

Methods and tools for IGA models for LS-DYNA

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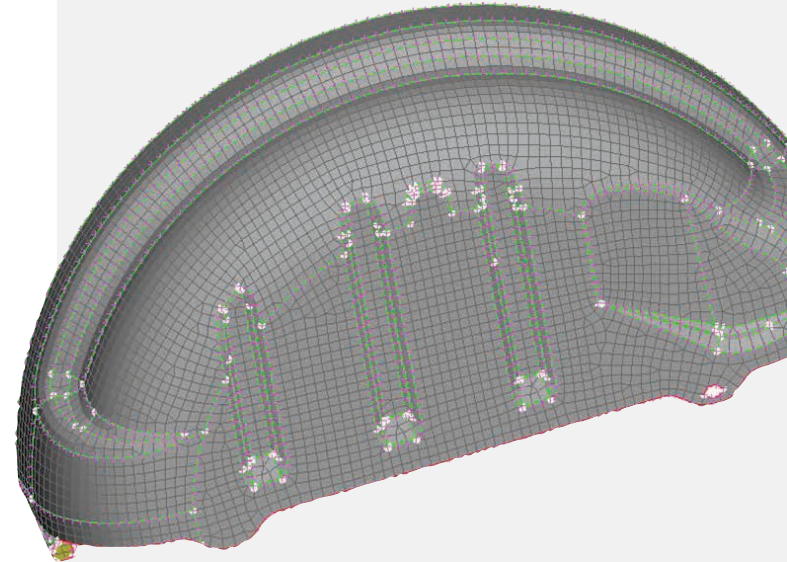
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What is Isogeometric Analysis

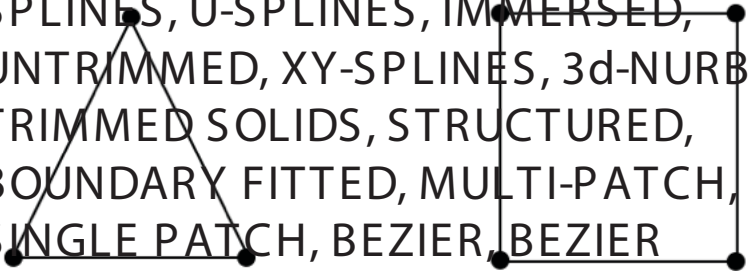
- Use NURBS as basis functions
- Use the same description for the Geometry and Analysis
- Do analysis on the CAD data
- No Meshing



- Different geometry between CAD and Analysis
- Geometric approximation leads to accuracy issues
- Accuracy of the deformations is currently the most important advantage of IGA in both ways
- Moving between CAD and Analysis is difficult
 - Feeding back geometry to CAD another important advantage
 - CAD to Analysis (Meshing)
 - Analysis to CAD
- Keeping geometry through the whole process CAD > Analysis > PostProcessing



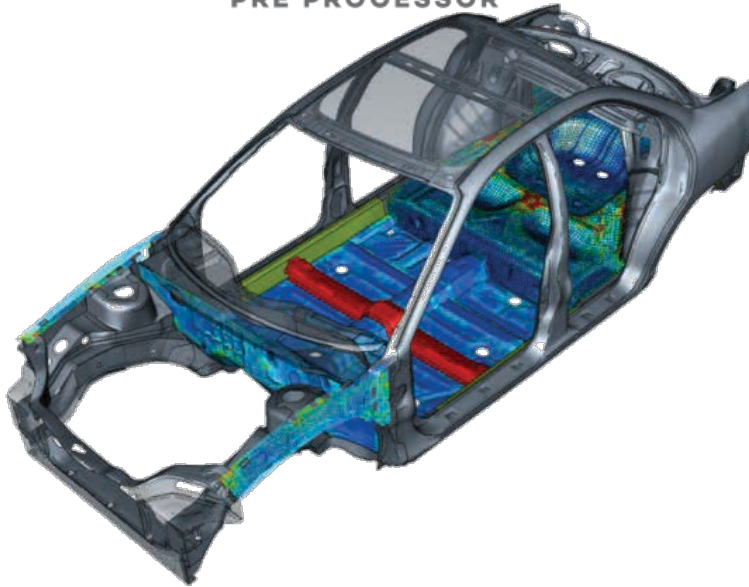
NURBS, B-SPLINES, TRIMMED, T-SPLINES, U-SPLINES, IMMERSED, UNTRIMMED, XY-SPLINES, 3d-NURBS, TRIMMED SOLIDS, STRUCTURED, BOUNDARY FITTED, MULTI-PATCH, SINGLE PATCH, BEZIER, BEZIER EXTRACTION, KNOT VECTOR, UNSTRUCTURED, KNOT VECTOR SPAN, BODY-FITTED...



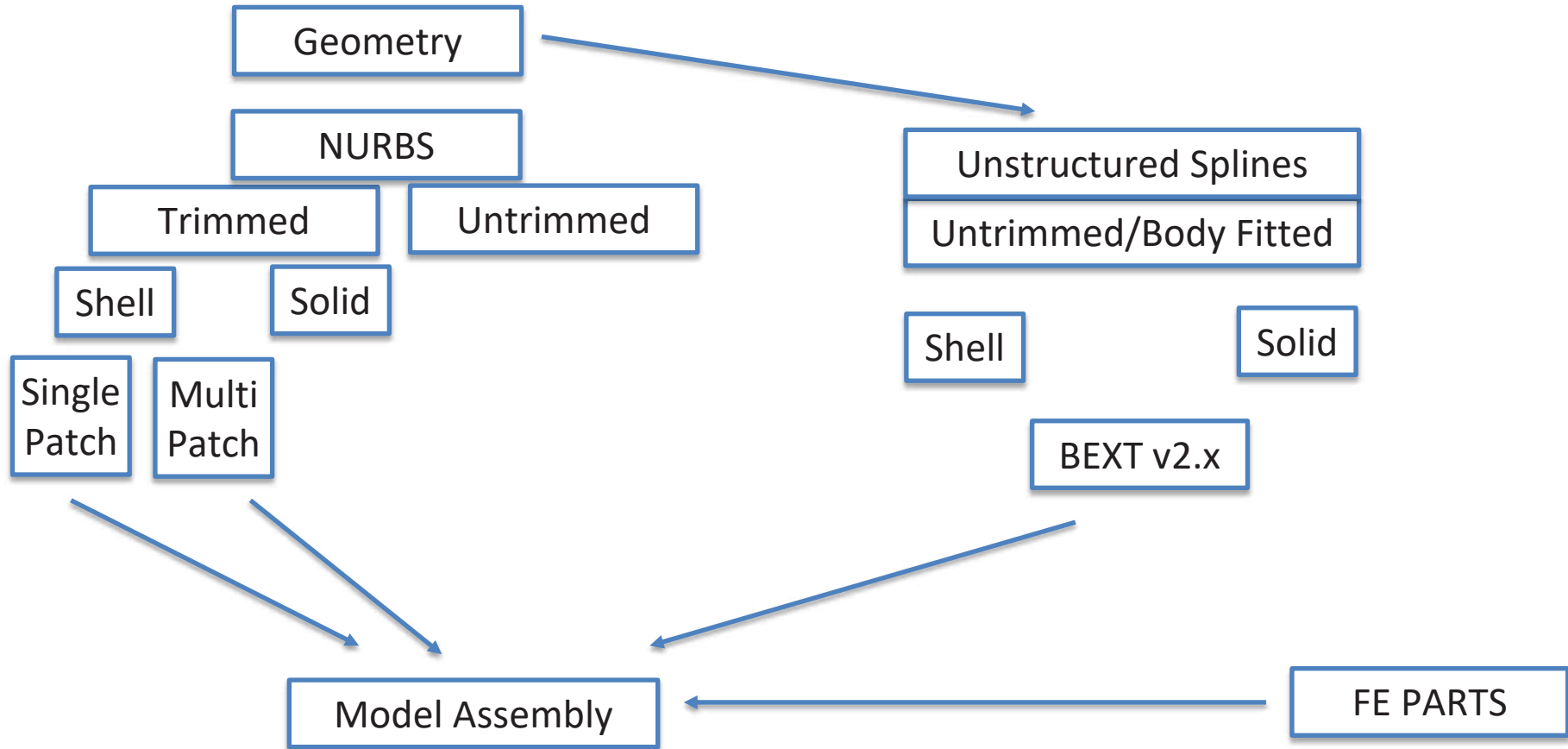
The diagram consists of two geometric shapes. On the left is a triangle with three vertices marked by black dots. Below it is the word 'Triangular'. On the right is a rectangle with four vertices marked by black dots. Below it is the word 'Rectangular'.

- Everybody hates Mesh
- But they love their elements and nodes

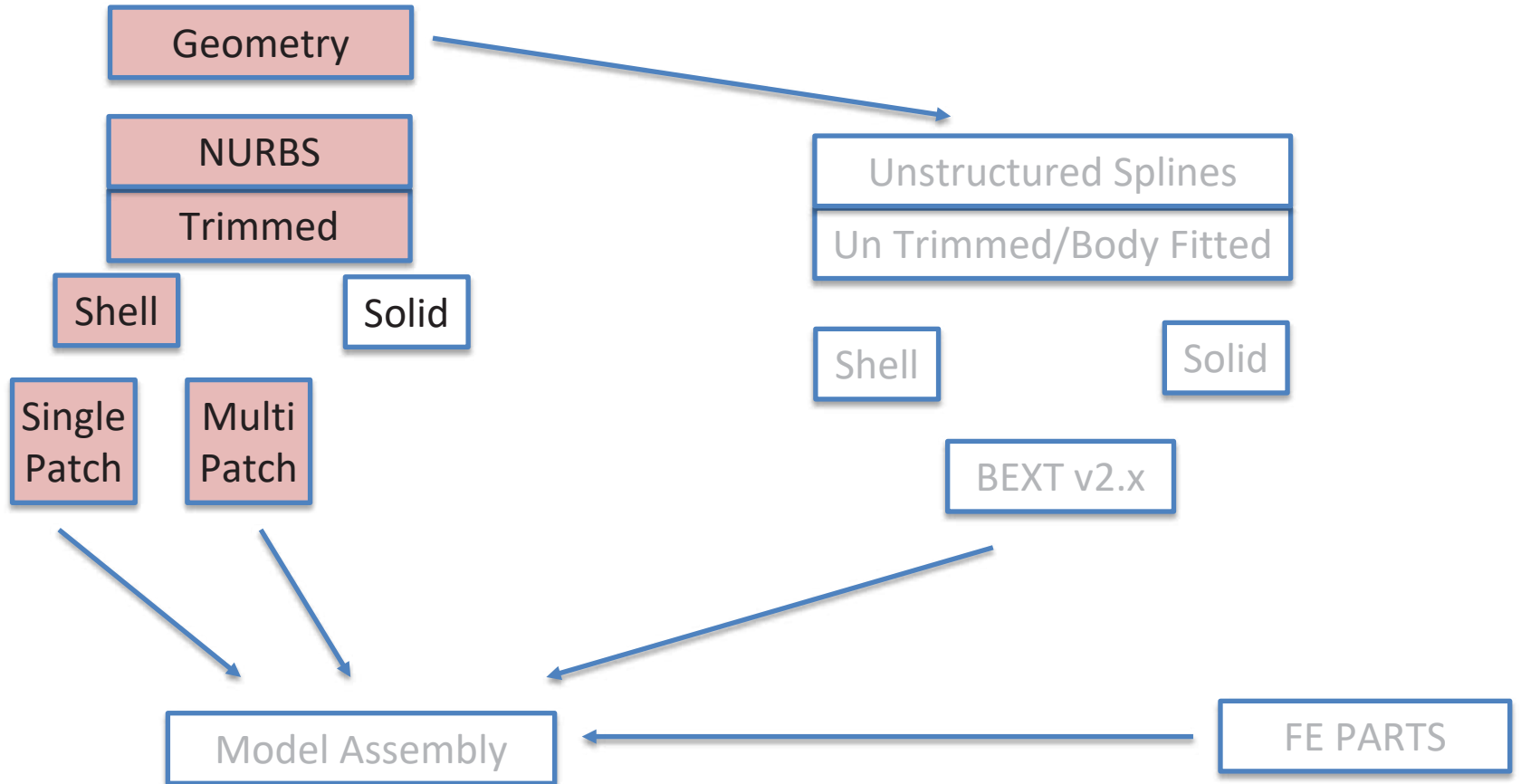
ANSA
PRE PROCESSOR

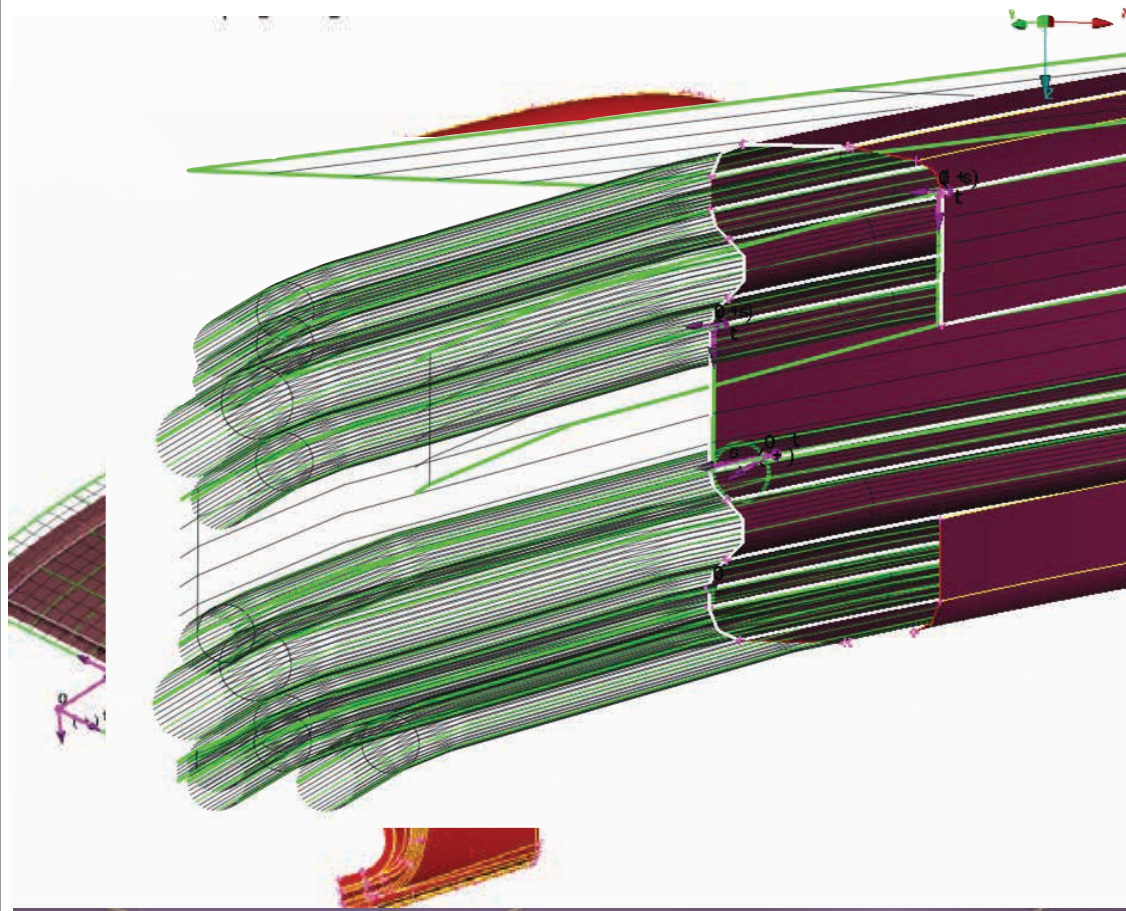


- Major pre-processor for LS-DYNA models
- Can operate directly on Geometry
- Our goal is to integrate IGA into current workflows



How To Build an IGA model, current mature path



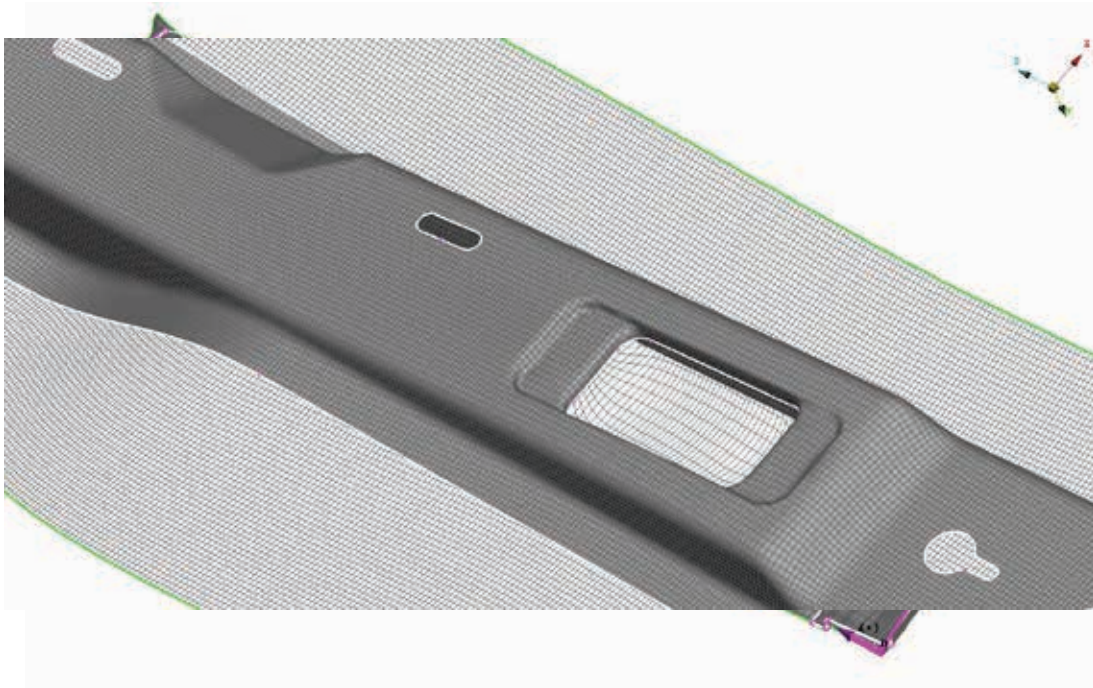


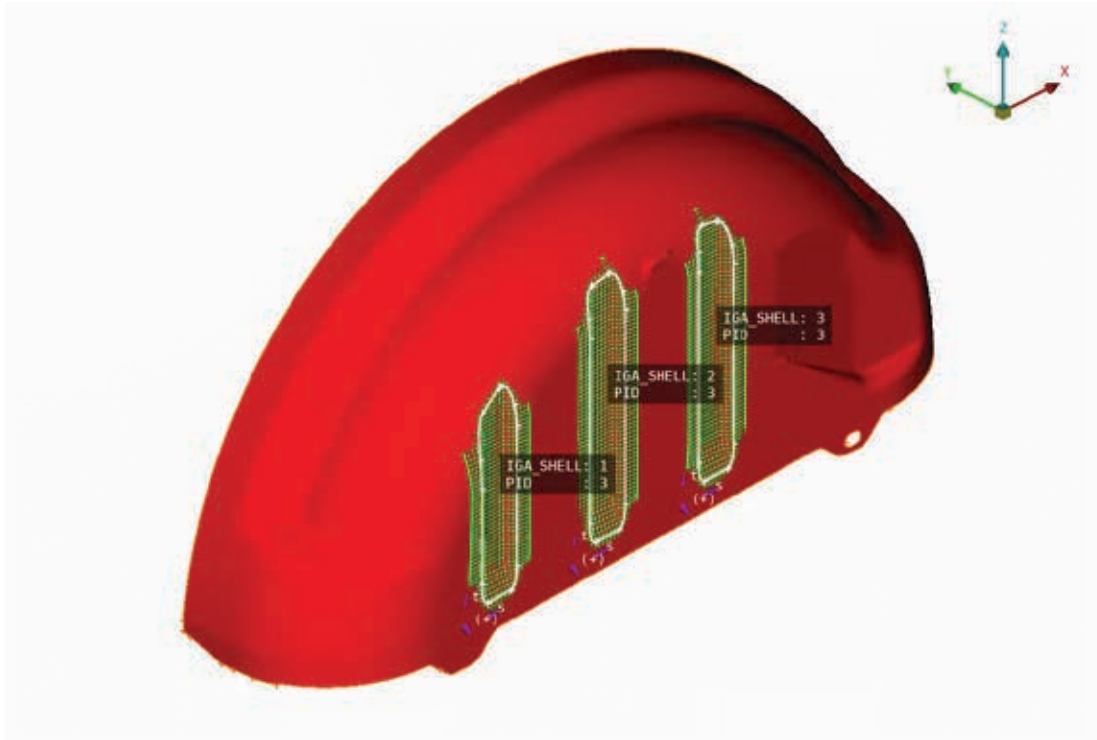
The messy reality of CAD files

- Solid
- Non - Watertight
- Trimmed
- Analytical Surfaces
 - Planes
 - Cylinders etc
- High order polynomials
- Many Surface Patches per Part

ANSA IGA Function

- From Multi-patched CAD
- To one trimmed surface part representation
- IGA Ready
- Can handle big parts
- With complex features
- Fast
- More tolerant to bad geometry





- Creation of complex parts with one click operation
- Creation of multi-patched IGA parts, semi-automatic

From Feature Manager to Multi Patch IGA

IGA

Direct Edit

Geometry

IGA

Patch Points

Create **Geometry** ▶

Modify Skin To Surface

Modify Geometry

Project Plane Cut Hole

Zone Cut

Topology ▶

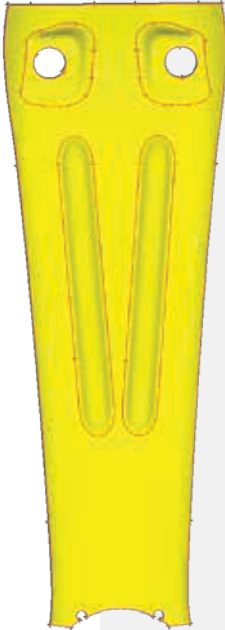
Paste Release Topo

Setup

Freeze/Un Set PID Orient

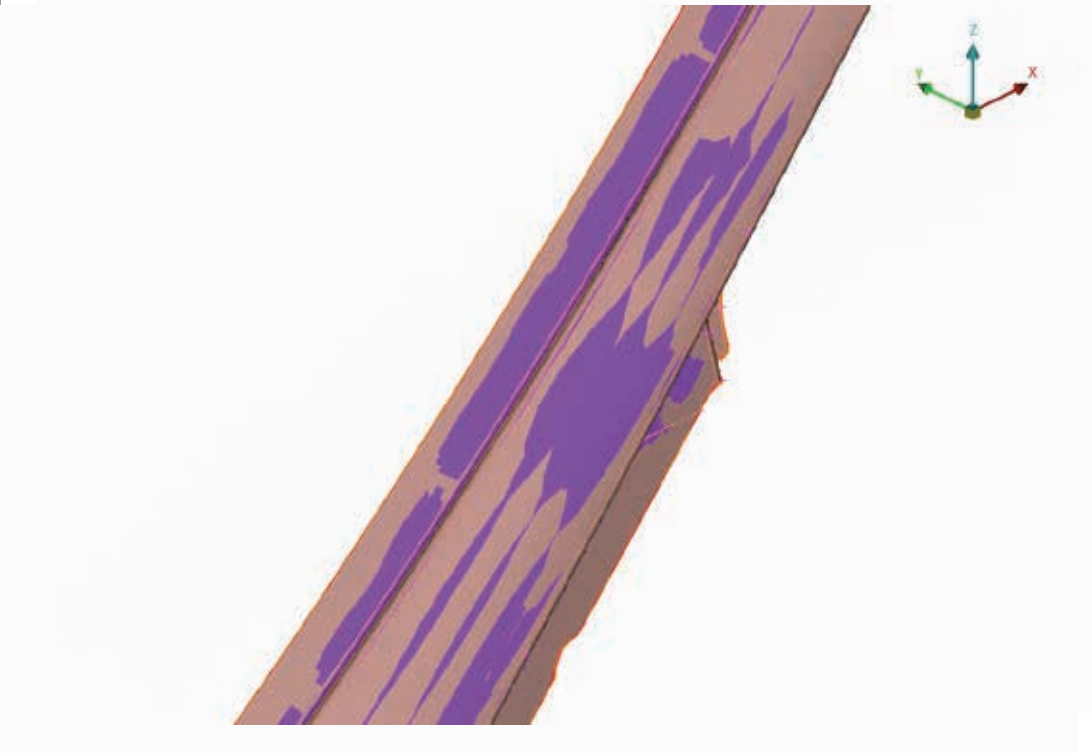
Utilities

Curves Points Fine



Options List

Mode	Create
New / Edit	New
<input type="checkbox"/> Distortion distance	0.05
Subinterval parameters	
<input checked="" type="checkbox"/> Min span	2.
<input type="checkbox"/> Max span	20.
Uniform	×
Extend	×
Join	Features
Order	4



- Implementation of Quality criteria
- Time Step Control
- Deviation from original Surface



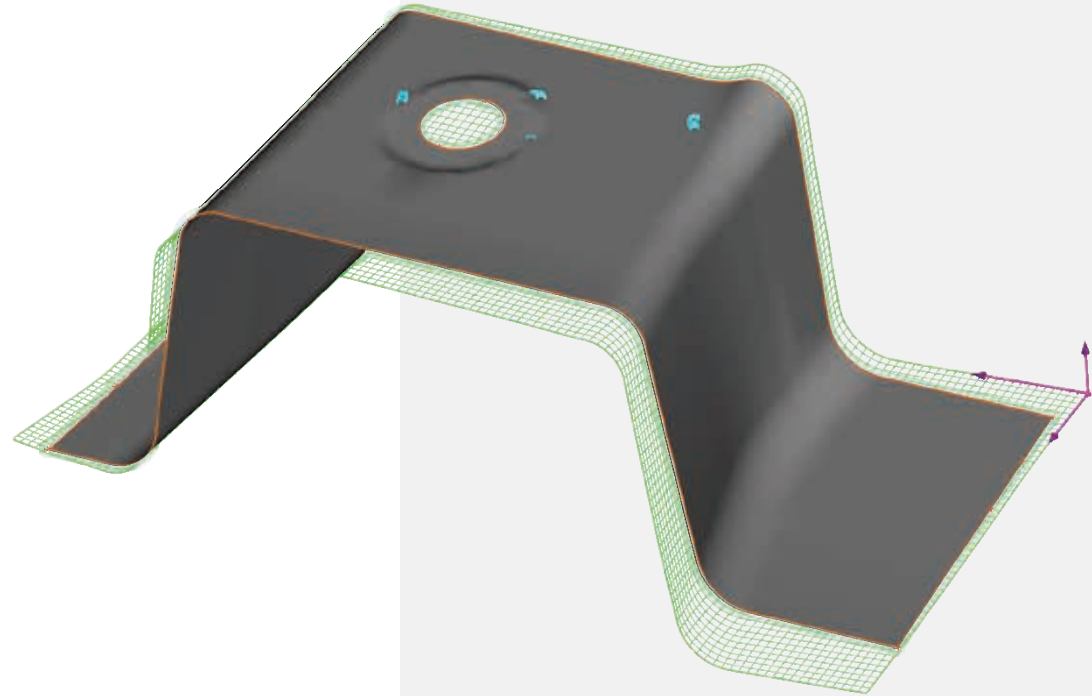
IGA_SHELL: 1

B-Spline surface [162 x 54], order (4 , 4)

	Minimum	Average	Maximum
S-span :	0.5133	2.1342	3.8511
T-span :	1.1931	2.1743	3.5366

Negative Jacobian areas :

2569.910510, 887.439579, 974.200864
2569.170565, 887.482502, 973.573627
2571.159950, 887.356148, 975.360319



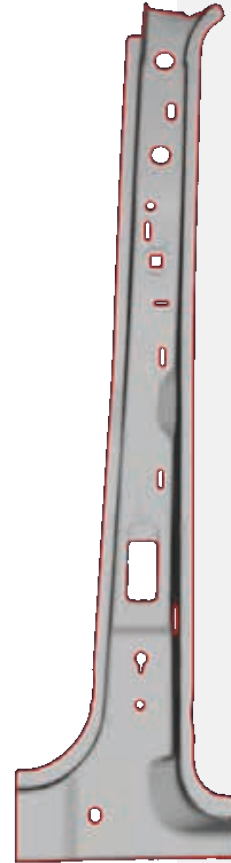
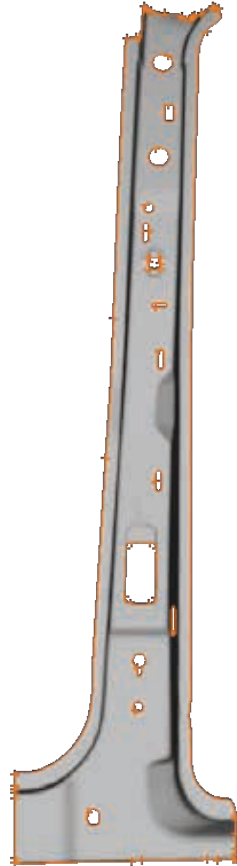
Edit IGA patch

Options List		x
Mode	Create	▾
New / Edit	Both	▾
<input type="checkbox"/> Distortion dis...	0.05	
▾ Subinterval par...		
<input checked="" type="checkbox"/> Min span	1.	
<input checked="" type="checkbox"/> Max span	10.	
Uniform	✓	
Extend	✓	
Join	All	▾
Order	4	▾



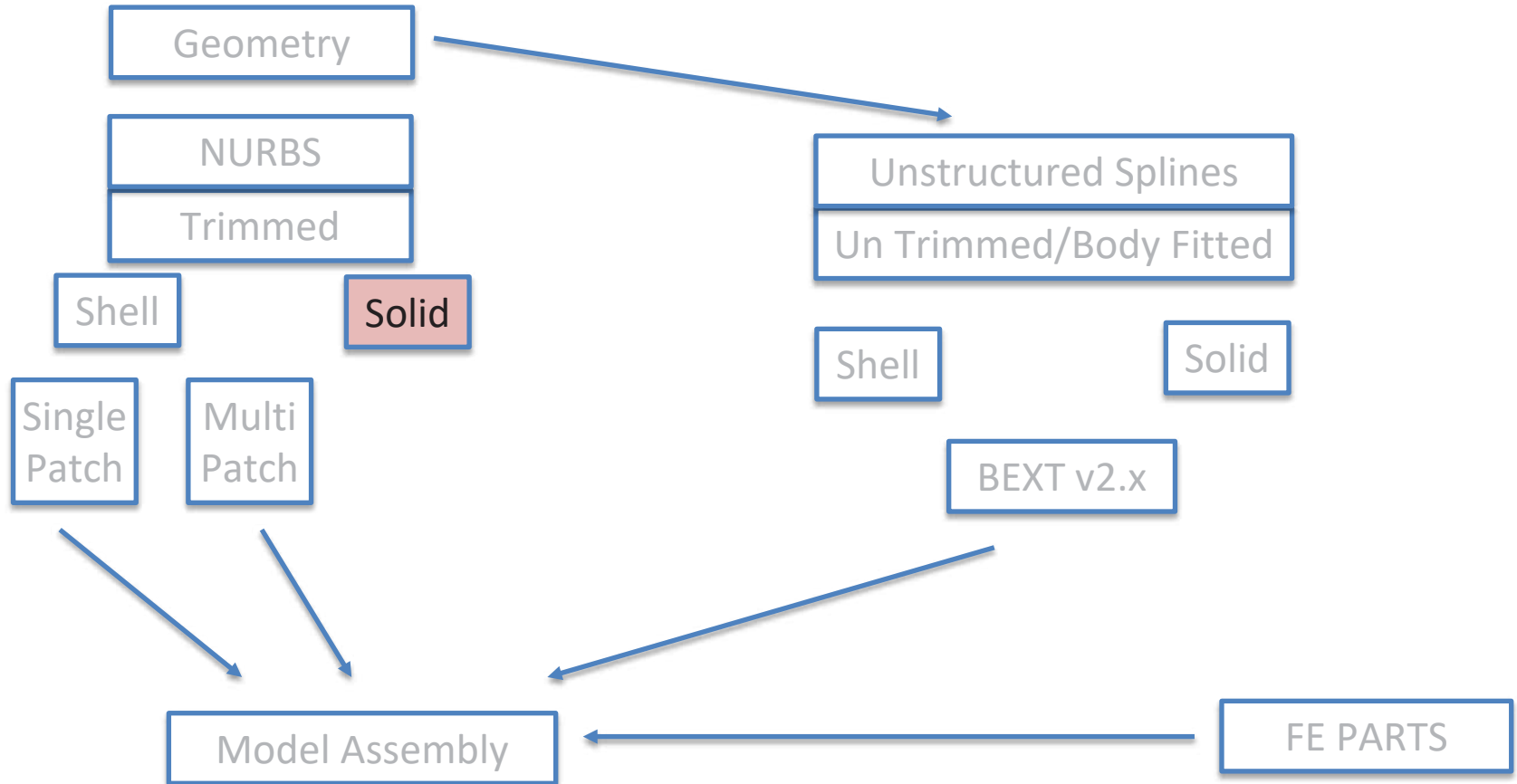
The image shows the 'IGA' software interface. The 'Direct Edit' menu is open, displaying various options for editing the IGA patch. The 'Patch' menu is selected, and the 'Create' option is highlighted. The 'Modify' menu is also visible, with 'Skin' and 'To Surface' options. The 'Modify Geometry' section includes 'Project', 'Plane Cut', and 'Hole' options. The 'Zone Cut' section is also visible. The 'Topology' section includes 'Paste', 'Release', and 'Topo' options. The 'Setup' section includes 'Freeze/Un', 'Set PID', and 'Orient' options. The 'Utilities' section includes 'Curves', 'Points', and 'Fine' options.

Conversion of IGA geometry to CAD



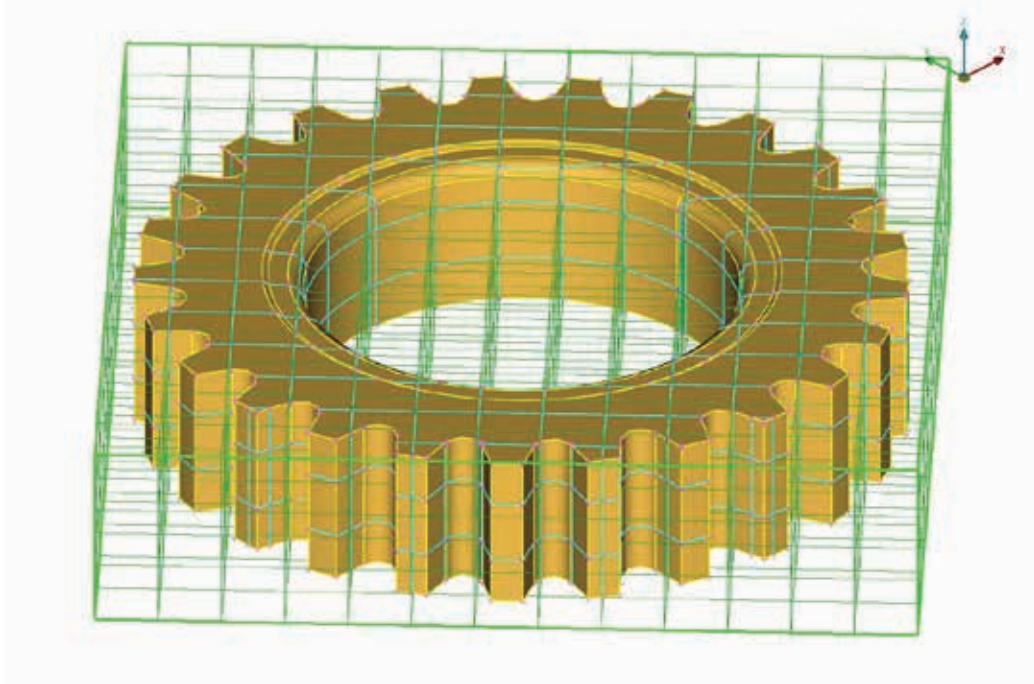
- Closing the loop
- CAD Geometry to IGA Patch
- IGA Patch to CAD Geometry

How to Build an IGA Model, Solids

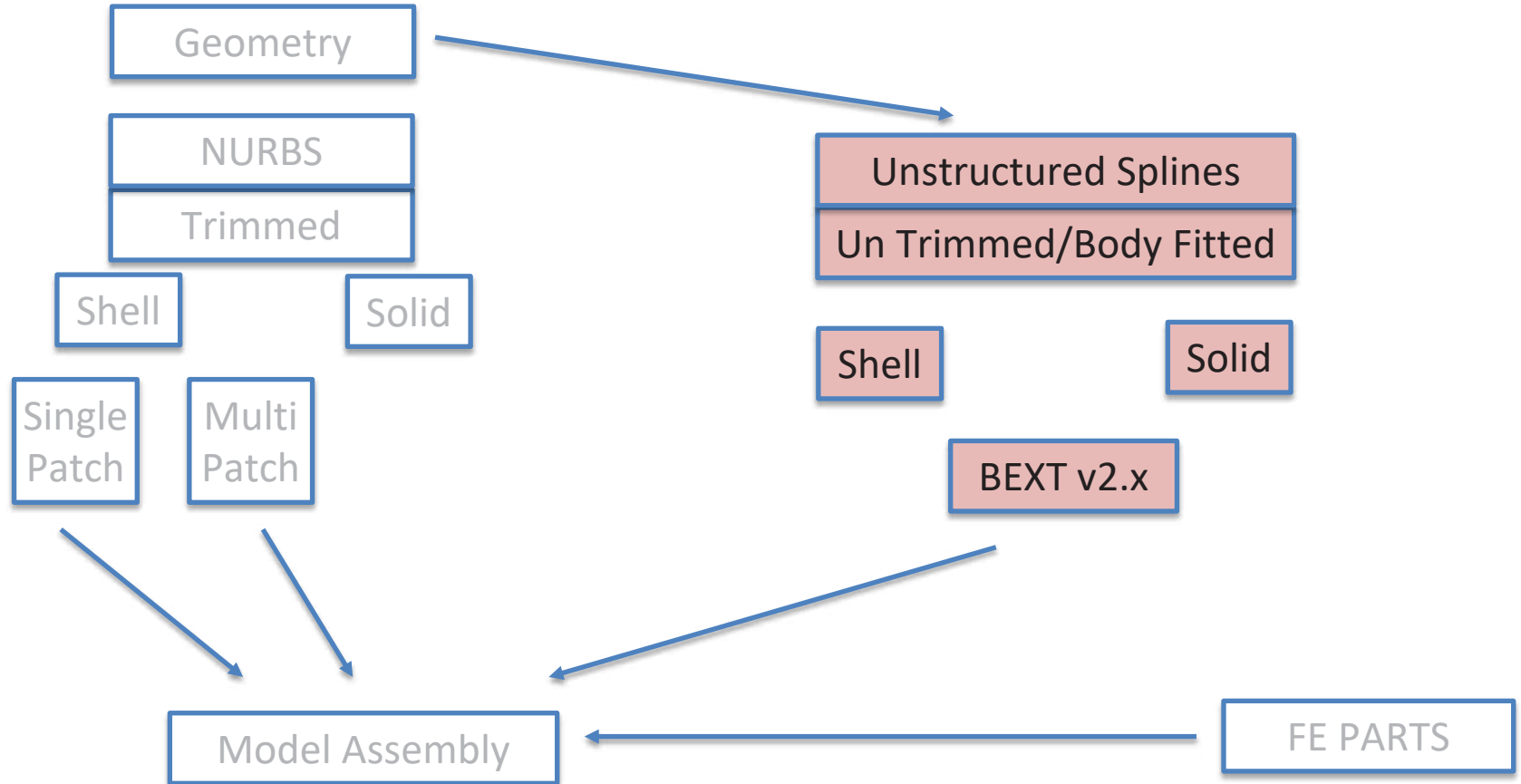


Current IGA developments - Solids

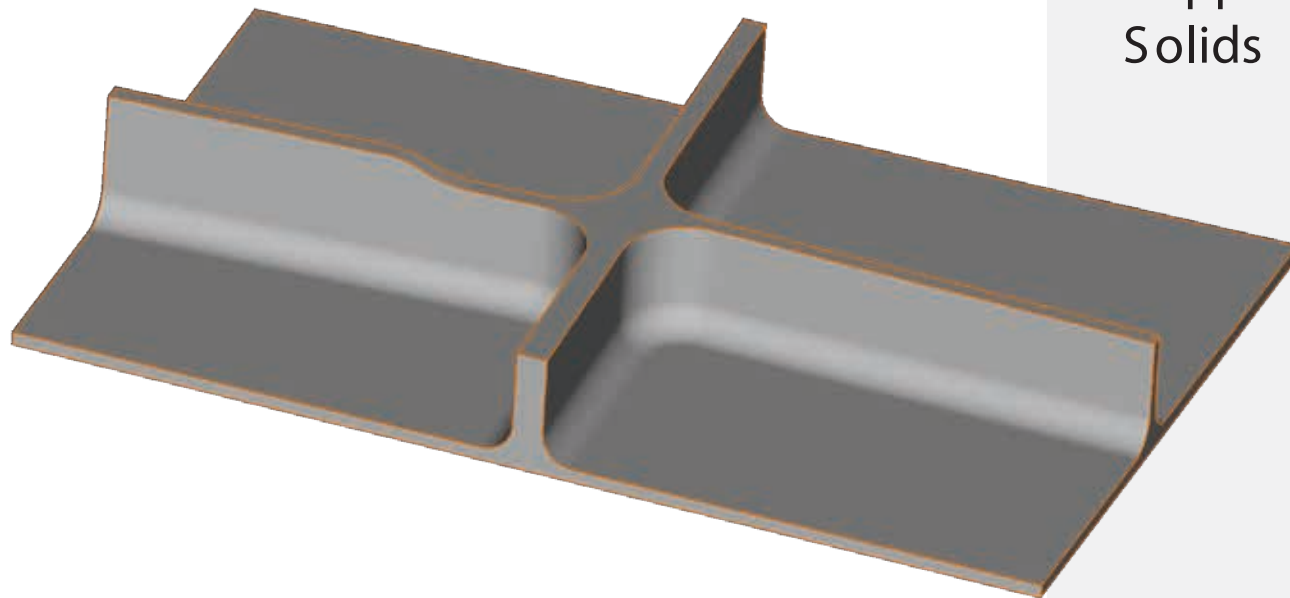
- Support of Trimmed and Untrimmed solids for pre-processing (3d-NURBS)
- Creation of Trimmed solid descriptions



How to Build an IGA model, Other options



- Support BEXT for Solids



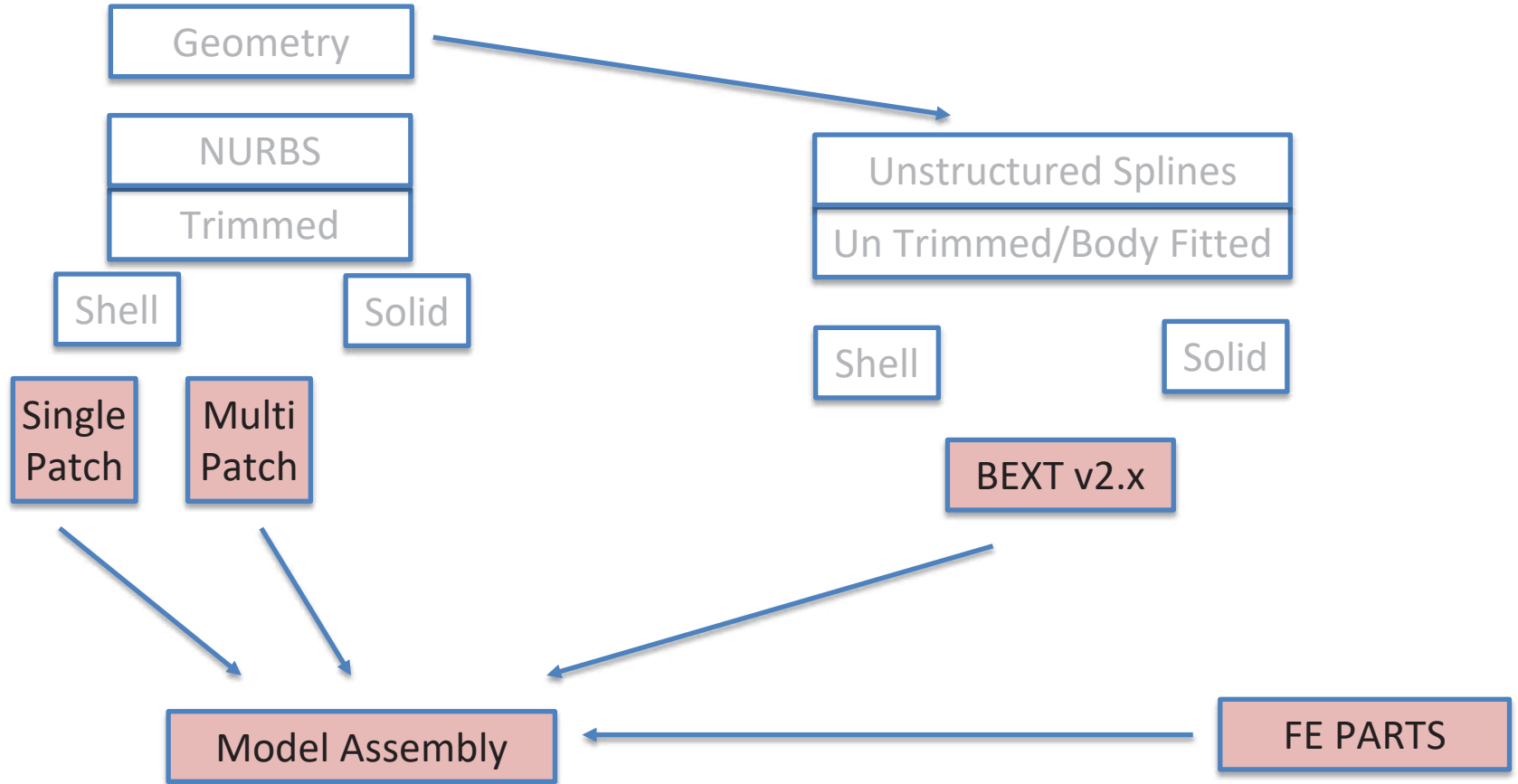


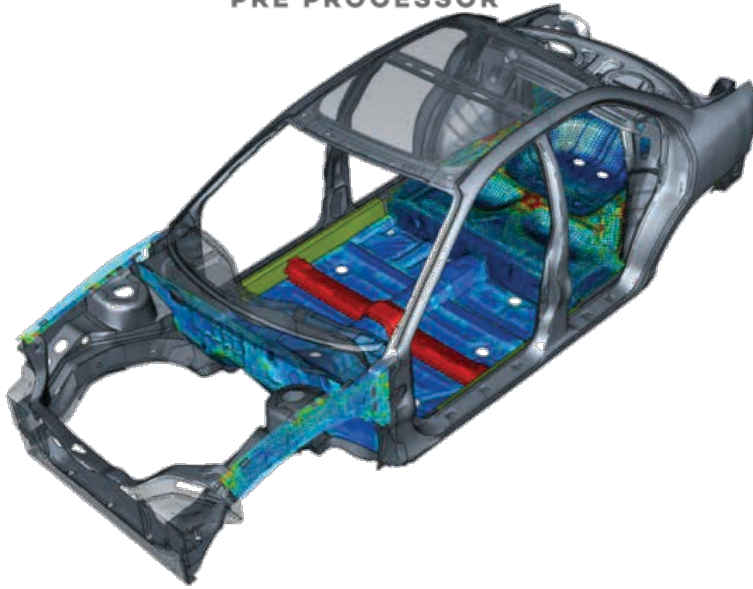
BEXT geometry
in LS-DYNA

- Support of other spline technologies through BEXT

Hugo Casquero, University of Michigan

How to Build an IGA model, Bring everything together



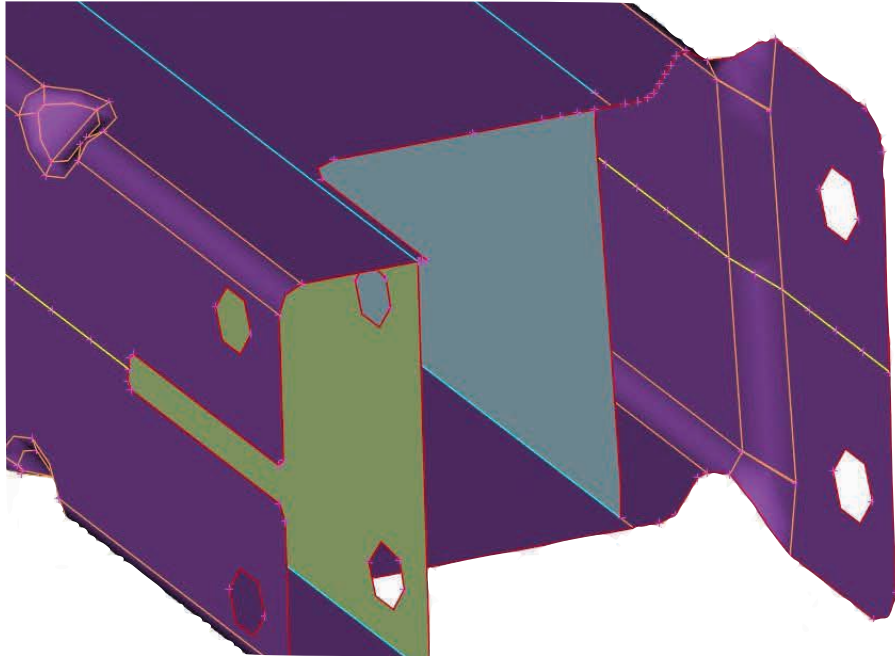


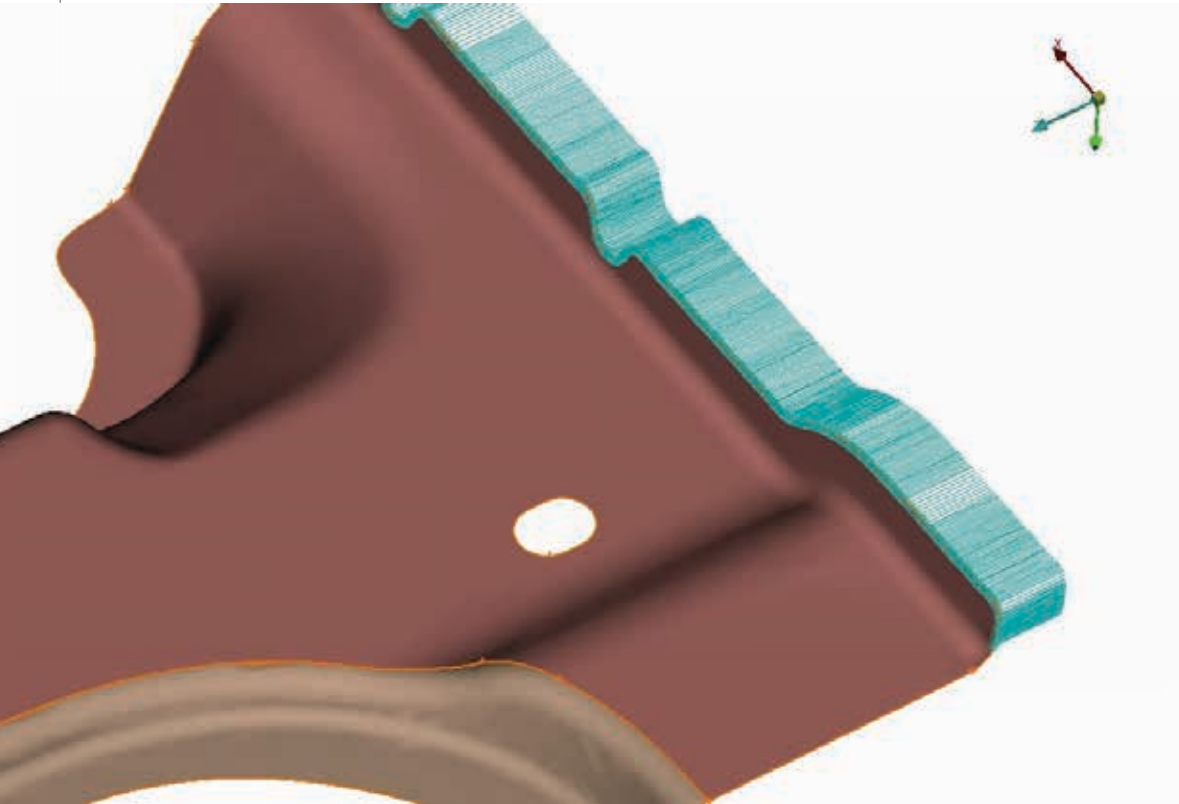
Automotive BIW Model Build w IGA

- Creation of Hybrid IGA - FE and IGA models
- Robust procedure
- Follow current practices
- Use tested workflows and tools

Current IGA Status - *IGA

- *IGA_Keyword Format
- Topology
- Performance
- Plug and play substitution of FE Mesh
- Easy Application of BCs, ICs, Constraints
- T-Junctions



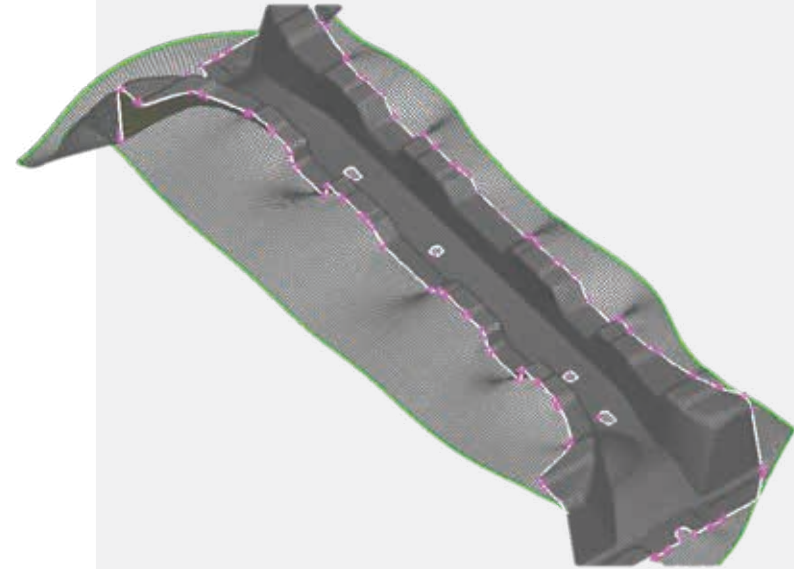


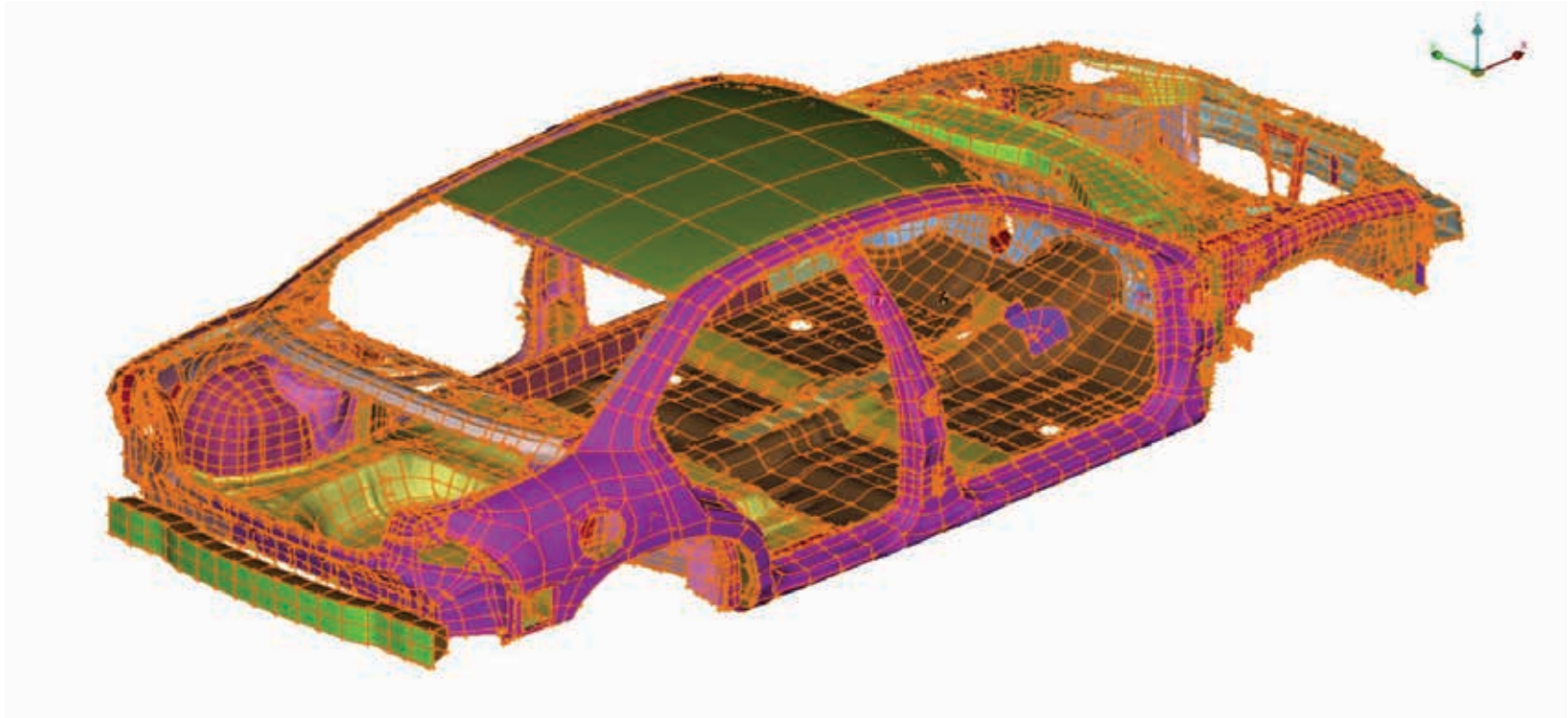
Current IGA Status - Assembly

- * IGA_POINT_UVW
- Multi projection of nodes to patches
- Spotwelding
- Assembly
- BCs on Geometric Entities

- Assembly either though Mesh Independent
- Or Mesh Dependent
- Application of Boundary conditions
- Most ANSA tools IGA aware

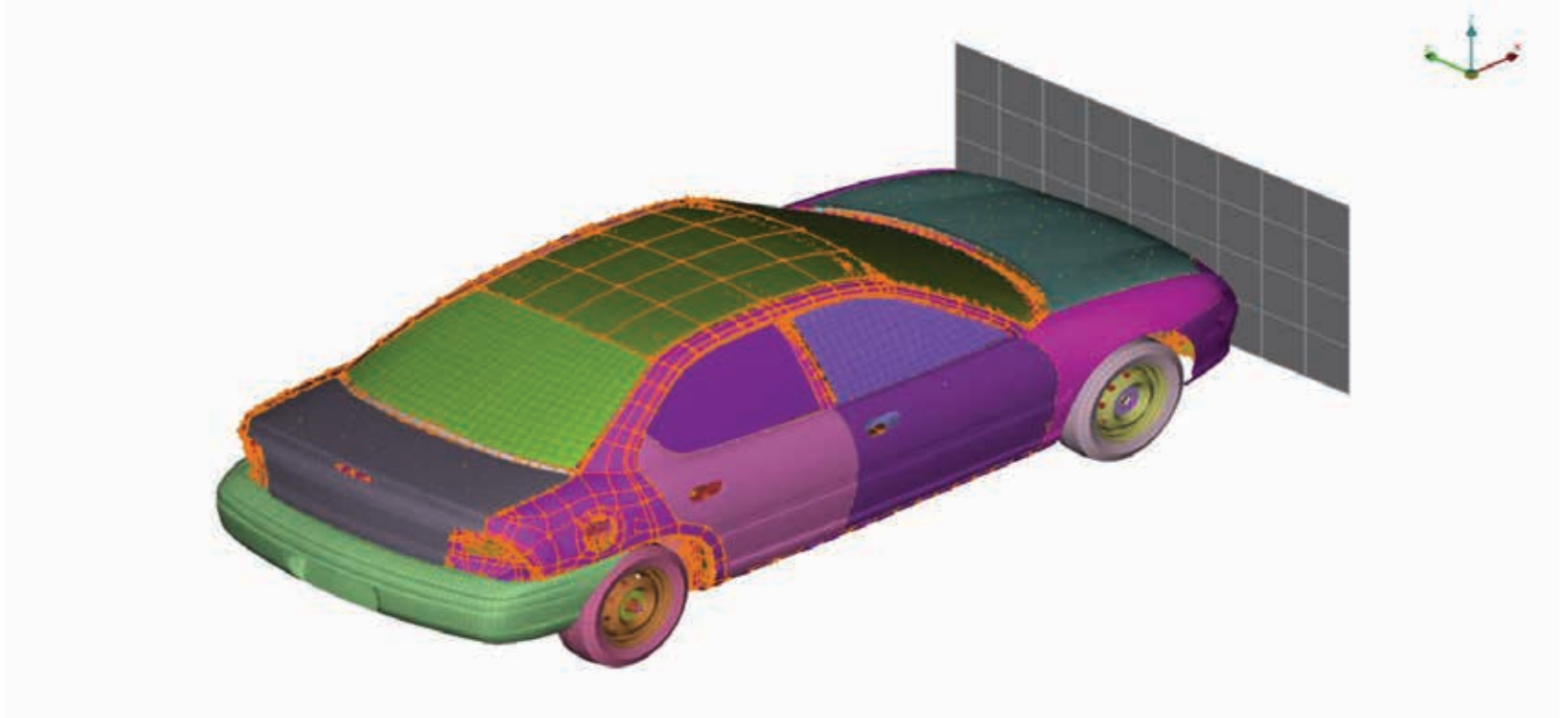
- Next steps
 - Variable Thickness
 - Initial Stress etc.





Kendrick Shepherd, Brigham Young University

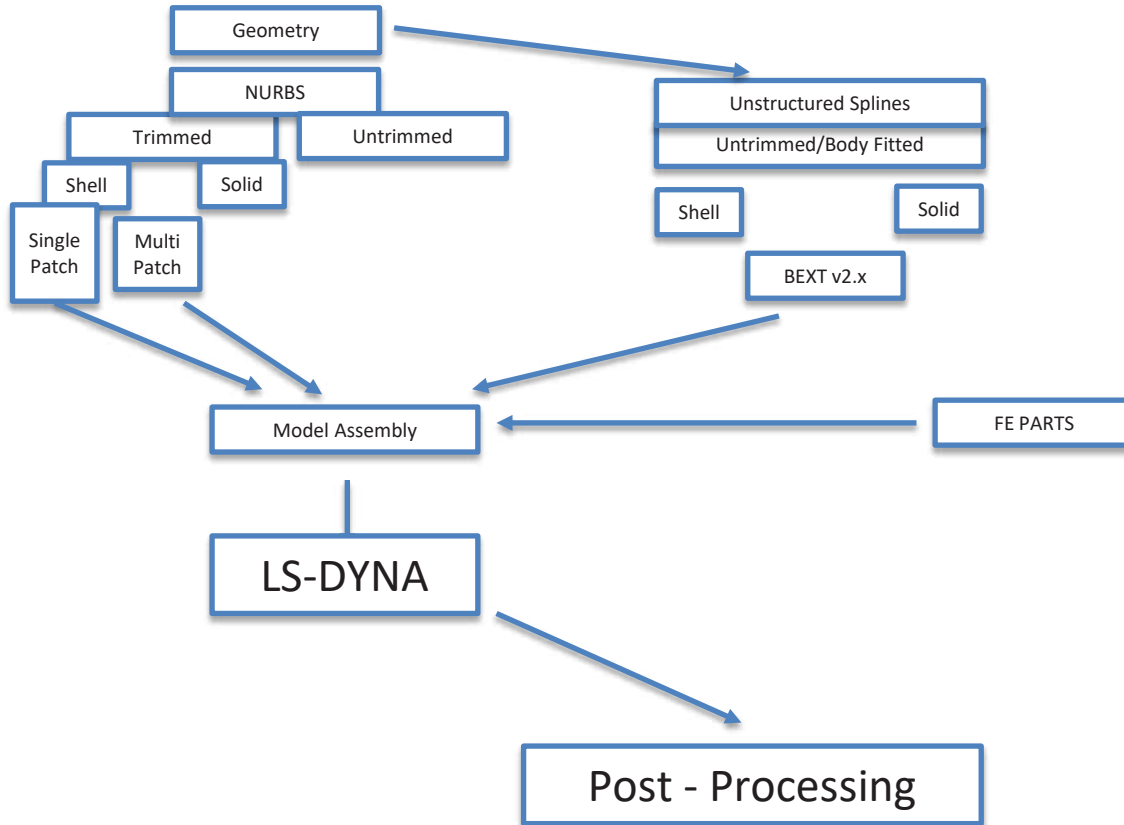
Adapting a legacy model with *IGA_POINT



Kendrick Shepherd, Brigham Young University

Kendrick Shepherd, Brigham Young University

Next Developments

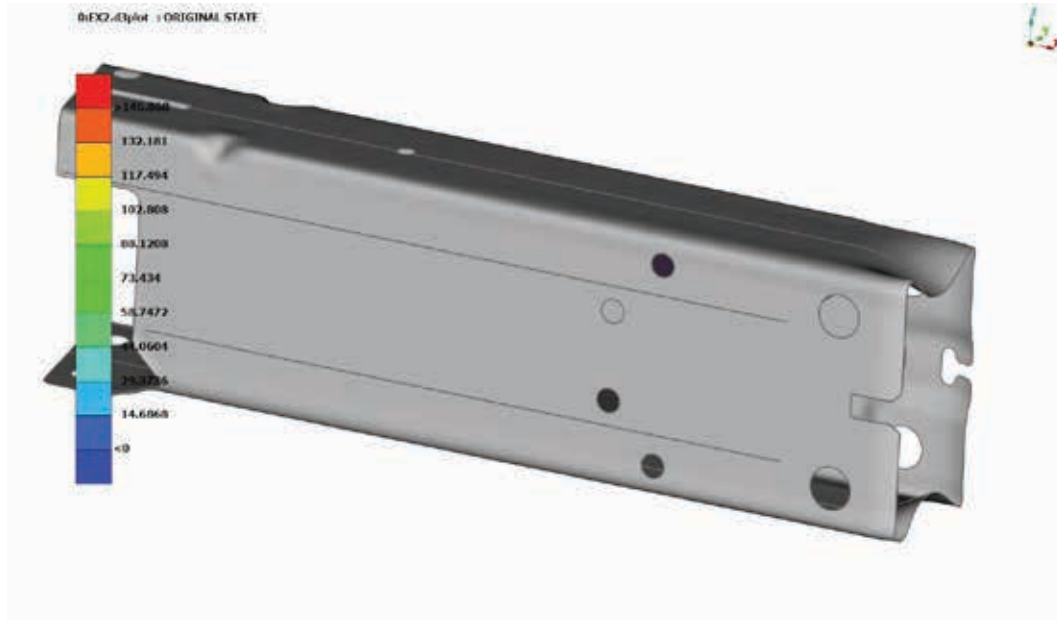


META

POST PROCESSOR



- Native Support for IGA results
- Directly on IGA Surface
- Fast
- Precise



Courtesy of BMW Group



Stay connected