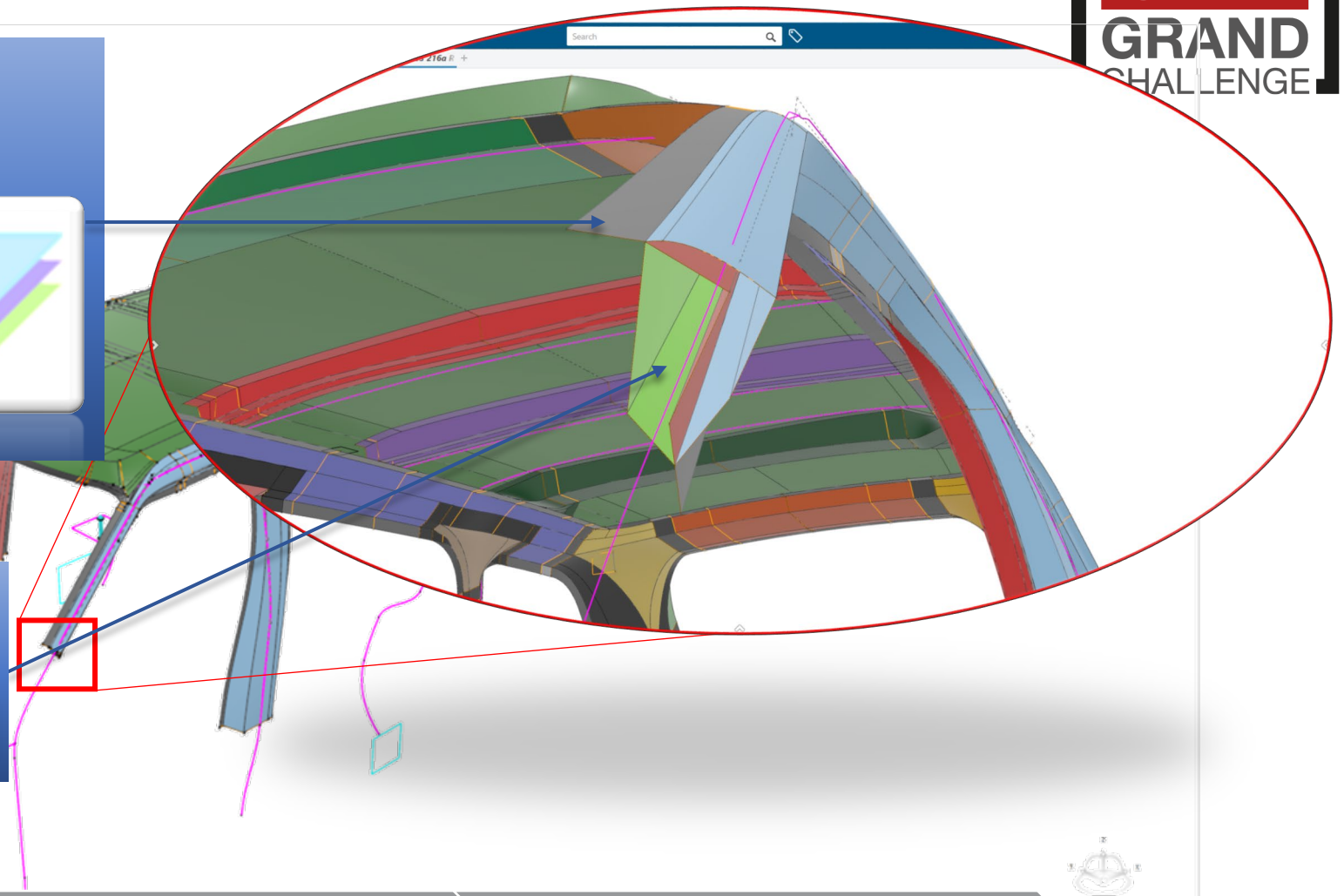
STACKING attribute on surface:

- ✓ Stacking of several LAYERs
- ✓ Connections



LAYER attribute on surface:

- ✓ Material reference
- ✓ Layer thickness



Single layer geometry → Multi-layer result → Simulation model

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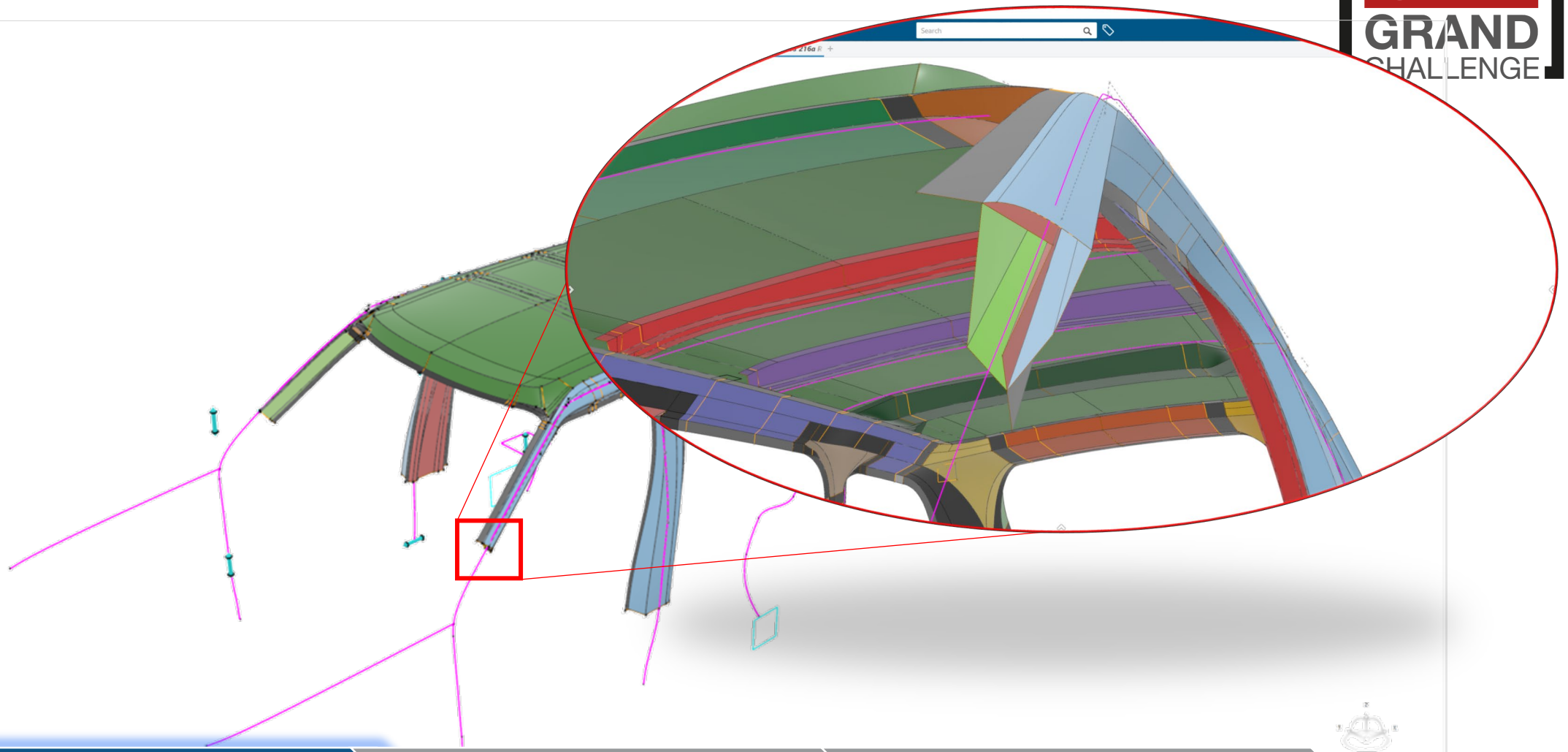

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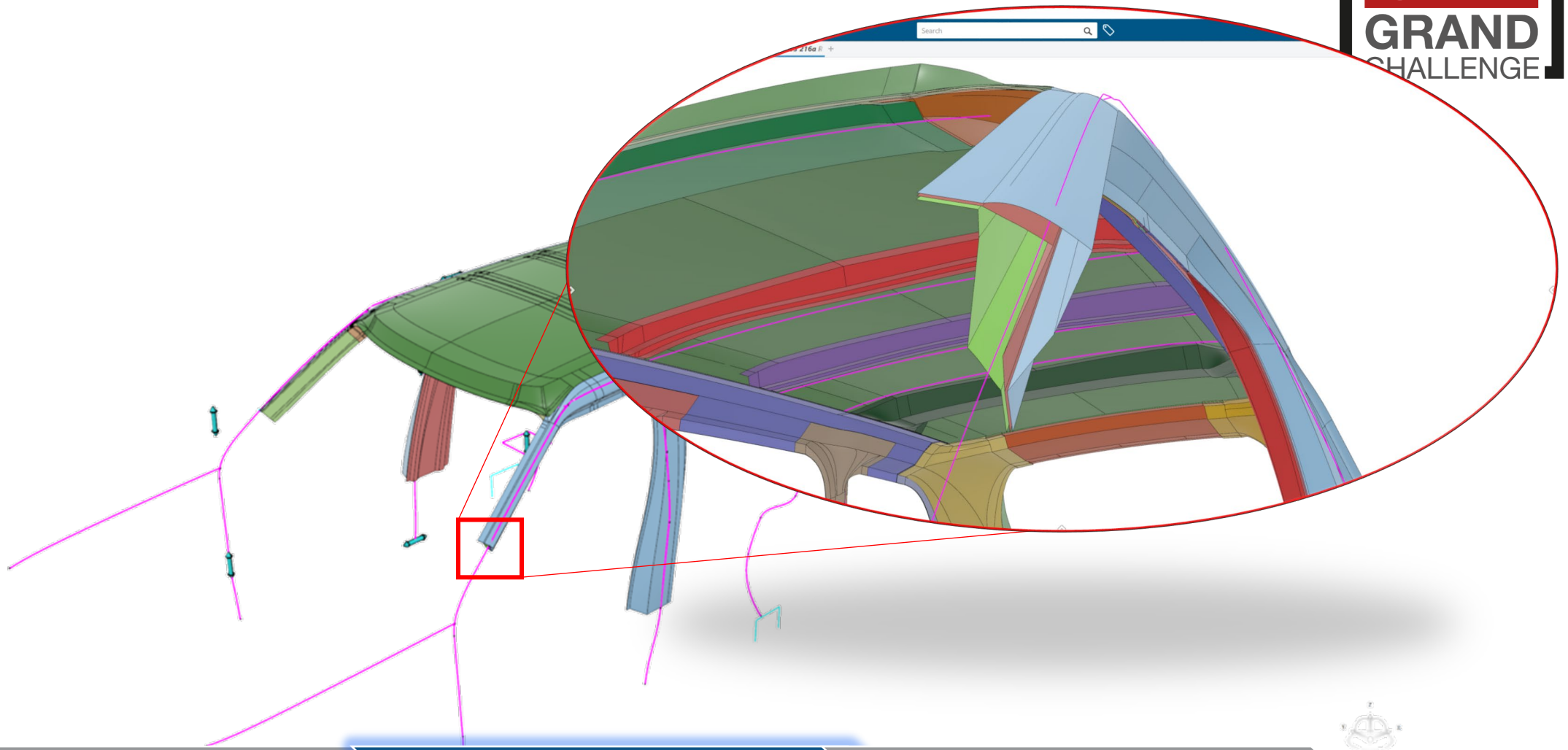

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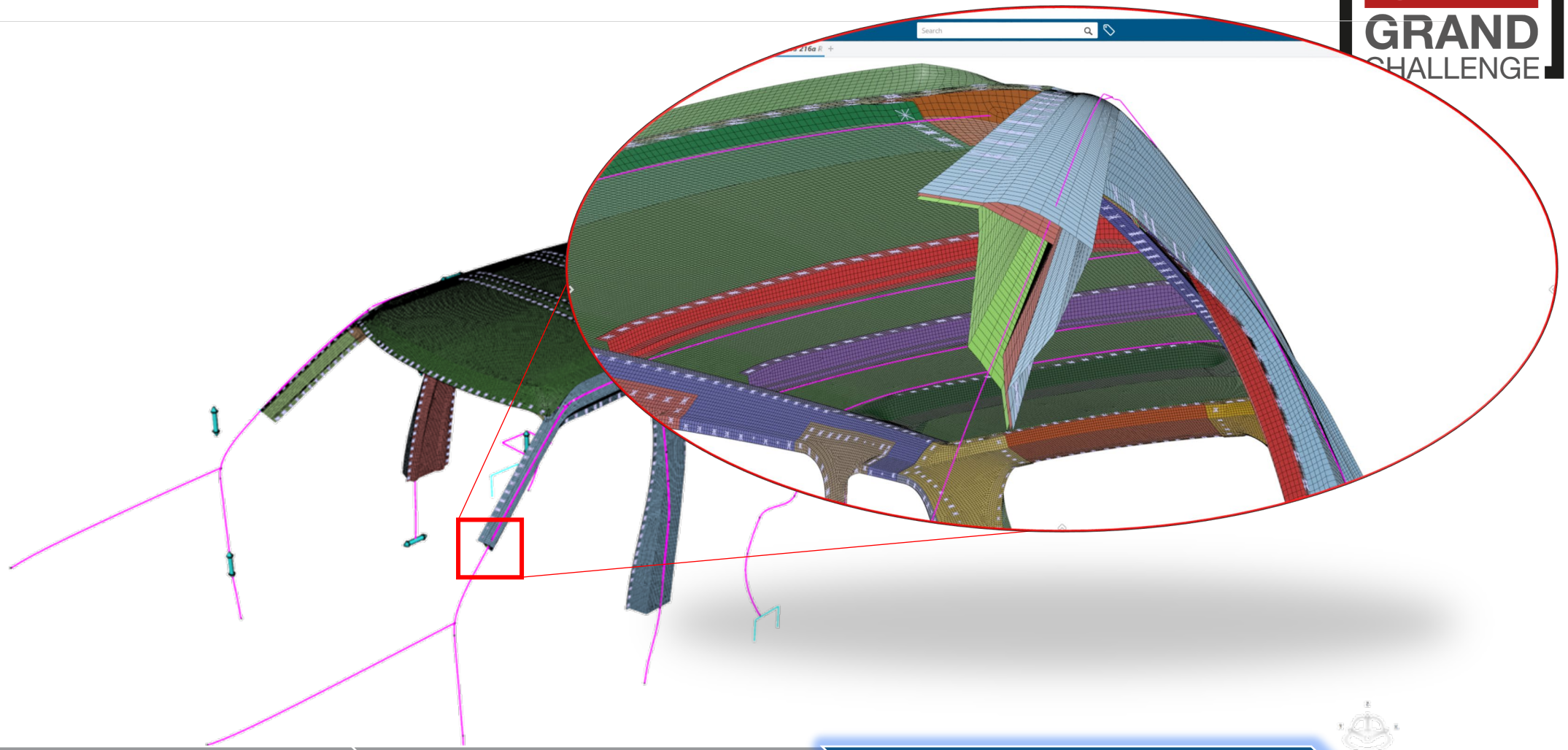

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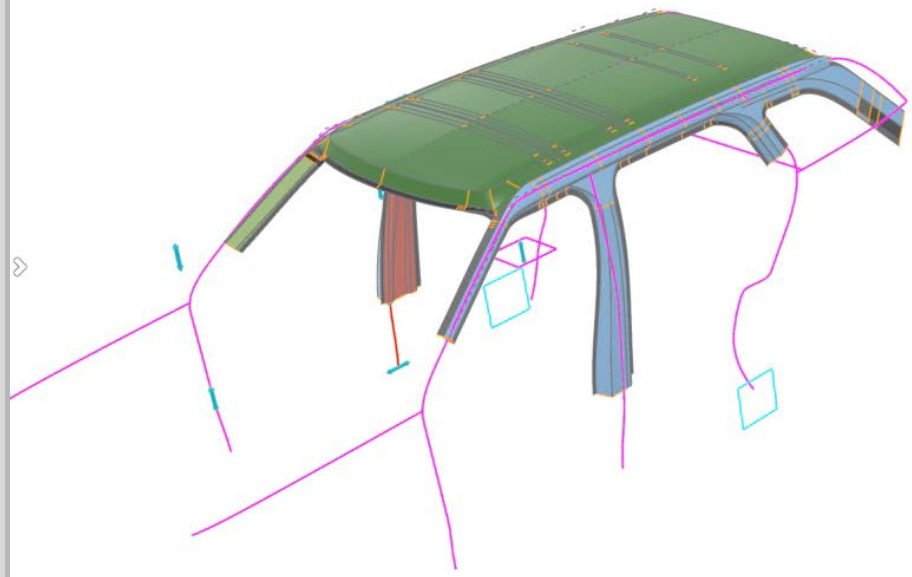
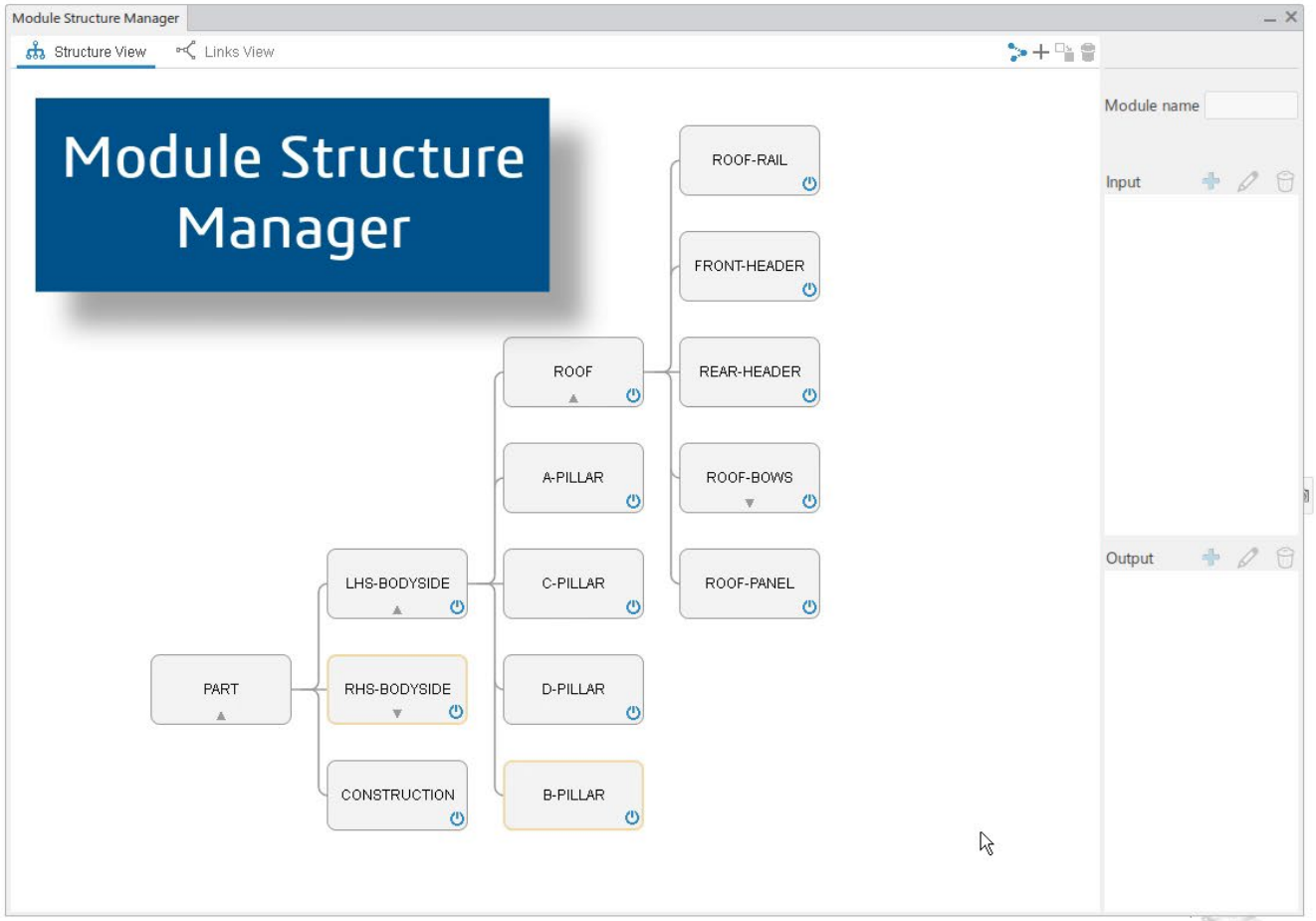
Modules – module structure manager





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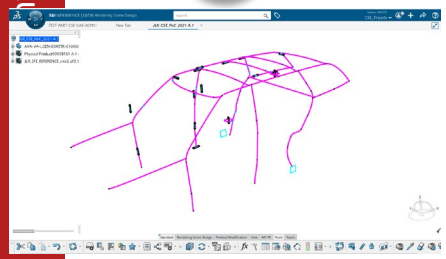

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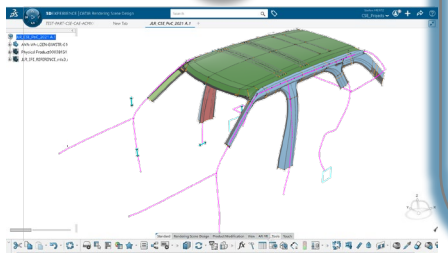

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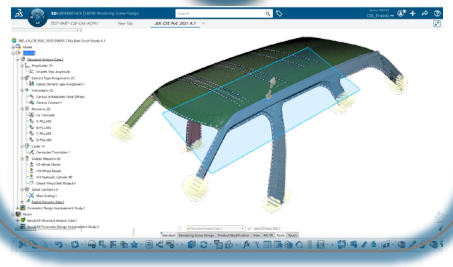

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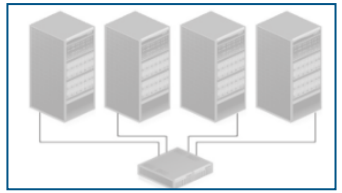

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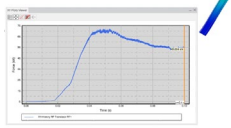

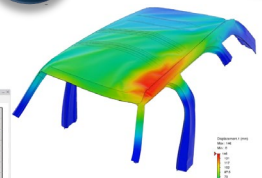

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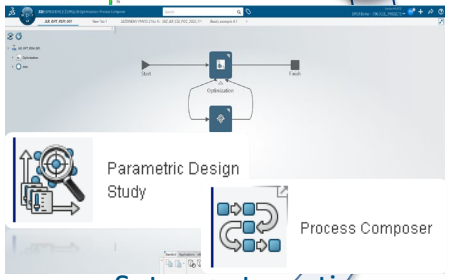

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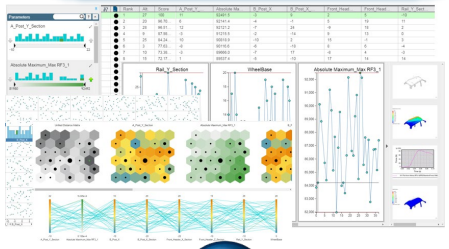

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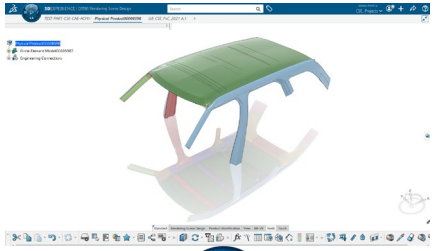

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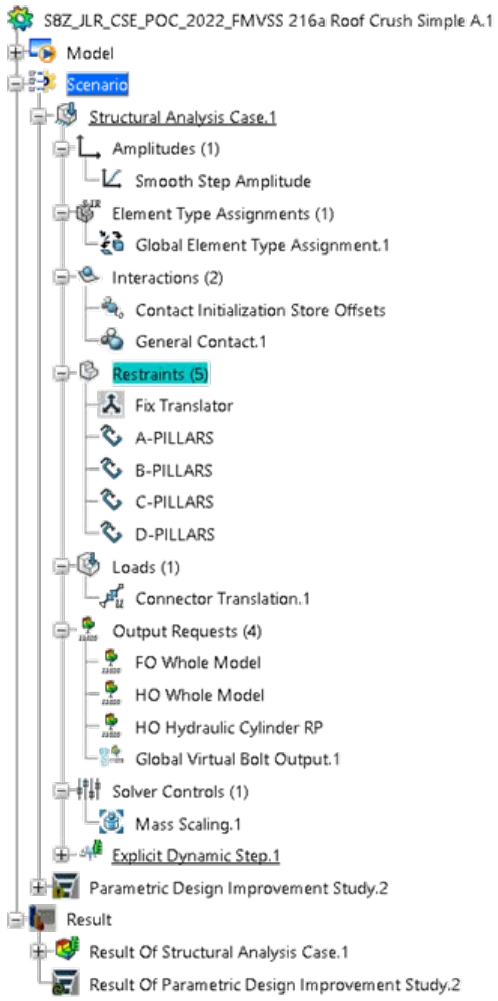
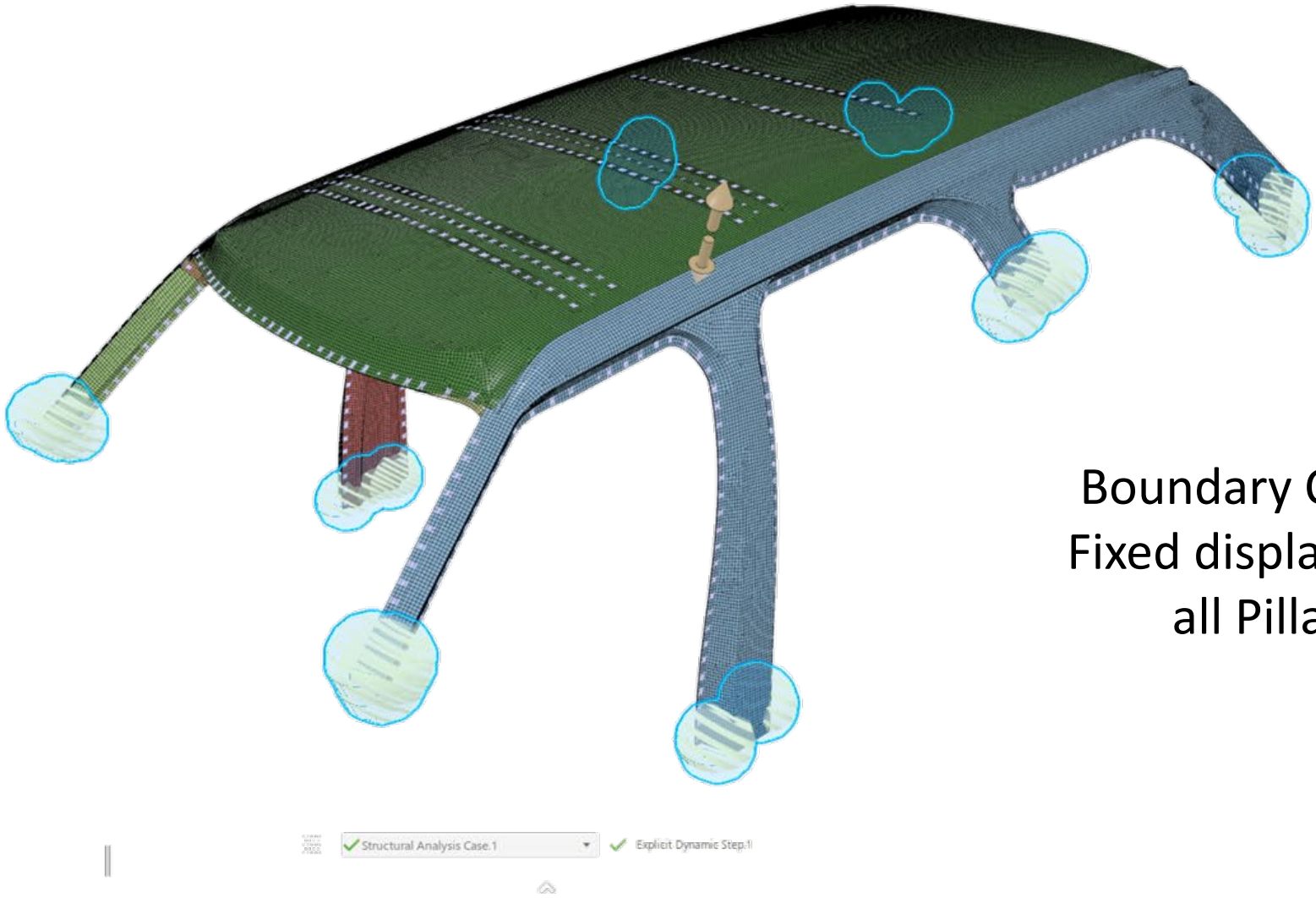
FMVSS 216a Roof Crush scenario

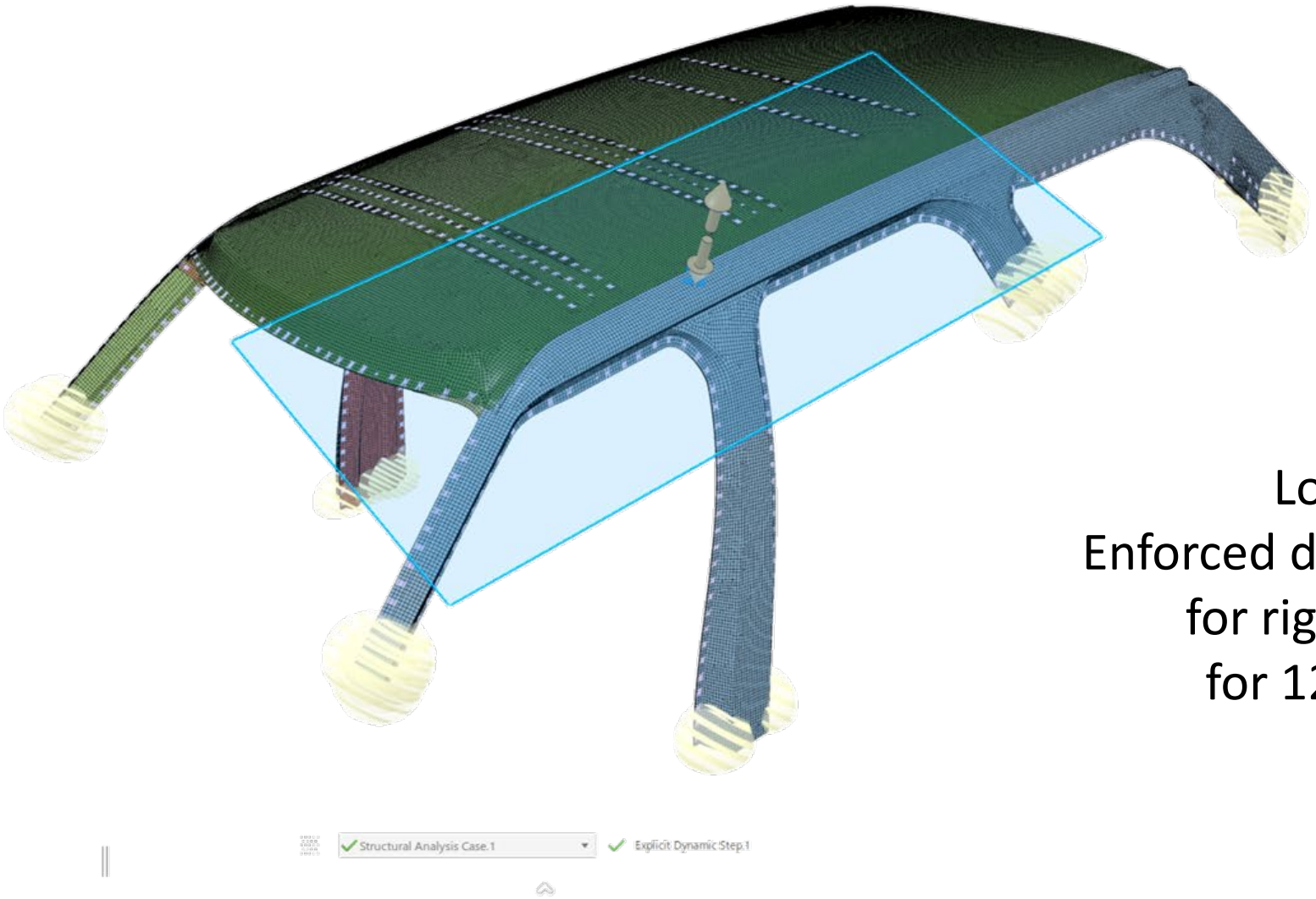




Boundary Conditions:
Fixed displacements of all Pillar ends

FMVSS 216a Roof Crush scenario

- S8Z_JLR_CSE_POC_2022_FMVSS 216a Roof Crush Simple A.1
  - Model
  - Scenario
    - Structural Analysis Case.1
      - Amplitudes (1)
        - Smooth Step Amplitude
      - Element Type Assignments (1)
        - Global Element Type Assignment.1
      - Interactions (2)
        - Contact Initialization Store Offsets
        - General Contact.1
      - Restraints (5)
        - Fix Translator
        - A-PILLARS
        - B-PILLARS
        - C-PILLARS
        - D-PILLARS
      - Loads (1)
        - Connector Translation.1
      - Output Requests (4)
        - FO Whole Model
        - HO Whole Model
        - HO Hydraulic Cylinder RP
        - Global Virtual Bolt Output.1
      - Solver Controls (1)
        - Mass Scaling.1
      - Explicit Dynamic Step.1
    - Parametric Design Improvement Study.2
  - Result
    - Result Of Structural Analysis Case.1
    - Result Of Parametric Design Improvement Study.2



Load:
Enforced displacement
for rigid plate
for 127 mm

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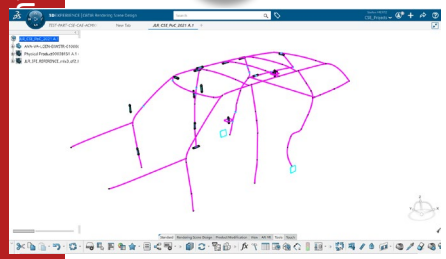
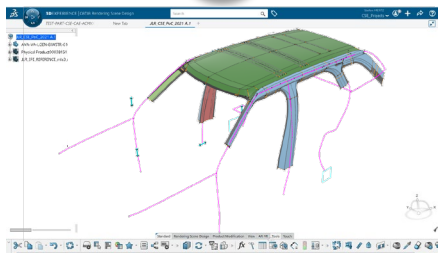
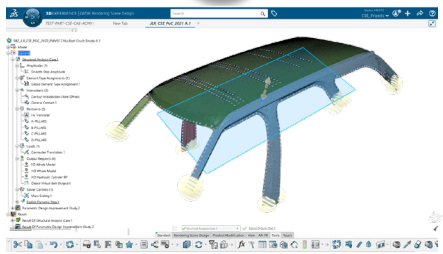
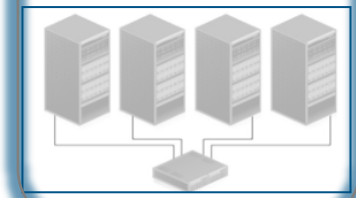
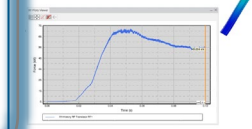
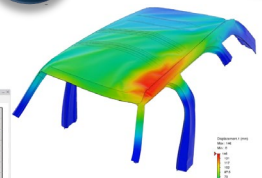
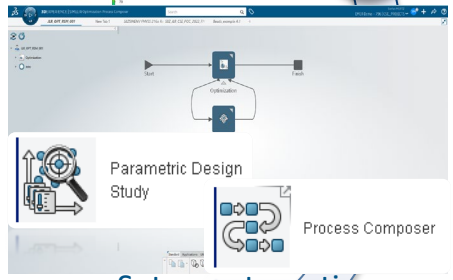

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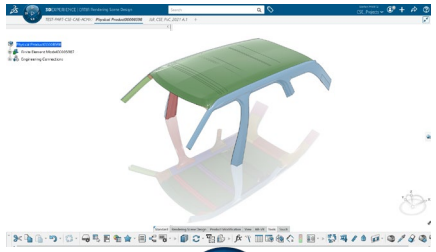
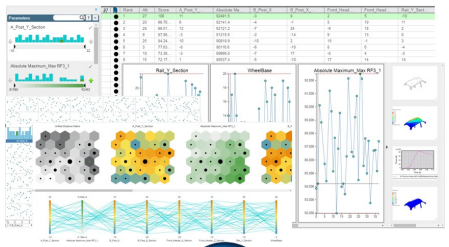

11 Select optimal concept geometry

Feed-back concept geometry recommendations to AVA

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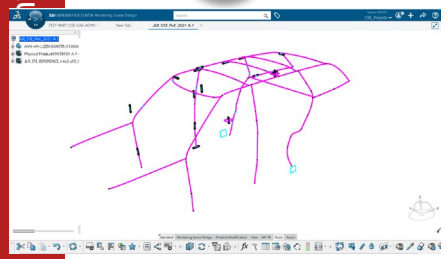

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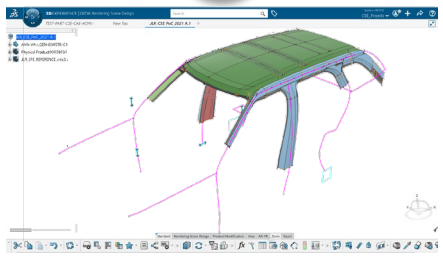

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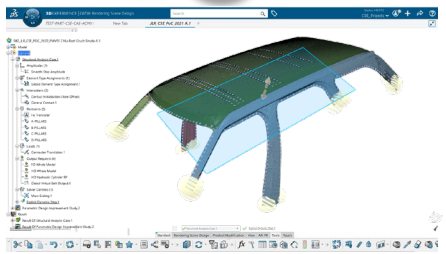

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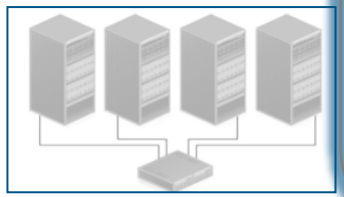

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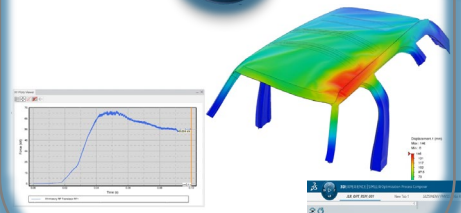

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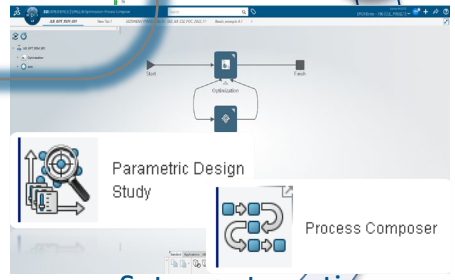

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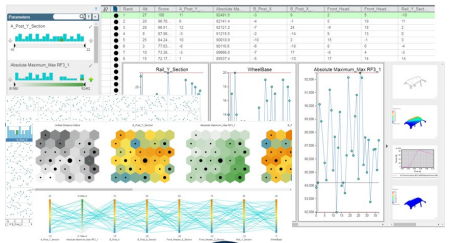

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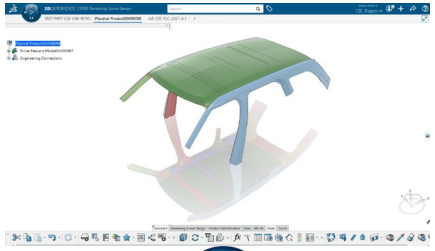
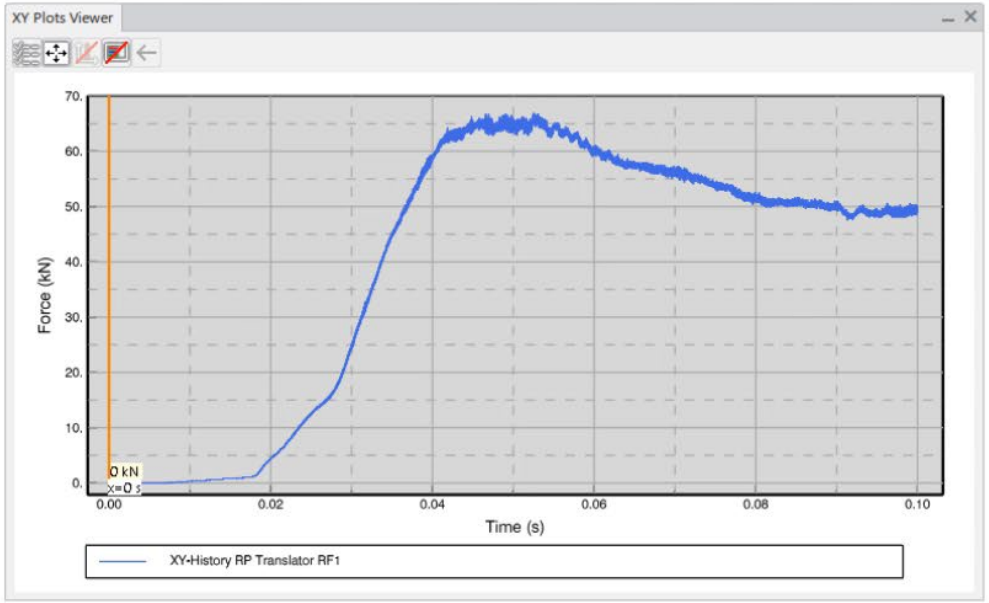
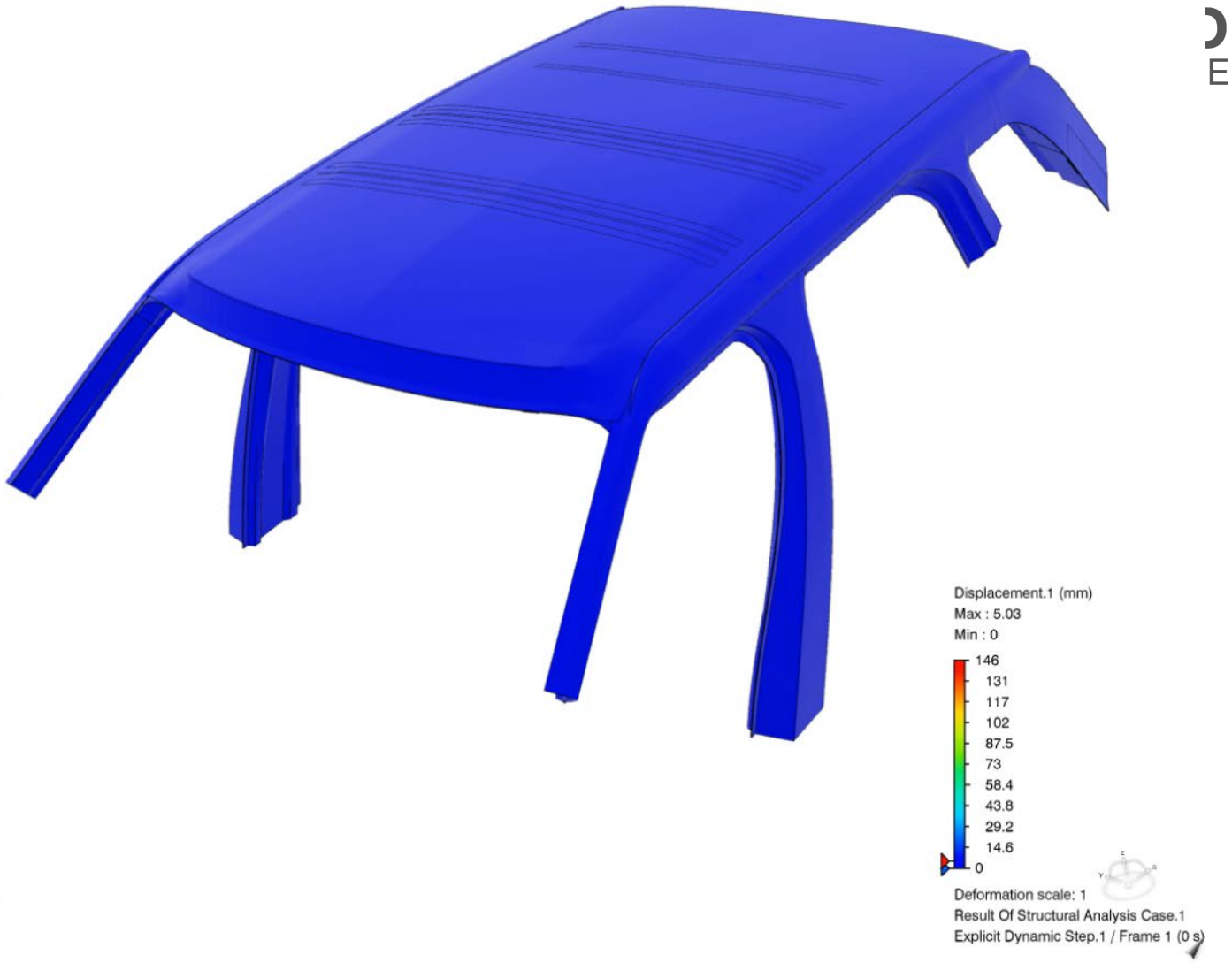


Feed-back concept geometry recommendations to AVA

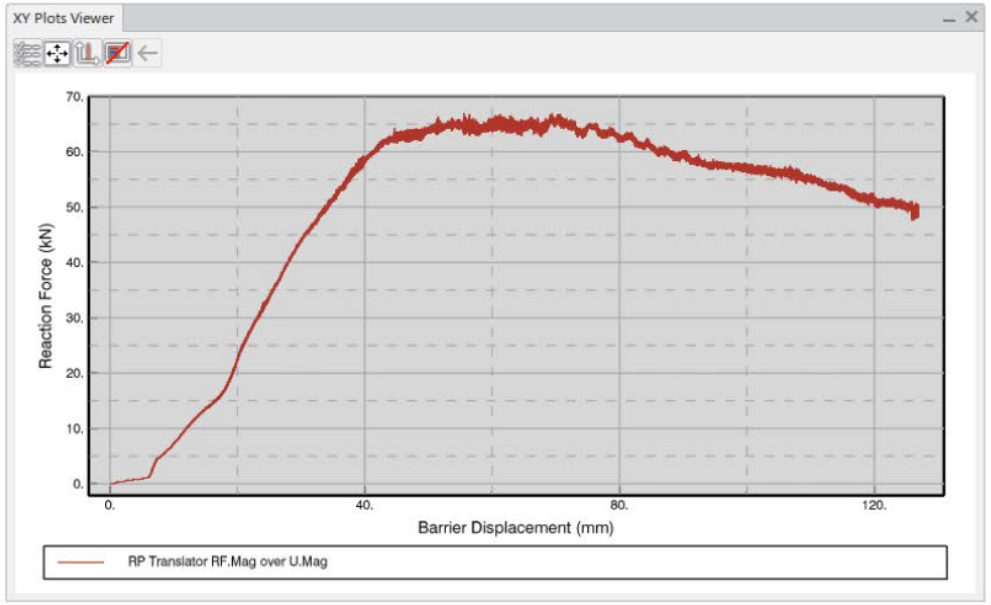
carhs Empowering Engineers

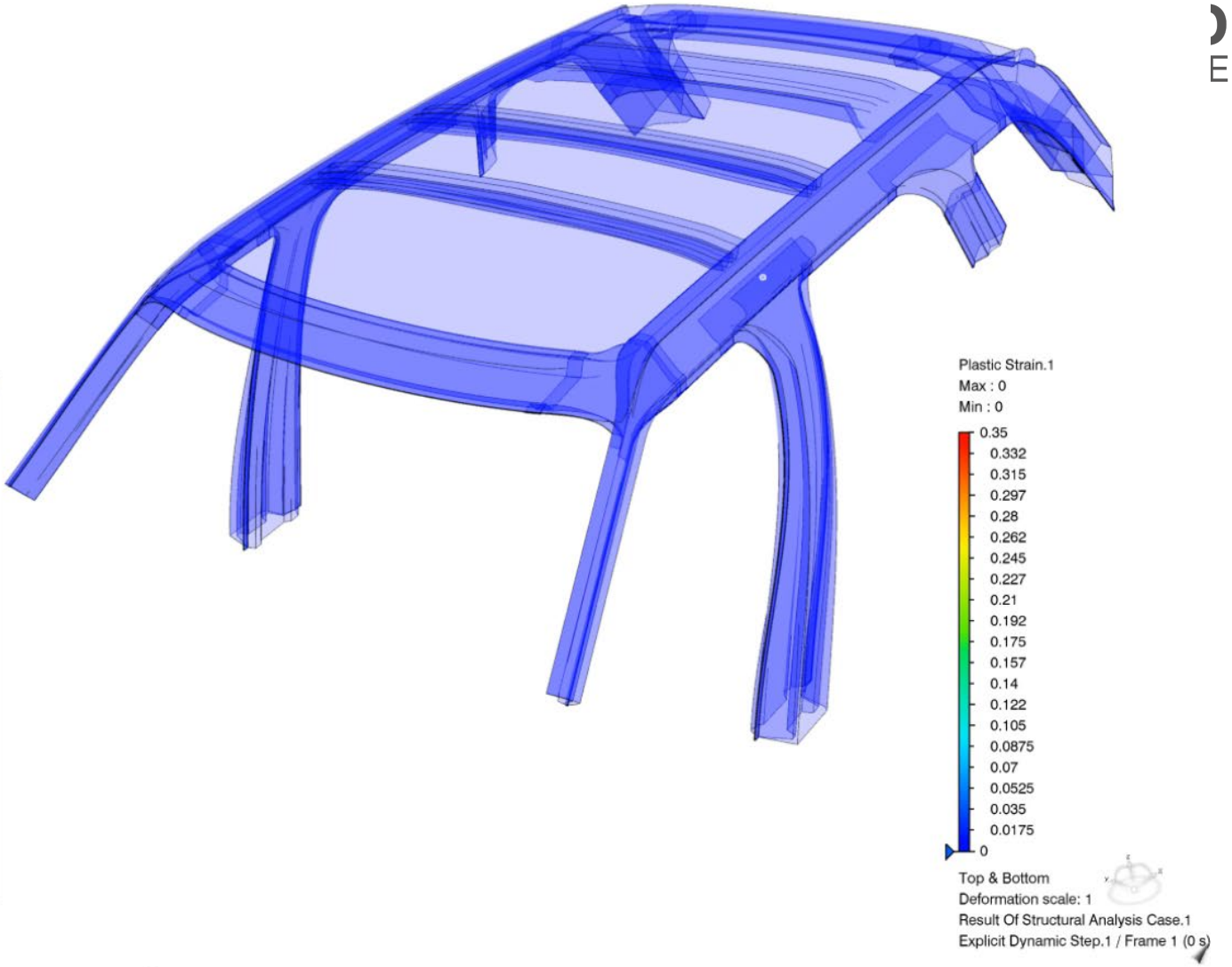
FMVSS 216a Roof Crush scenario - results





Scenario results





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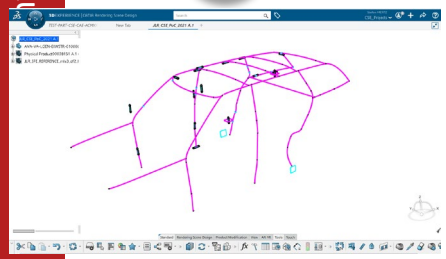

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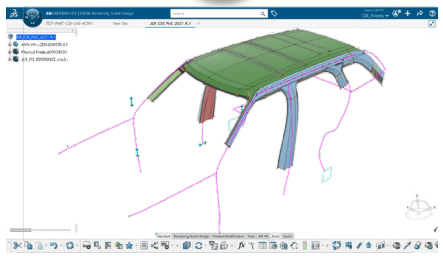

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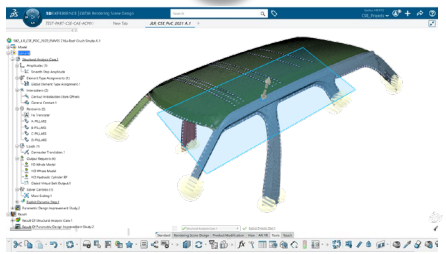

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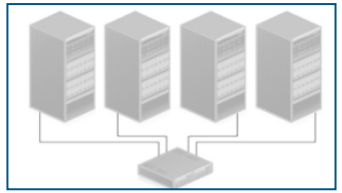

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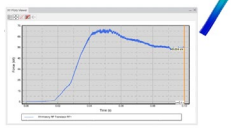

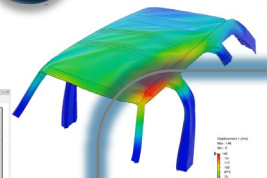

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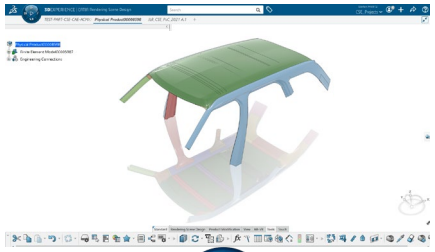

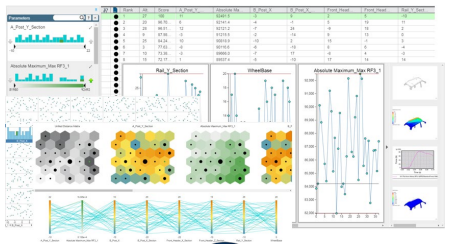

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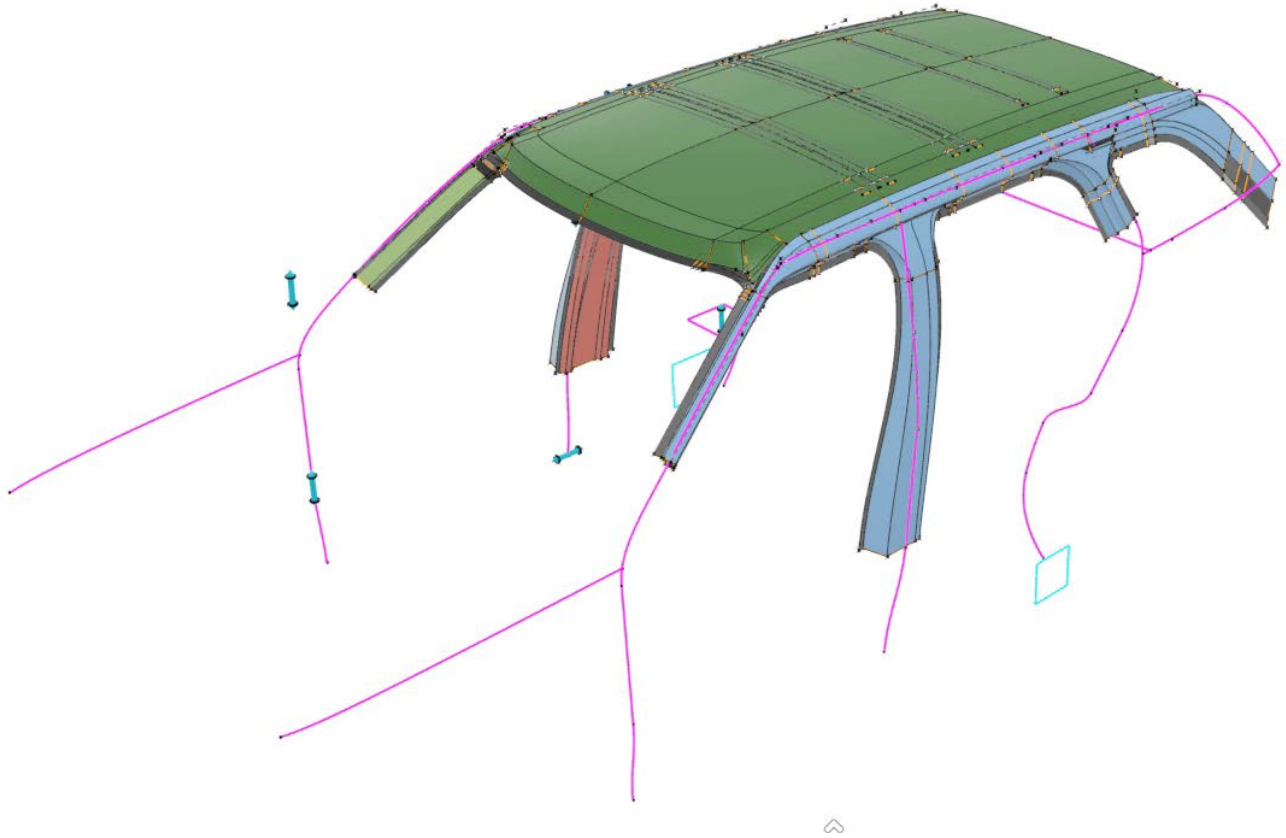
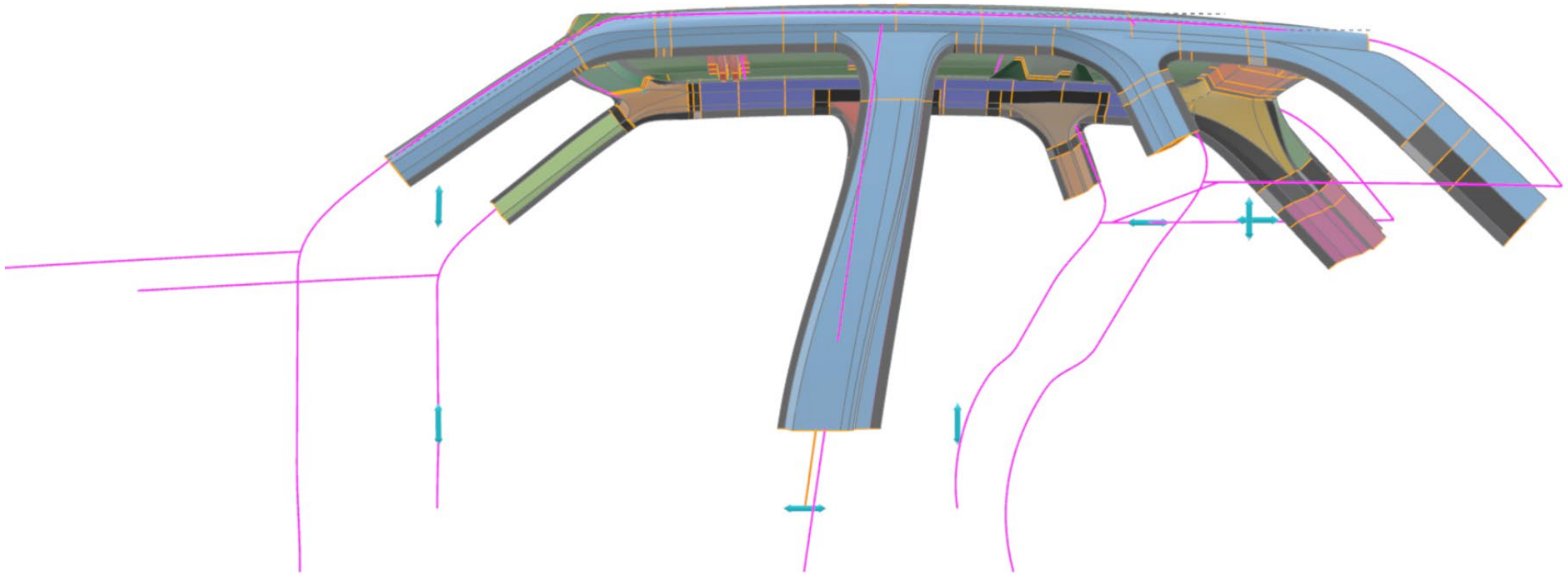
carhs Empowering Engineers

Associativity - Structural Model and AVA Skeleton

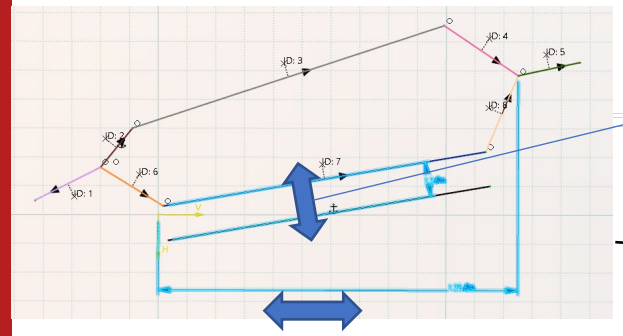


Change AVA skeleton parameter

PARAMETERS - WHEELBASE

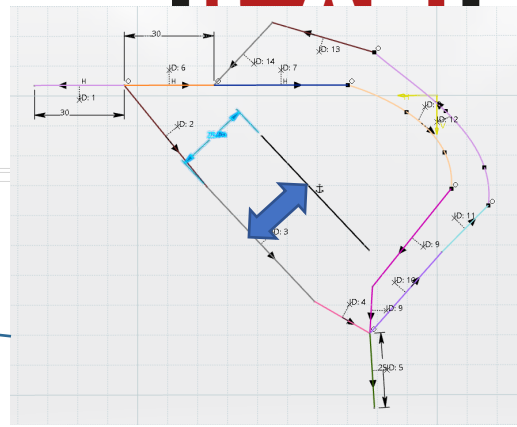


PARAMETERS - SECTIONS

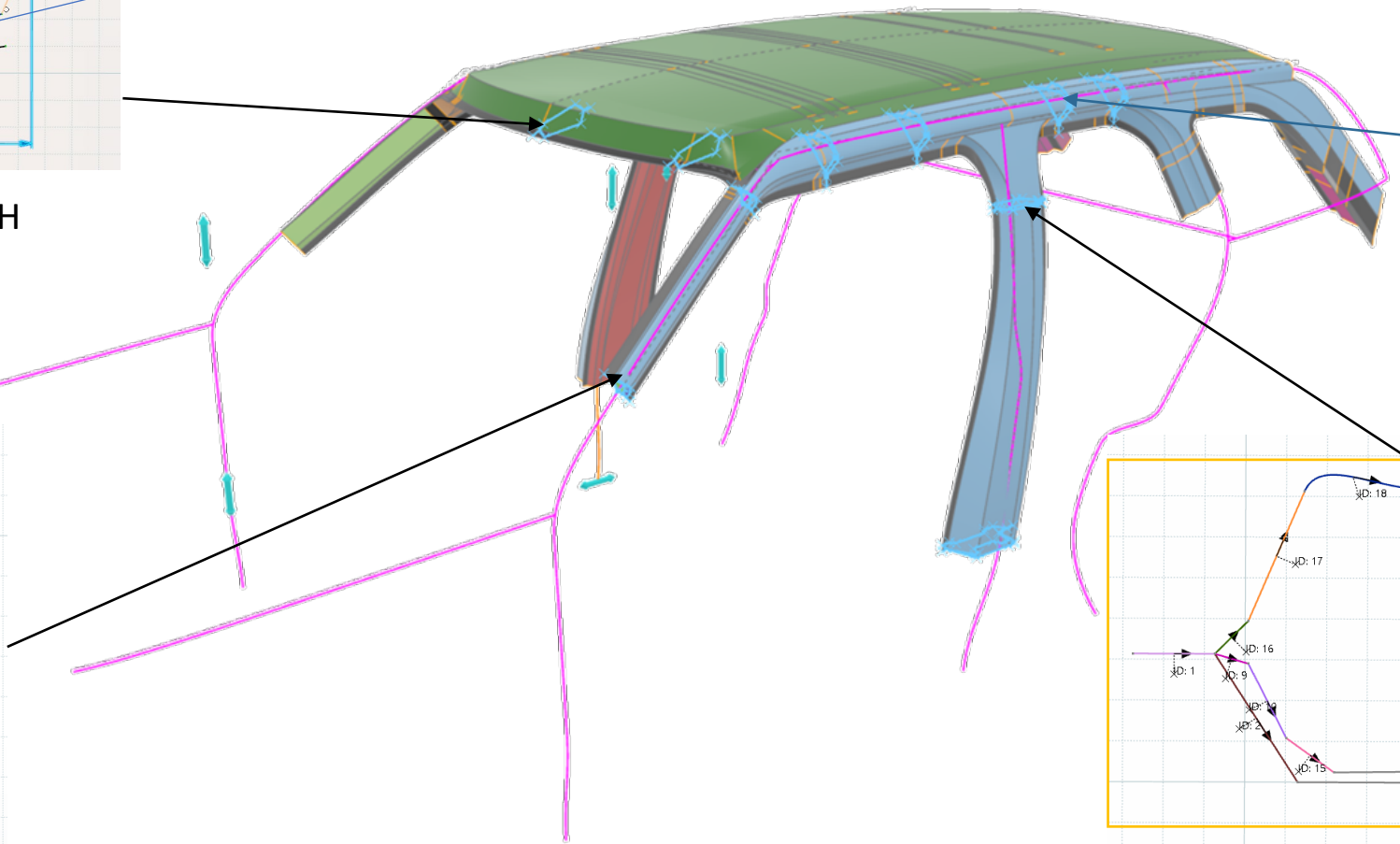


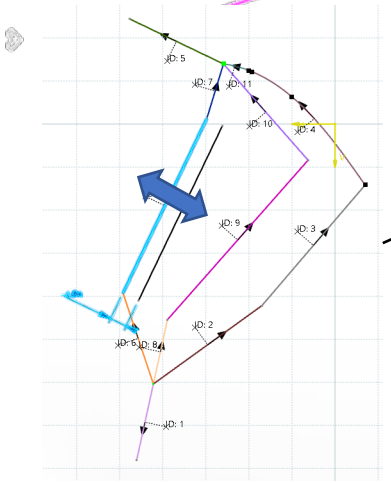
FRONT-HEADER-SEC_HEIGHT

FRONT-HEADER-SEC_WIDTH

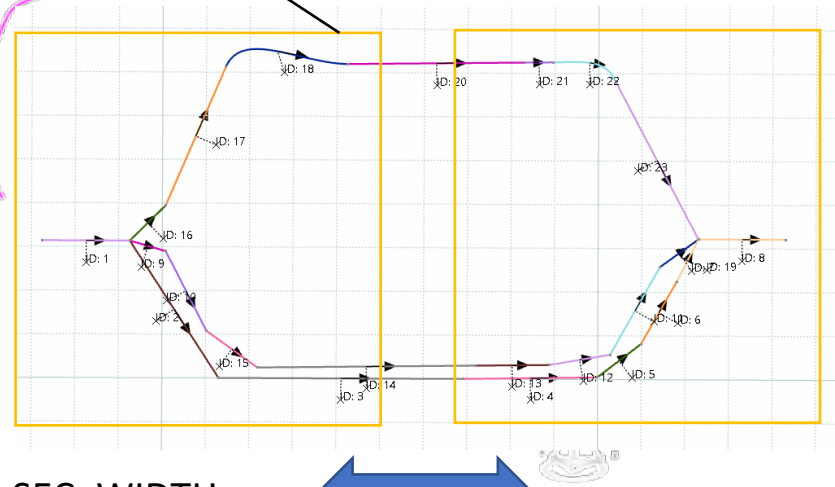


ROOF-RAIL-SEC-WIDTH



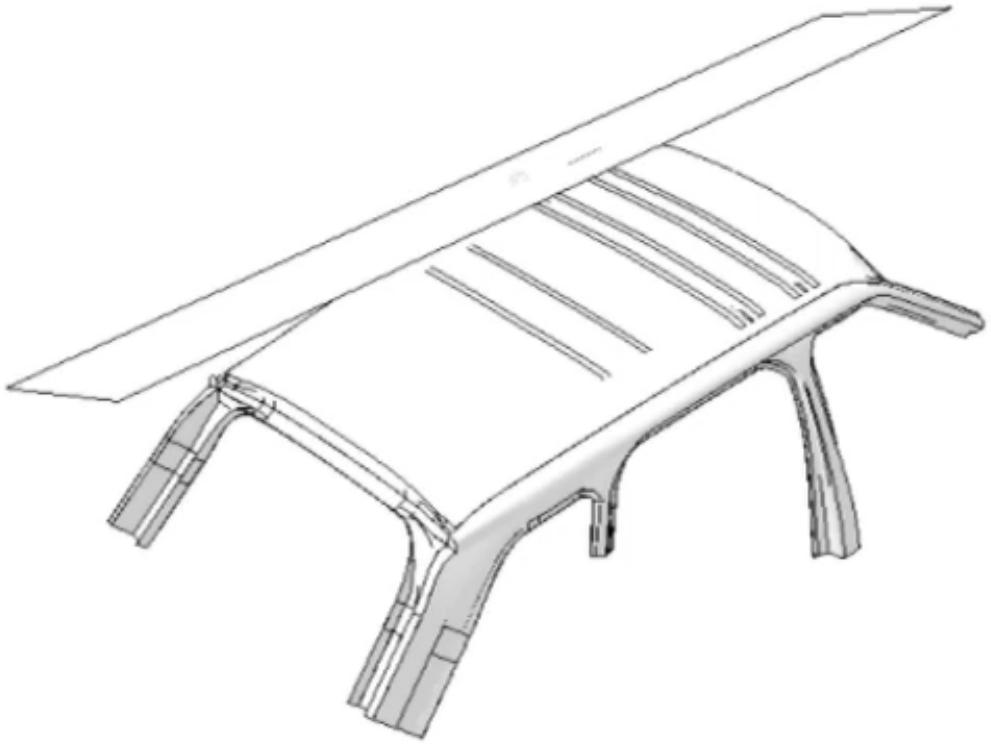


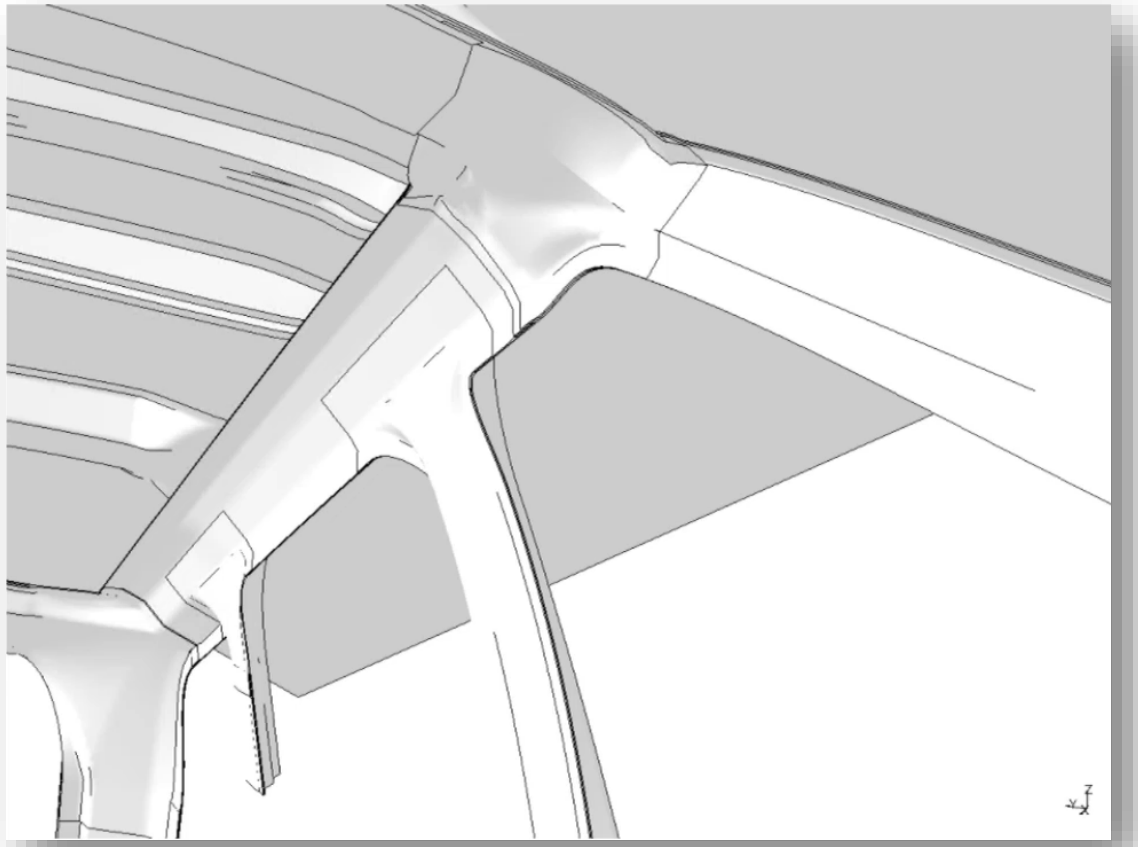
A-PILLAR_SEC_WIDTH



B-PILLAR_SEC_WIDTH

Parameter combinations





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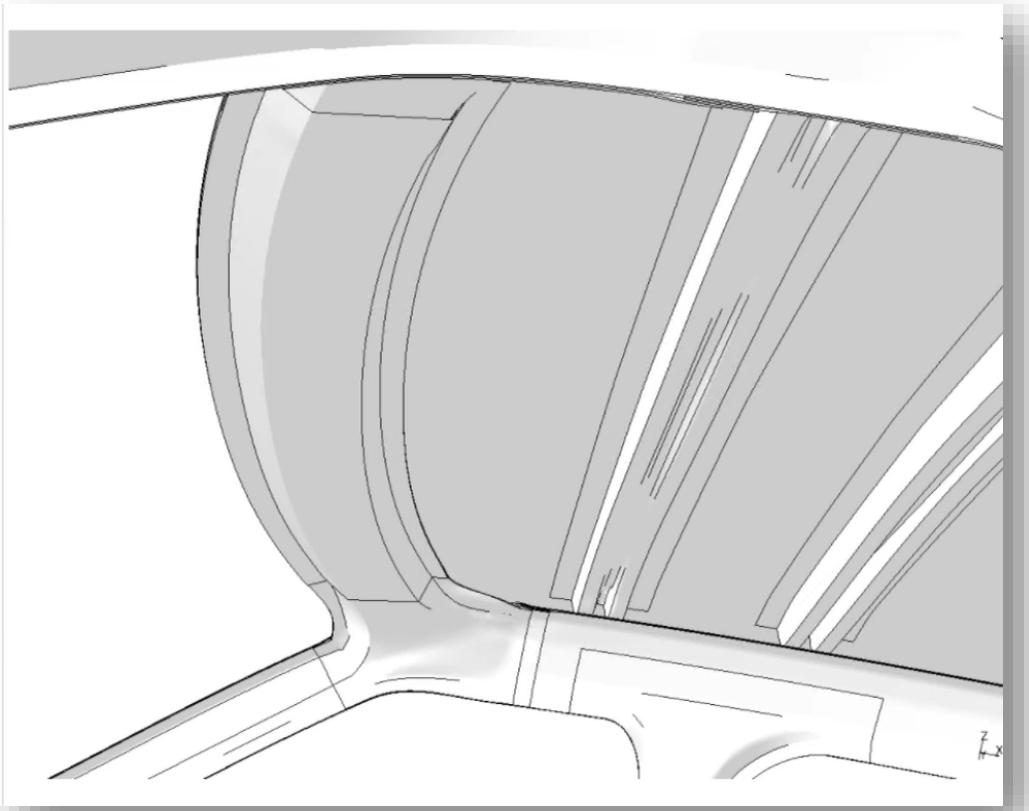
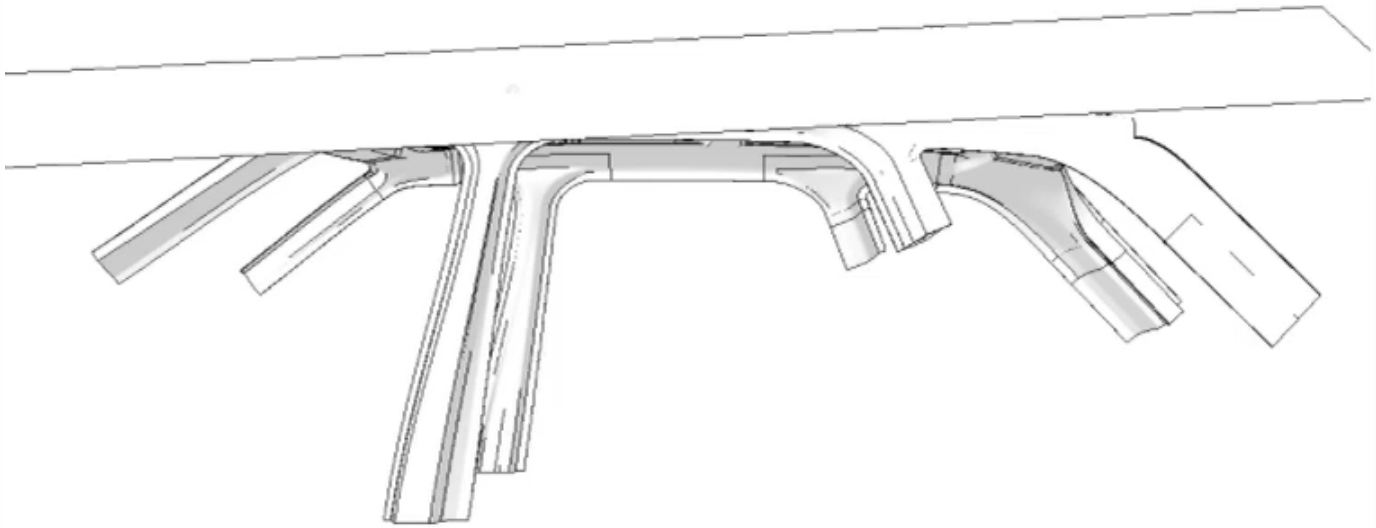
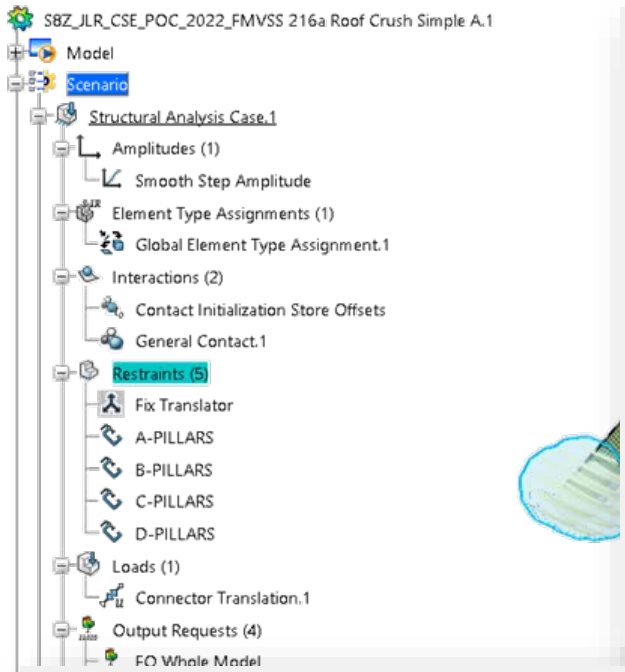




parametric design study - setup



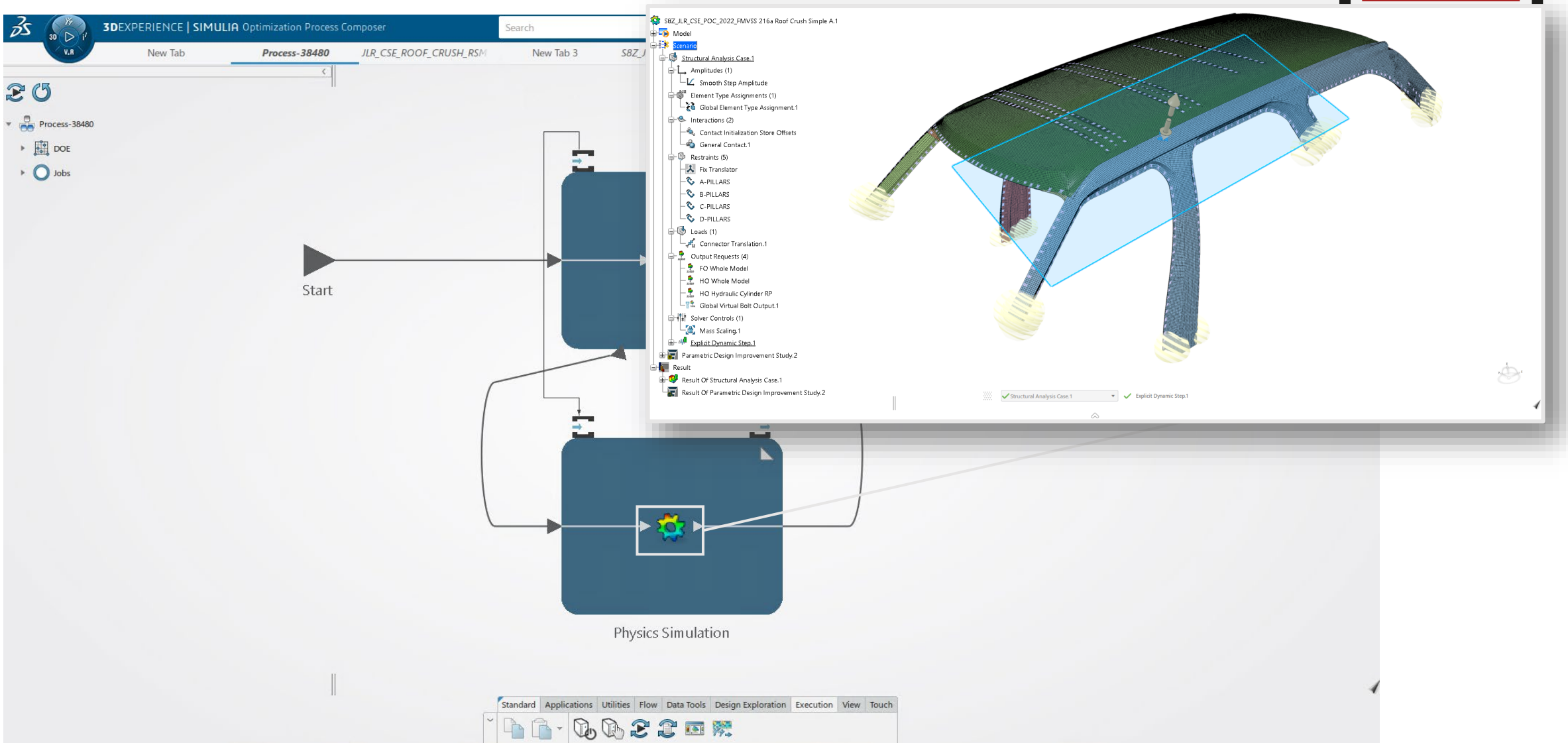
Design variables

Select	Name	Value	Minimum	Maximum
☑	CROSS MEMBER 1 OFFSET FROM FRONT HEADER...	302.6mm	320mm	420mm
☑	CROSS MEMBER 2 OFFSET FROM FRONT HEADER...	835mm	700mm	800mm
☑	CROSS MEMBER 3 OFFSET FROM FRONT HEADER...	1257.8mm	1200mm	1300mm
☑	DS_DEFINED_BPOST_POS_X_DELTA\B-POST\USER ...	5.08mm	-50mm	50mm
☑	WHEELBASE_delta	175.75mm	0mm	300mm
☑	ROOF-RAIL-DEPTH_delta	-0.92mm	-10mm	15mm
☑	FRONT_HEADER_SEC_HEIGHT_delta	-8.1mm	-10mm	10mm
☑	FRONT_HEADER_SEC_WIDTH_delta	-0.84mm	-11mm	10mm
☑	A-PILLAR_SEC_WIDTH_delta	0.2mm	-10mm	10mm
☑	B-PILLAR_SEC_WIDTH_delta	1.2mm	0mm	30mm

Response variables

Sel	Name	Value	Minimum	Maximum	Objective
☑	Mass\Mass Sensor.1\Result Of Structural Analysis Case.1\Result Manager	173.487kg			
☑	Maximum\Reaction Force.1\Result Of Structural Analysis Case.1\Result Manager	7.57e+009N			Maximize
☑	Maximum\Von Mises Stress.1\Result Of Structural Analysis Case.1\Result Manager	1401.979N_mm2			
☑	Maximum\Displacement Magnitude.1\Result Of Structural Analysis Case.1\Result Manager	138.218mm			

PROCESS COMPOSER workflow in 2022x



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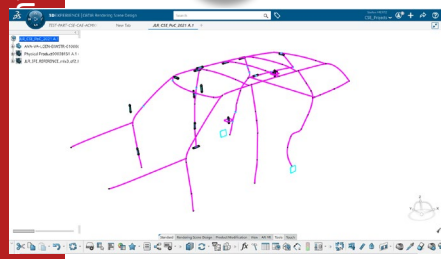

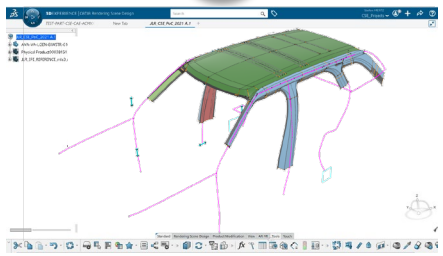

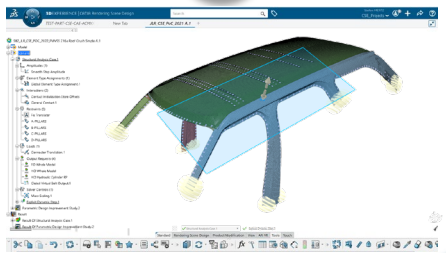

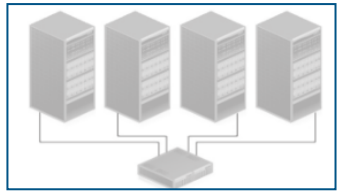

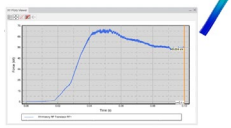

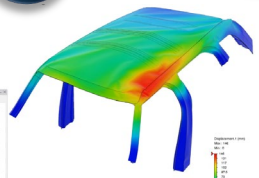

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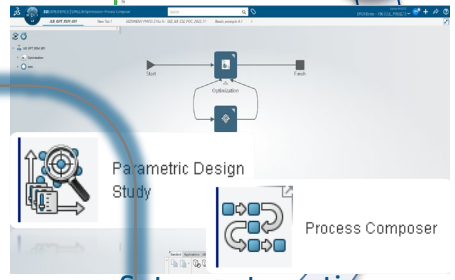

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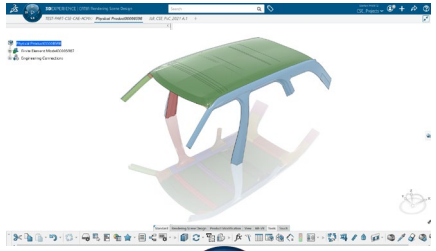
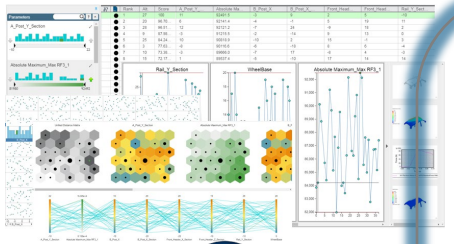
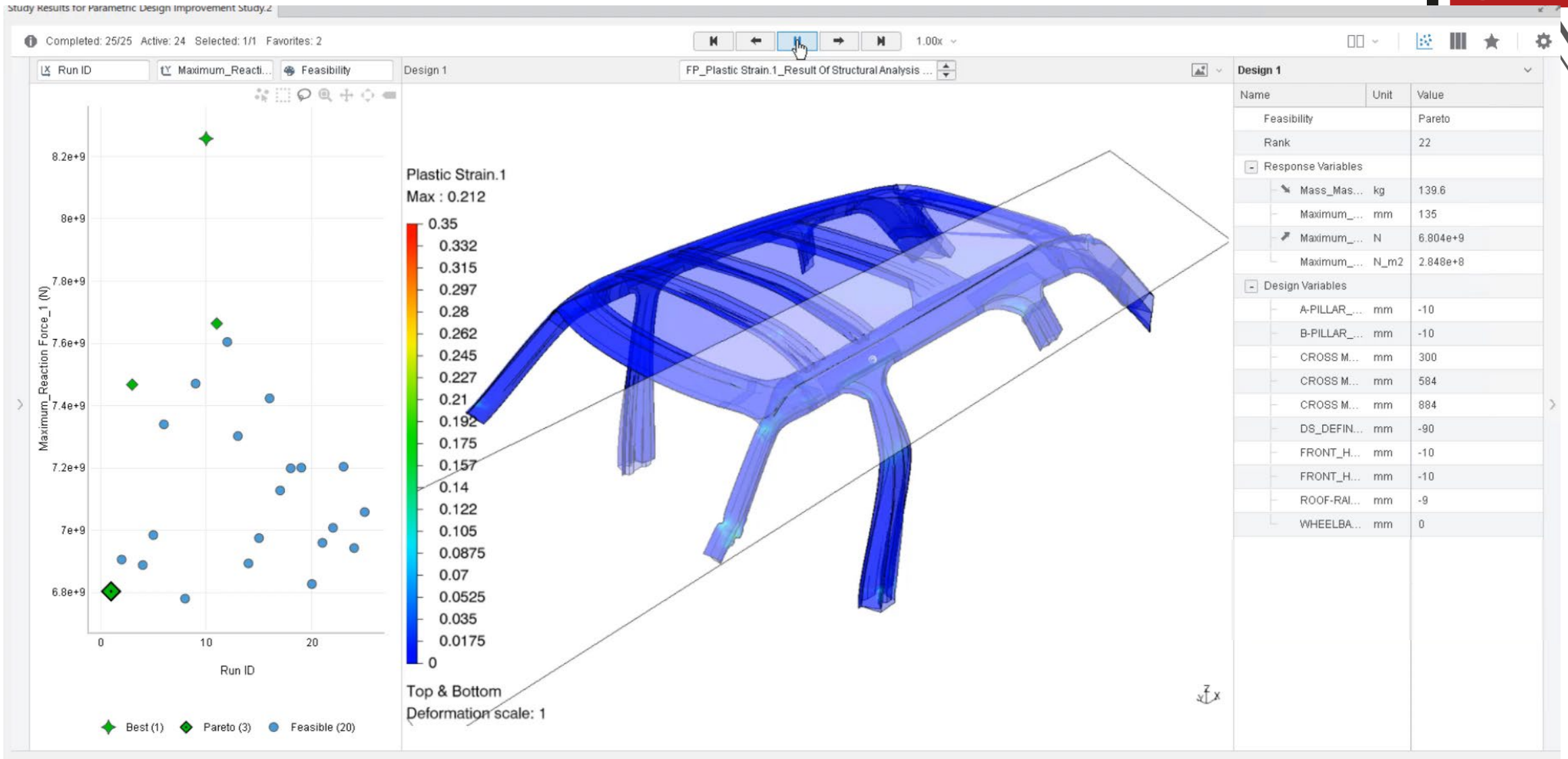




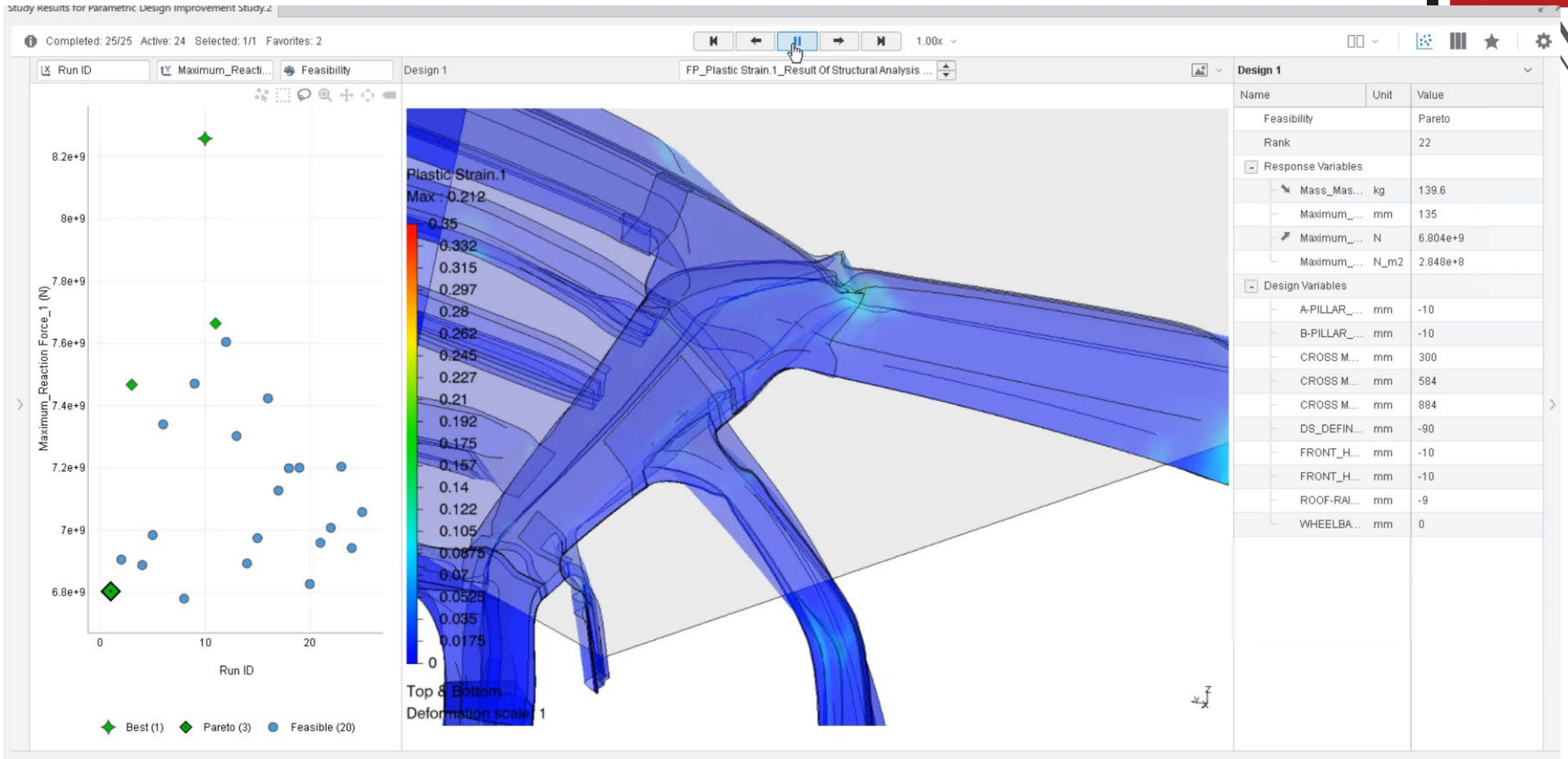
11 Select optimal concept geometry

Feed-back concept geometry recommendations to AVA

Parametric design study - Results



Parametric design study - Results



Conceptual Design – Modelling and Simulation MODSIM

automotive CAE GRAND CHALLENGE

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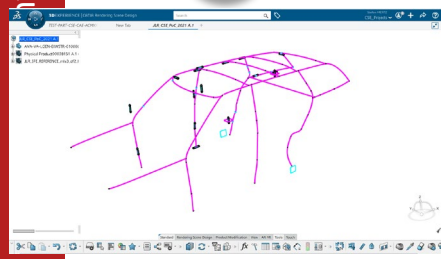

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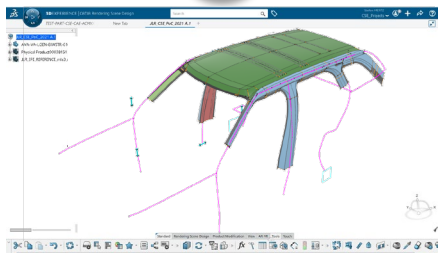

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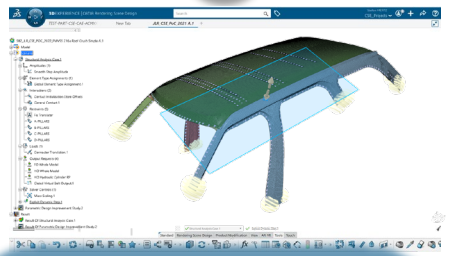

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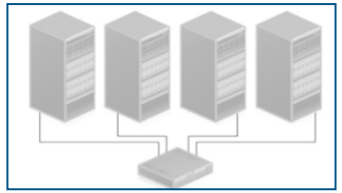
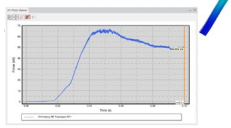
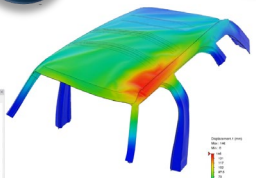


5 **Interpret results & collaborate with stakeholders**
Launch animations, view results, report & analyze KPI's





6 **Setup automation workflow**
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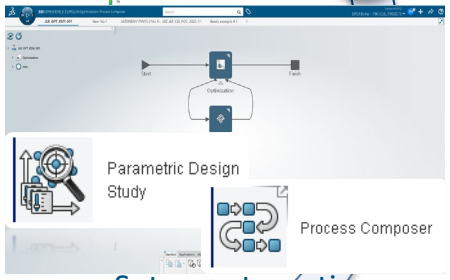

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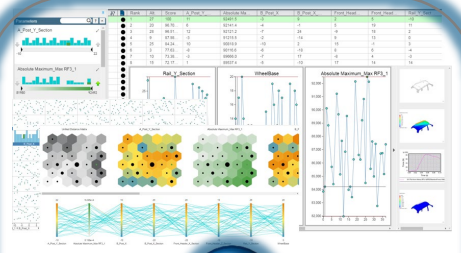

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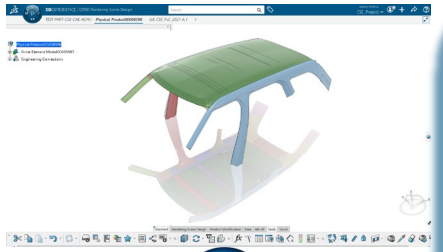
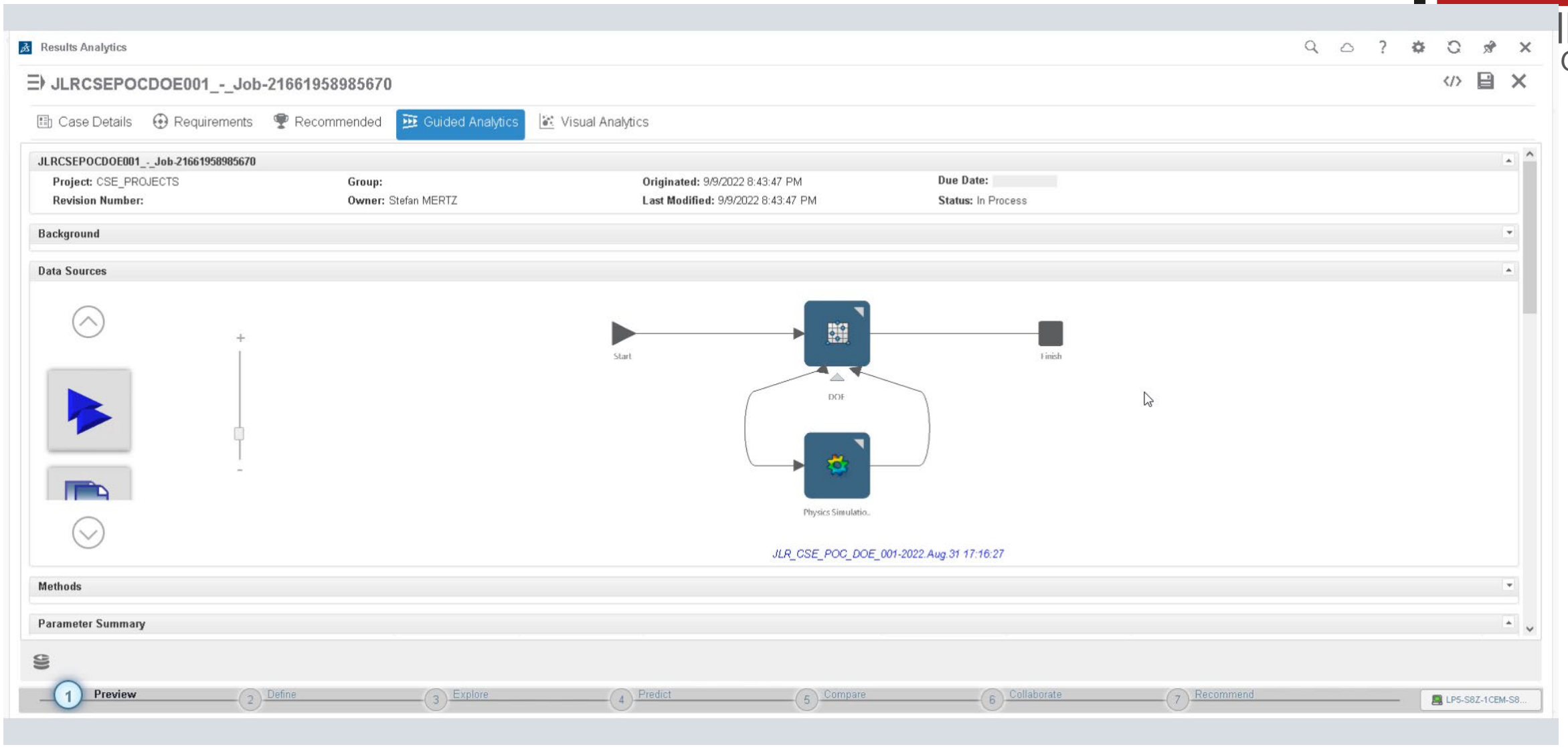


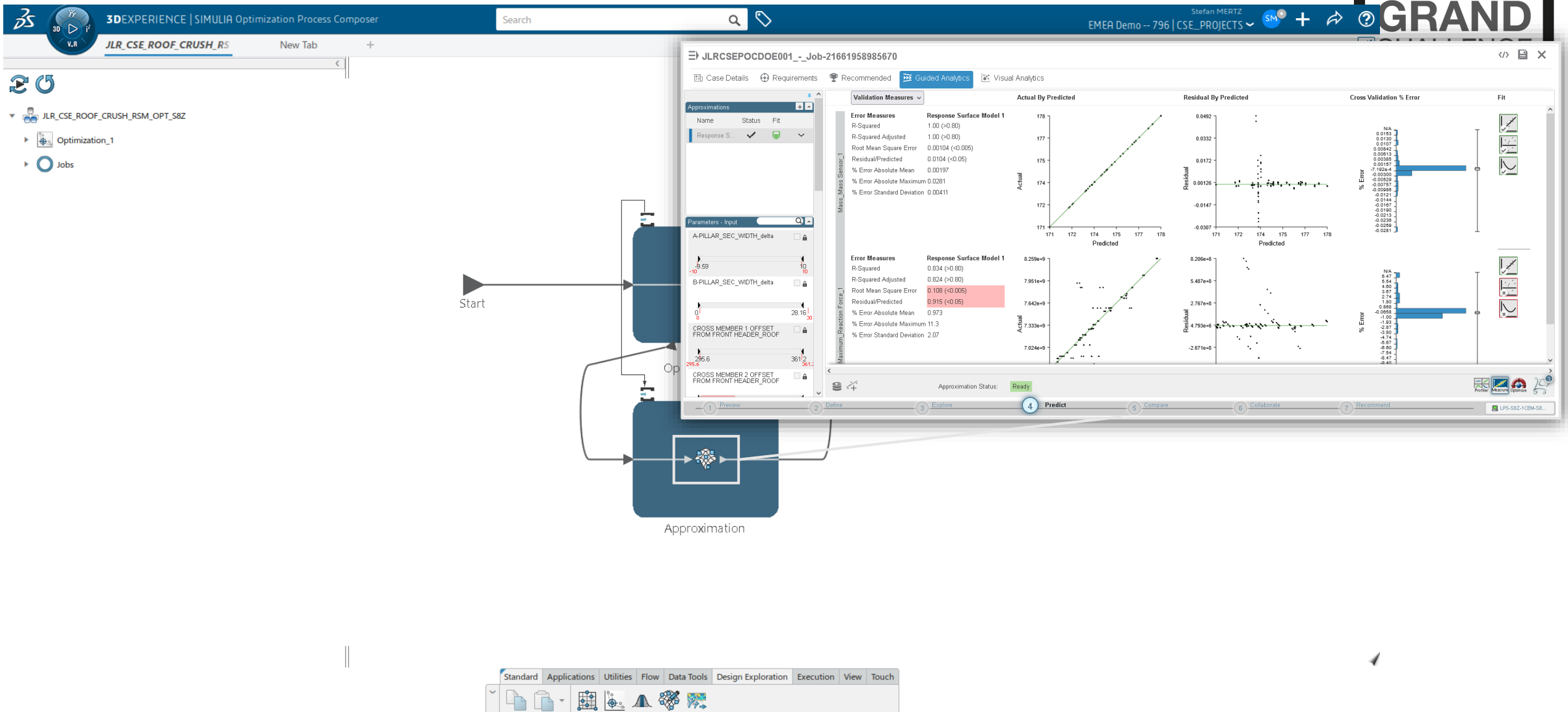
Feed-back concept geometry recommendations to AVA

carhs Empowering Engineers

Results analytics



Optimization with approximation



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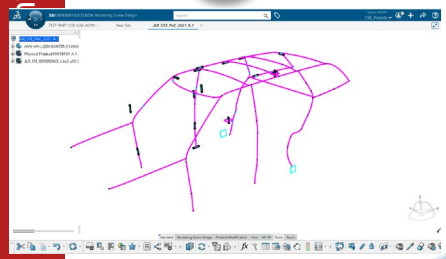
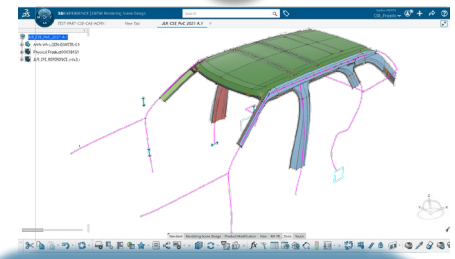
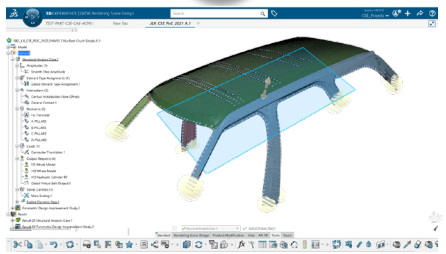
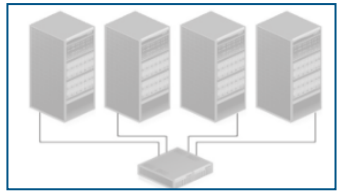
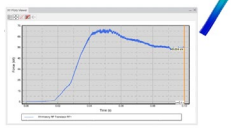
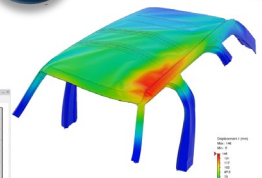
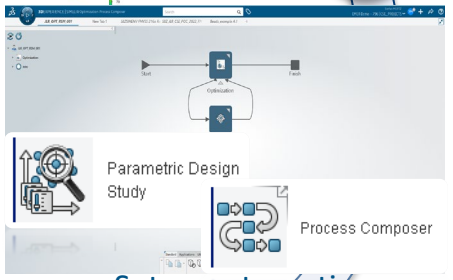

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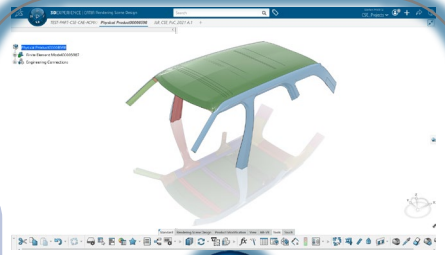
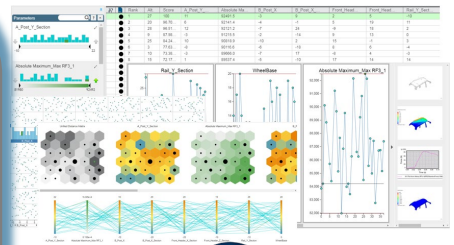

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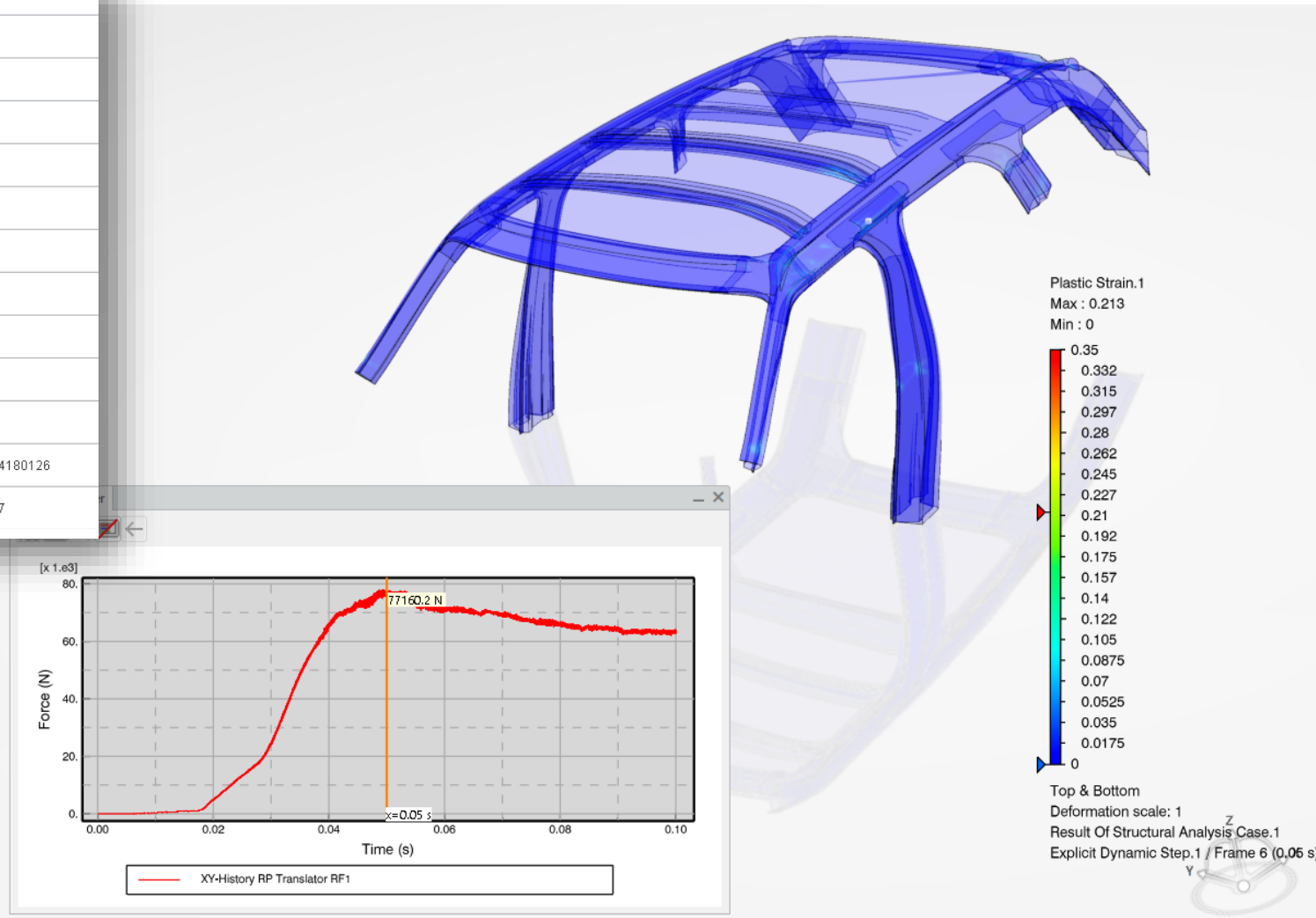
Verification run of best design

Approximation Results

Run_Number	0
A-PILLAR_SEC_WIDTH_delta	-10
B-PILLAR_SEC_WIDTH_delta	4
CROSS MEMBER 1 OFFSET FROM FRONT HEADER_ROOF	320
CROSS MEMBER 2 OFFSET FROM FRONT HEADER_ROOF	744
CROSS MEMBER 3 OFFSET FROM FRONT HEADER_ROOF	964
DS_DEFINED_BPOST_POS_X_DELTA_B-POST	50
FRONT_HEADER_SEC_HEIGHT_delta	4
FRONT_HEADER_SEC_WIDTH_delta	-2
ROOF-RAIL-DEPTH_delta	9
WHEELBASE_delta	100
Mass_Mass_Sensor_1	171.93352404180126
Maximum_Reaction_Force_1	78359.416807



	Approximation	FEM
Reaction force [N]	78359	77160

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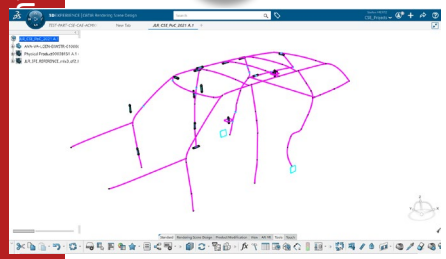
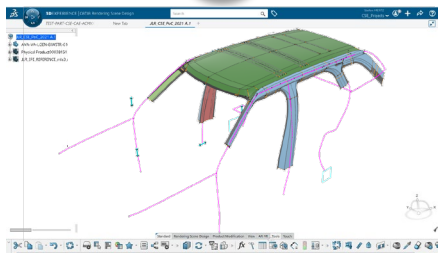
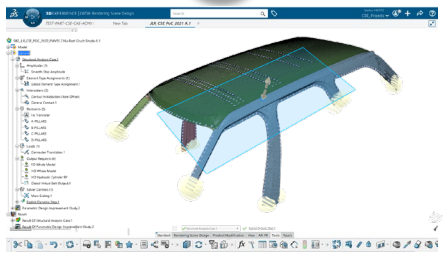
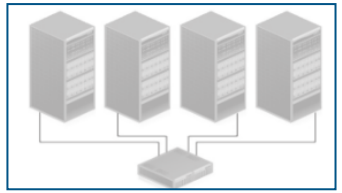
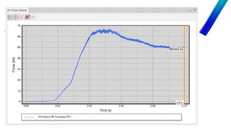
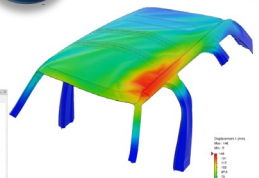
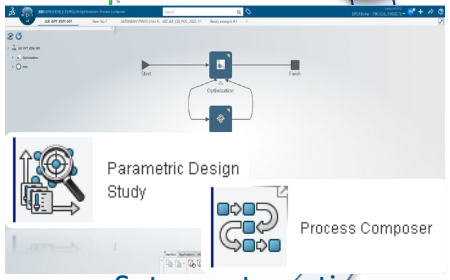

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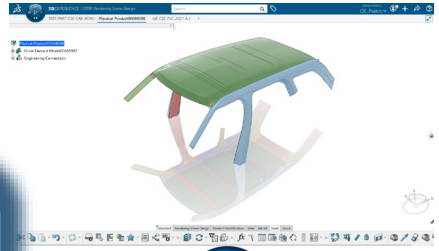
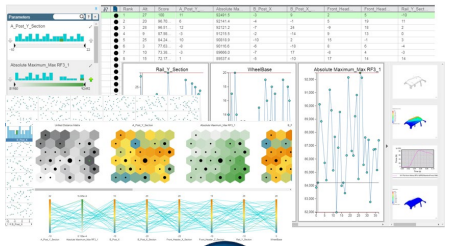

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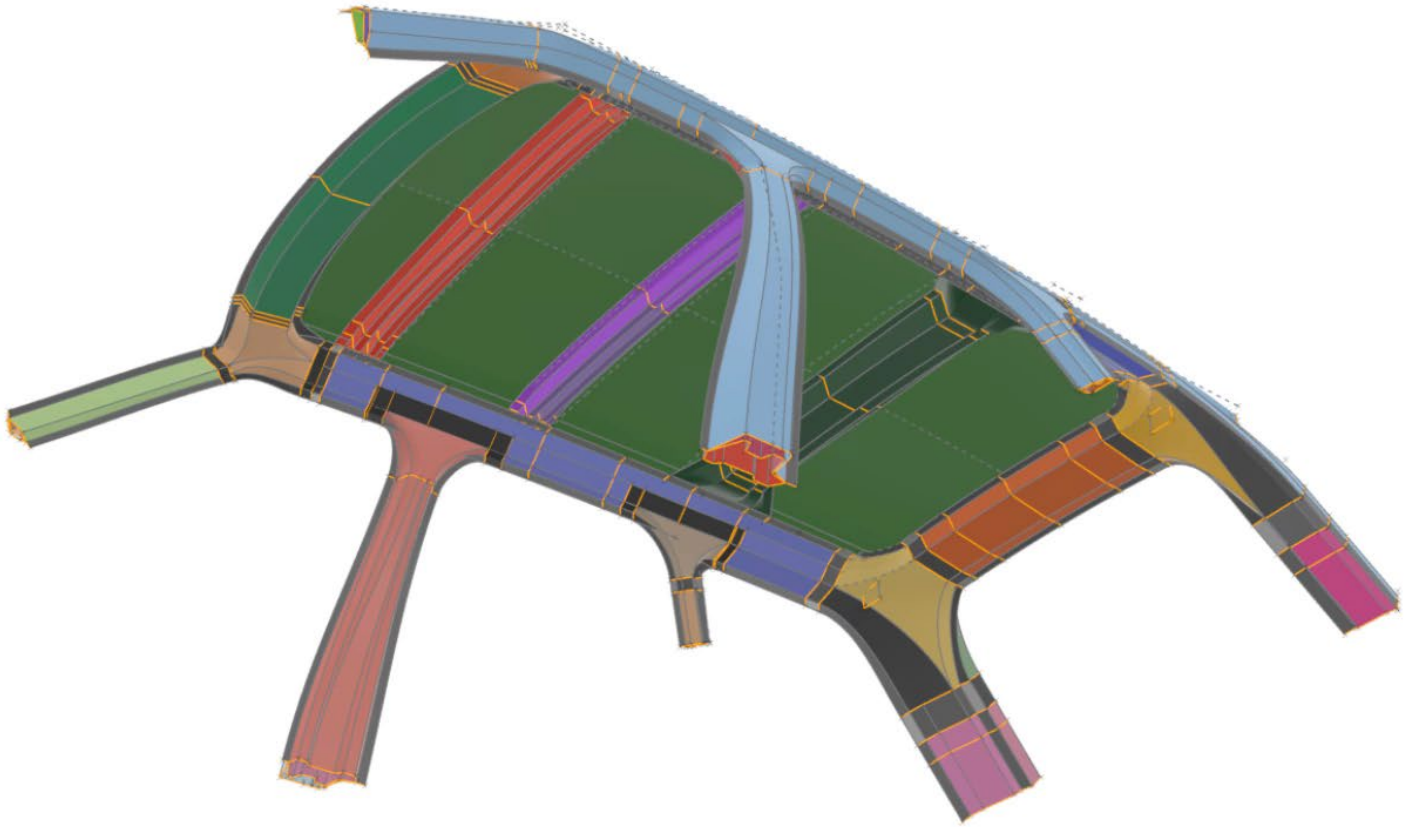
carhs Empowering Engineers

Add details to concept



3DEXPERIENCE Concept Structure Engineer | New Role

Conclusion

- ✓ End-to-end workflow ready to be used by everyone
- ✓ Saved time and reduced process complexity
- ✓ Enabler for optimization through simulation driven design
- ➢ The flexibility of the model, the automation of parametric variations and the gapless access to simulation enables a new level of evidence-based engineering driven by systematic design space exploration

Questions ?