# Methods and tools for IGA models for LS-DYNA

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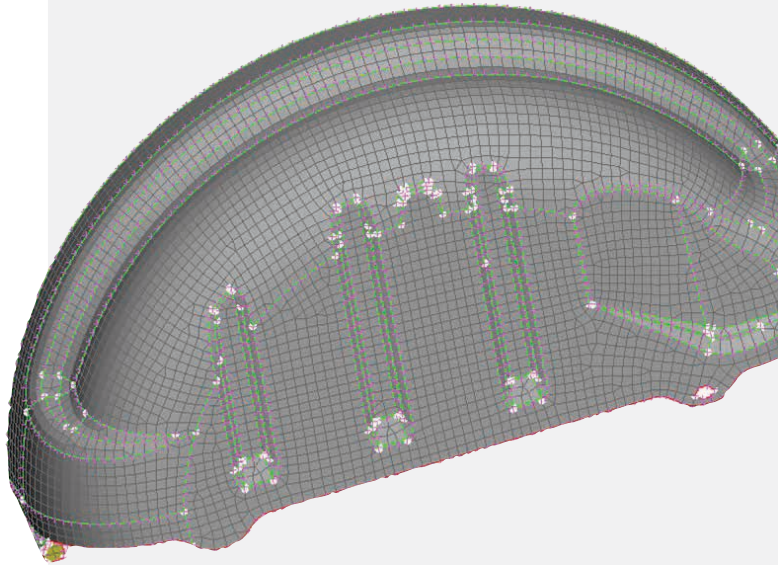
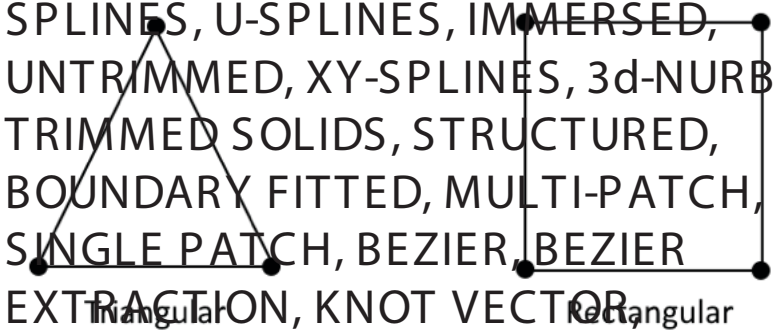
## What is Isogeometric Analysis

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

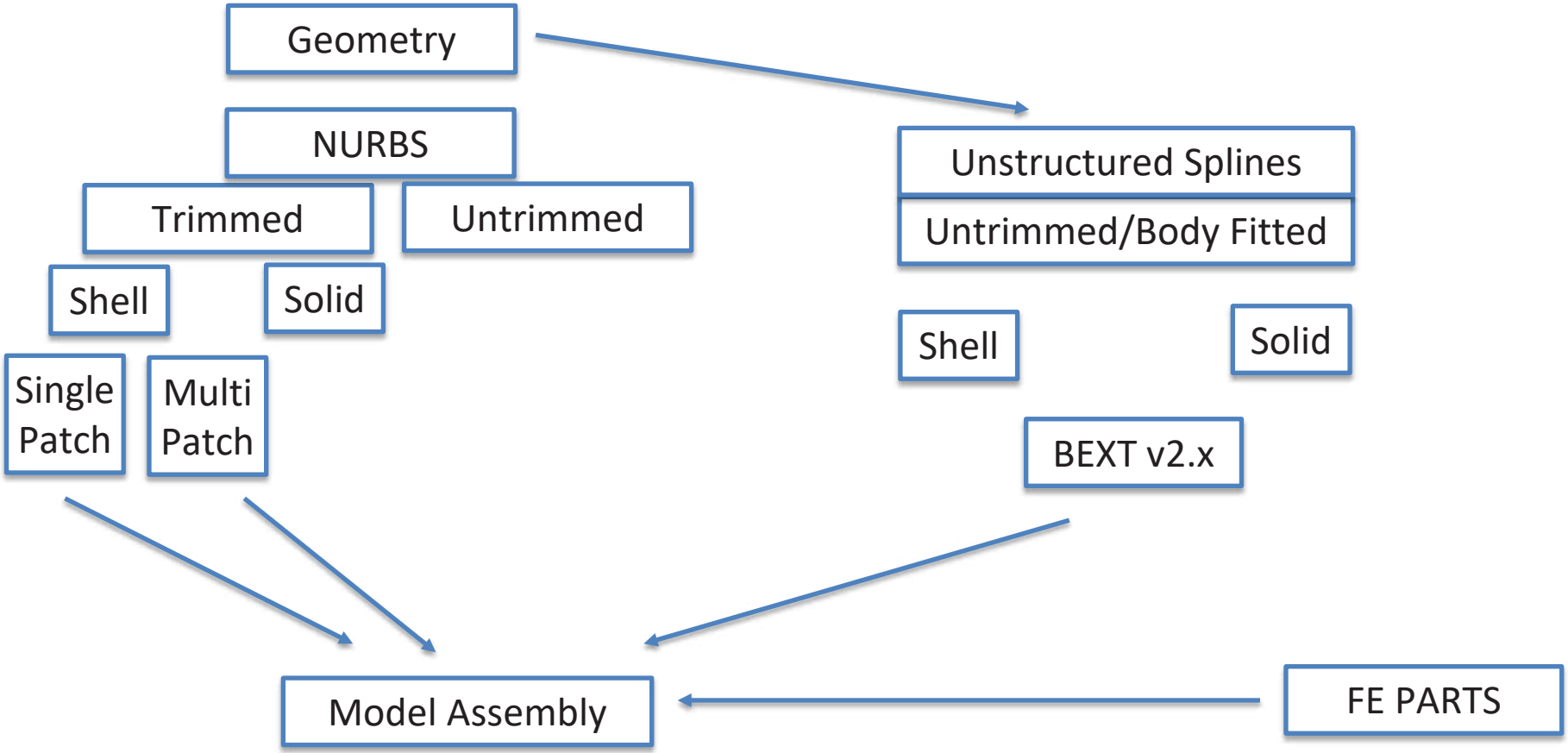


NURBS, B-SPLINES, TRIMMED, T-SPLINES, U-SPLINES, IMMERSED, UNTRIMMED, XY-SPLINES, 3d-NURBS, TRIMMED SOLIDS, STRUCTURED, BOUNDARY FITTED, MULTI-PATCH, SINGLE PATCH, BEZIER, BEZIER EXTRACTION, KNOT VECTOR, UNSTRUCTURED, KNOT VECTOR SPAN, BODY-FITTED…




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

- Major pre-processor for LS-DYNA models
- Can operate directly on Geometry
- Our goal is to integrate IGA into current workflows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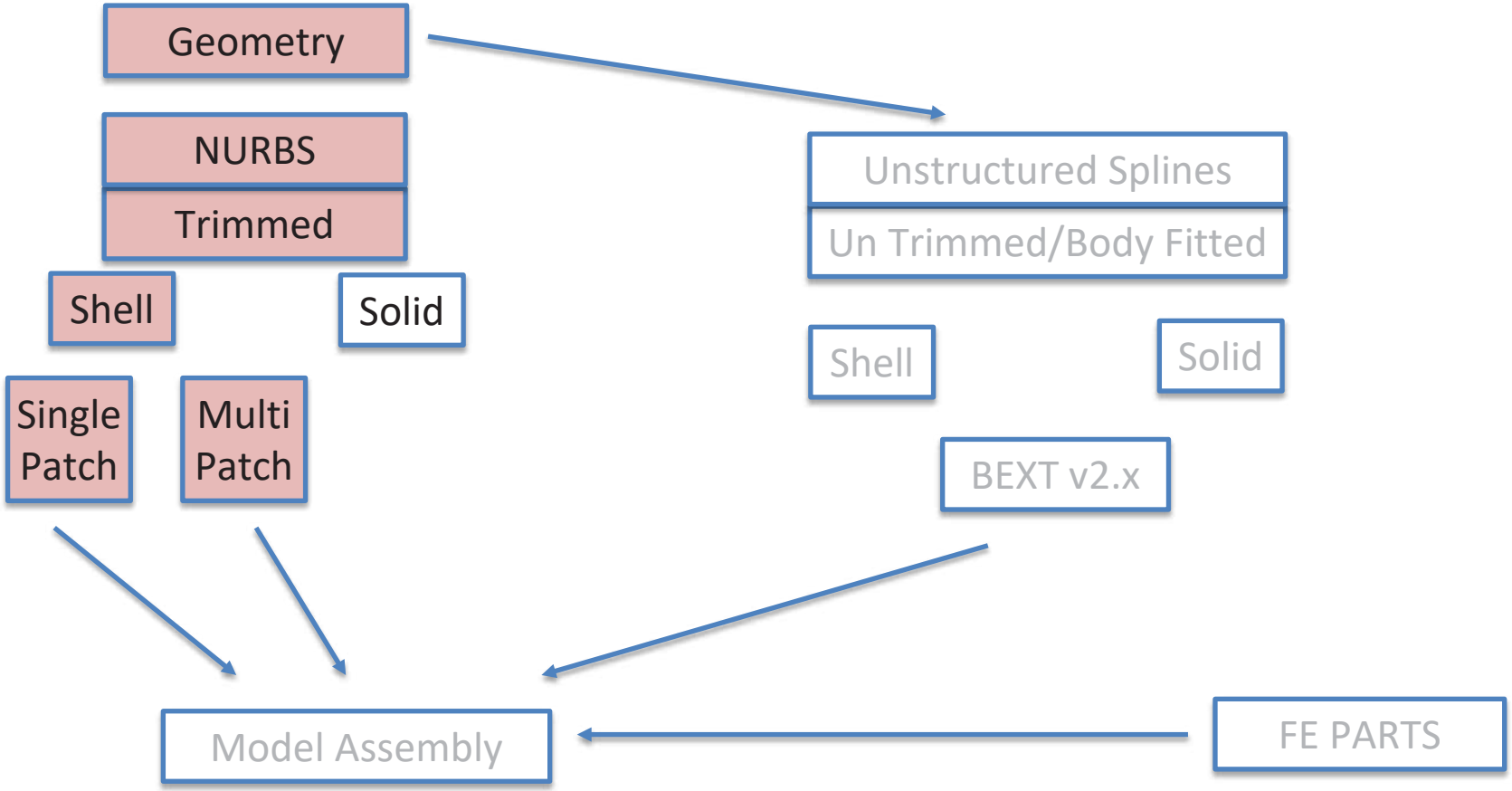
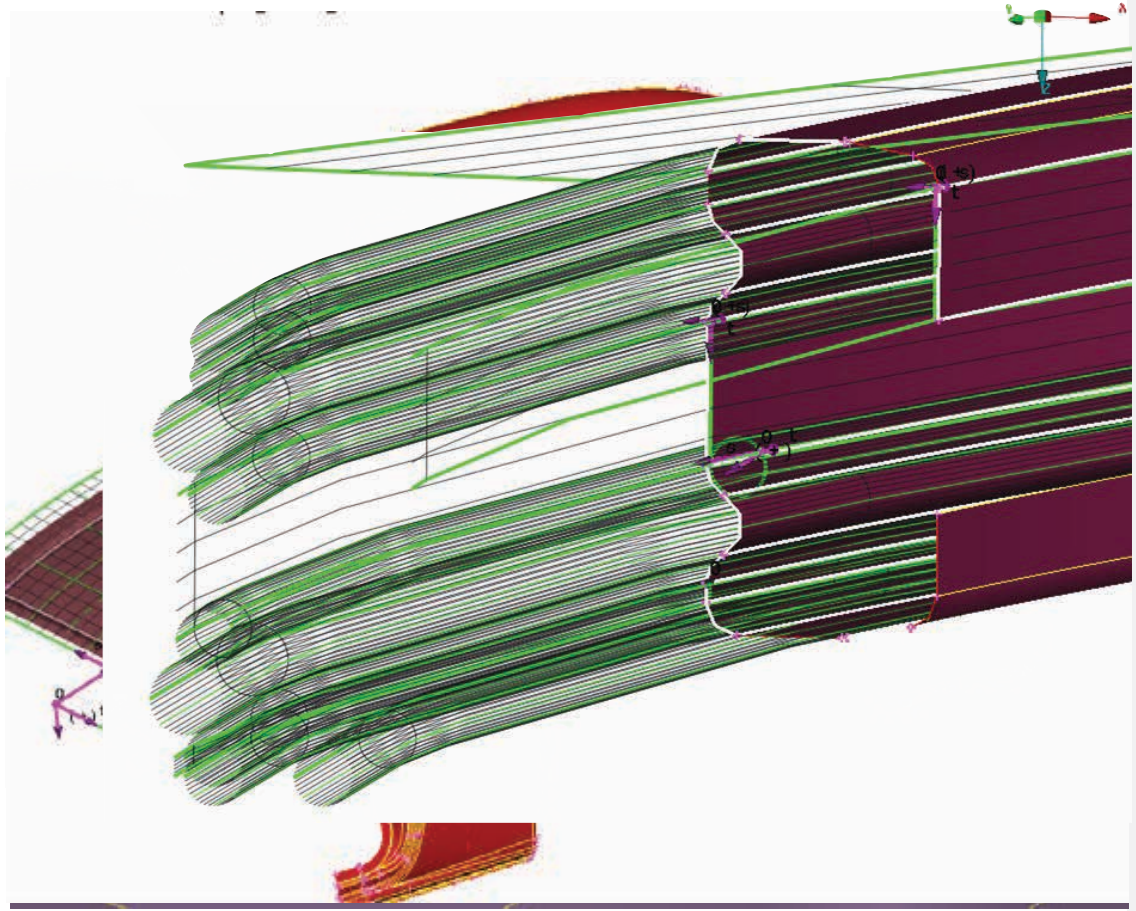
BEXT v2.x
Model Assembly
FE PARTS

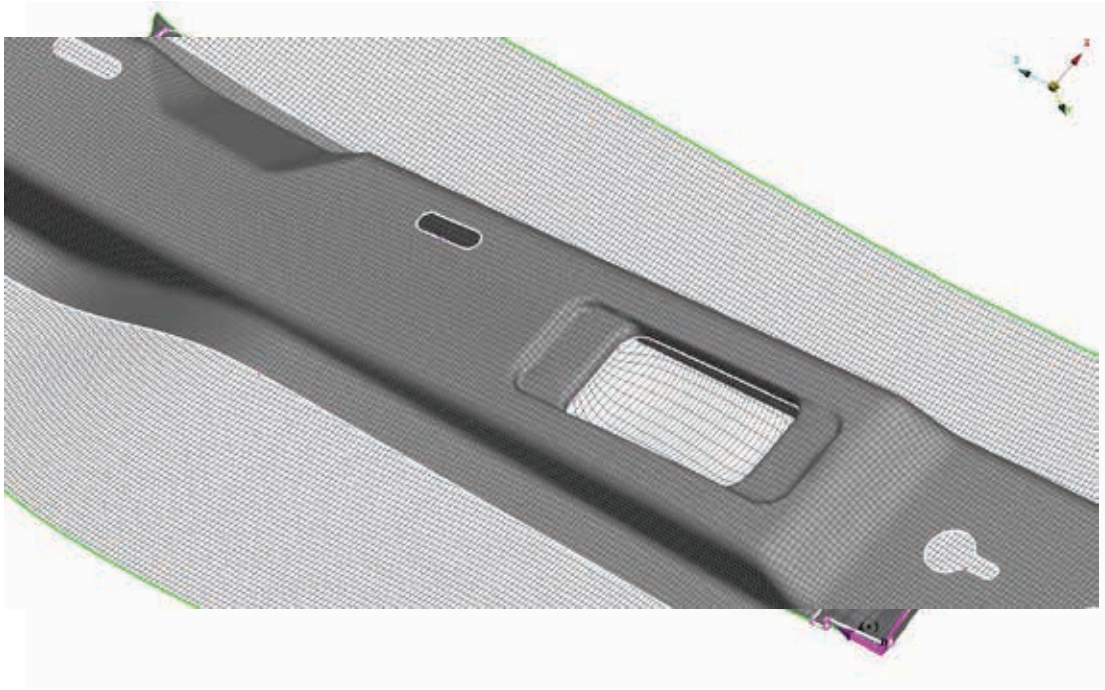
## How To Build an IGA model, current mature path



## The messy reality of CAD files

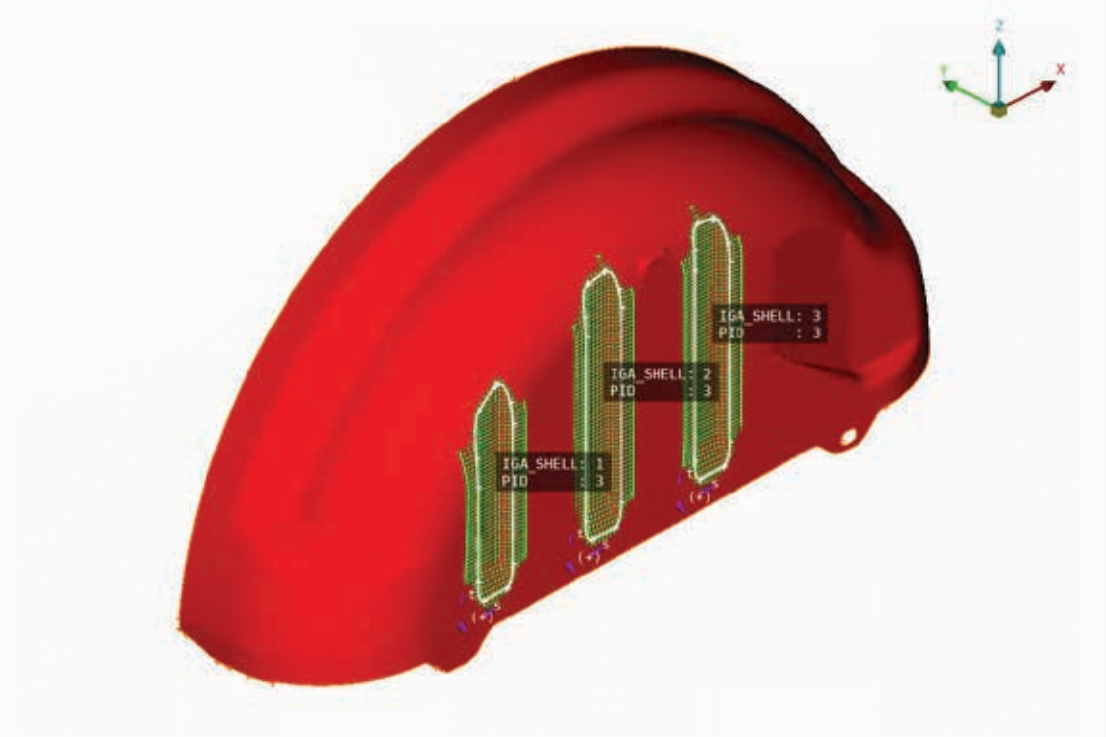


- Solid
- Non - Watertight
- Trimmed
- Analytical Surfaces
  - Planes
  - Cylinders etc
- High order polynomials
- Many Surface Patches per Part



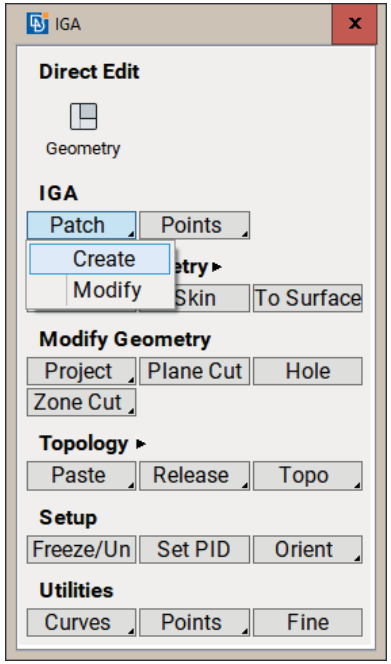
## ANSA IGA Function

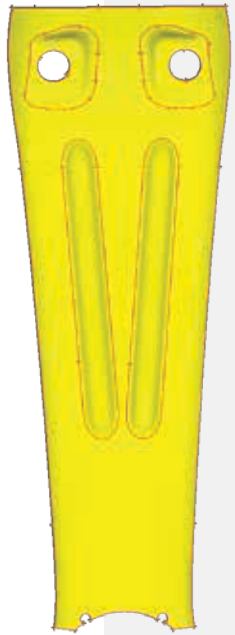
- From Multi-patched CAD
- To one trimmed surface part representation
- IGA Ready
- Can handle big parts
- With complex features
- Fast
- More tolerant to bad geometry

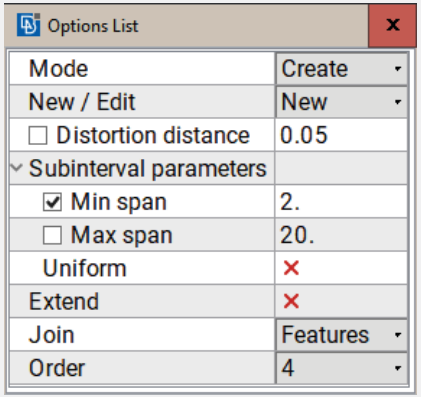


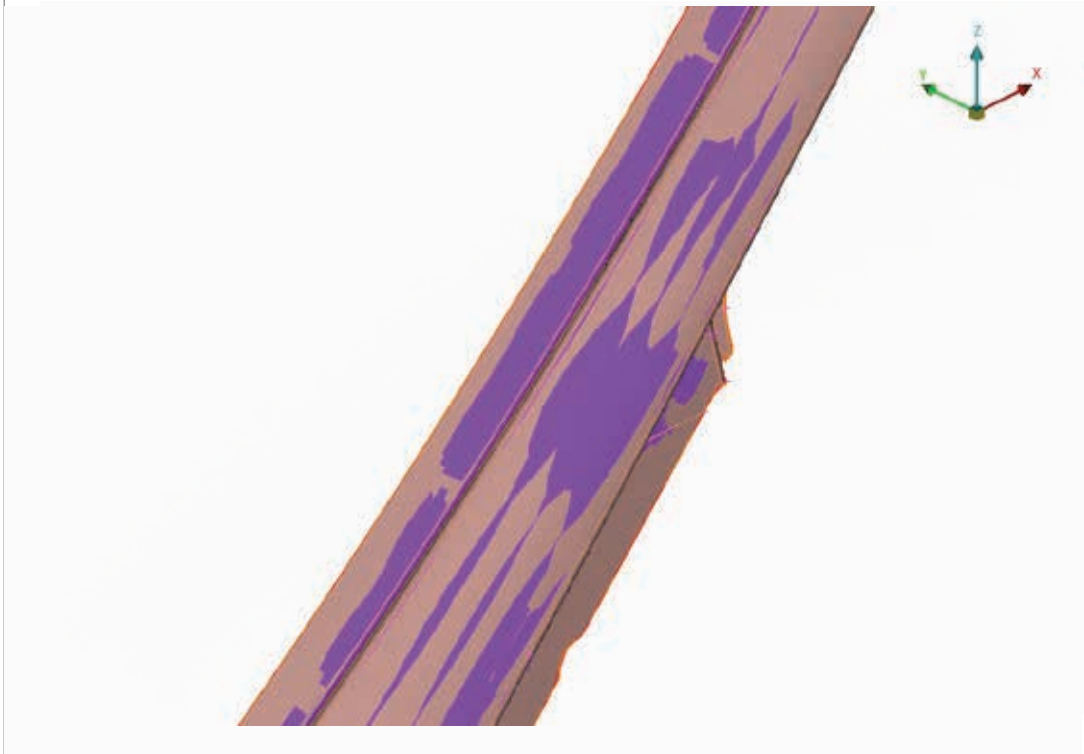

- Creation of complex parts with one click operation
- Creation of multi-patched IGA parts, semi-automatic

# From Feature Manager to Multi Patch IGA









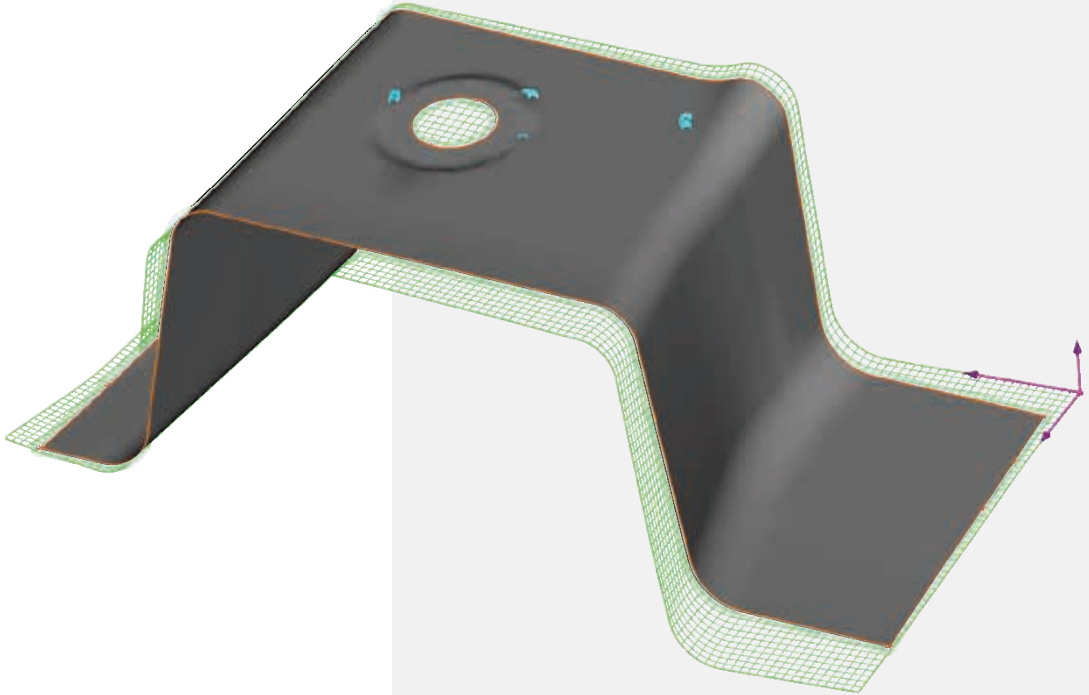
- Implementation of Quality criteria
- Time Step Control
- Deviation from original Surface

# ANSA IGA Helper Functions

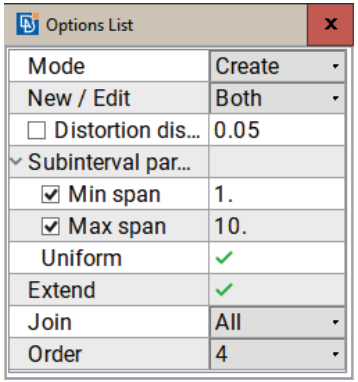
IGA_SHELL: 1
 B-Spline surface [ 162 x 54 ], order ( 4 , 4 )

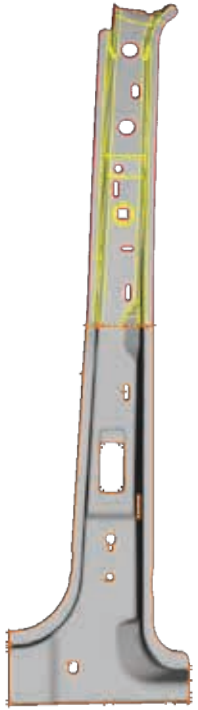
| | | Minimum | Average | Maximum |
|---|---|---|---|---|
| S-span | : | 0.5133 | 2.1342 | 3.8511 |
| T-span | : | 1.1931 | 2.1743 | 3.5366 |

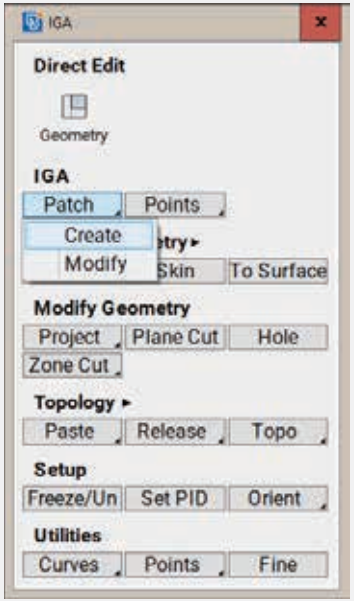
Negative Jacobian areas :
 2569.910510, 887.439579, 974.200864
 2569.170565, 887.482502, 973.573627
 2571.159950, 887.356148, 975.360319



# Edit IGA patch



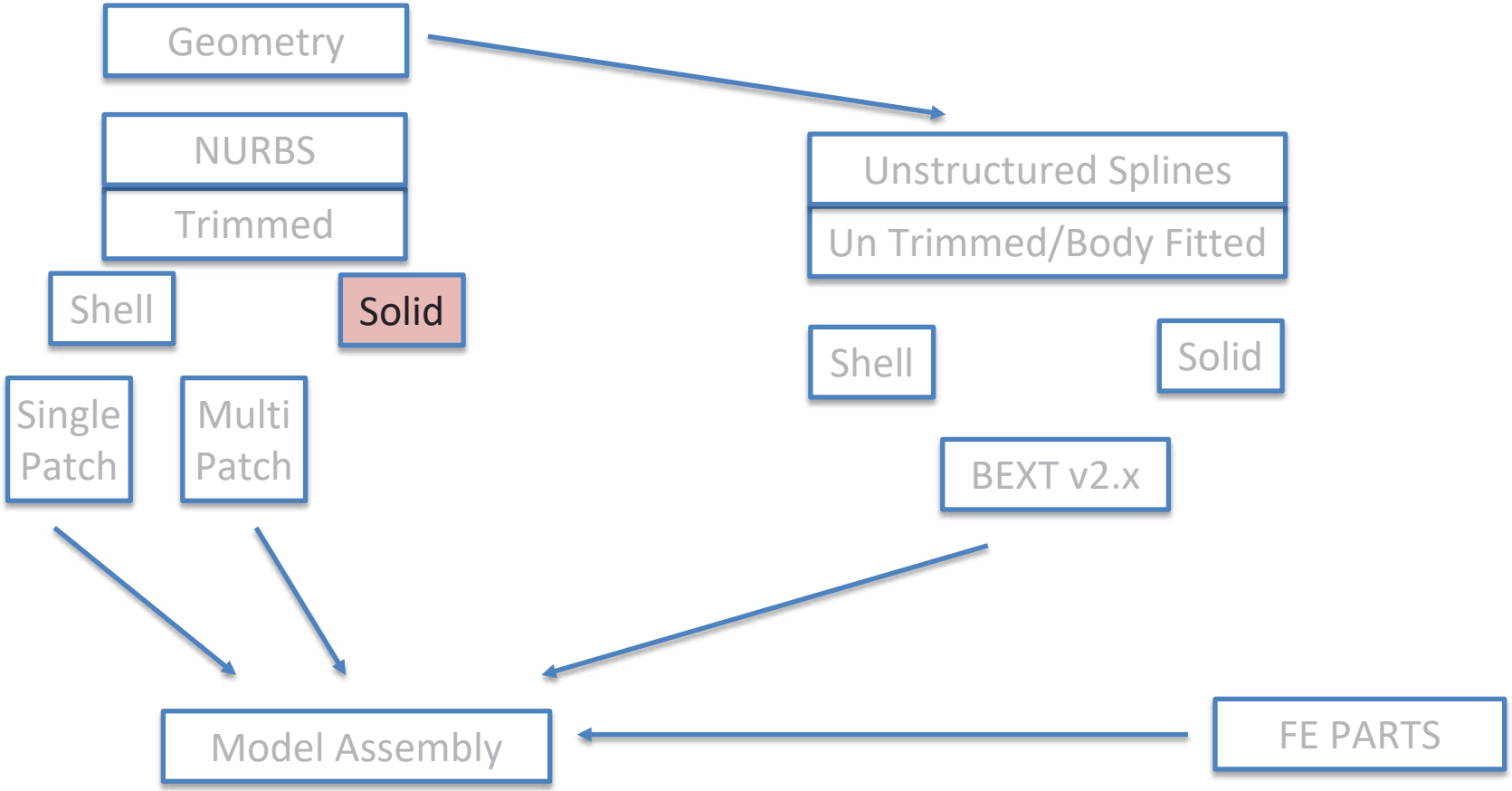





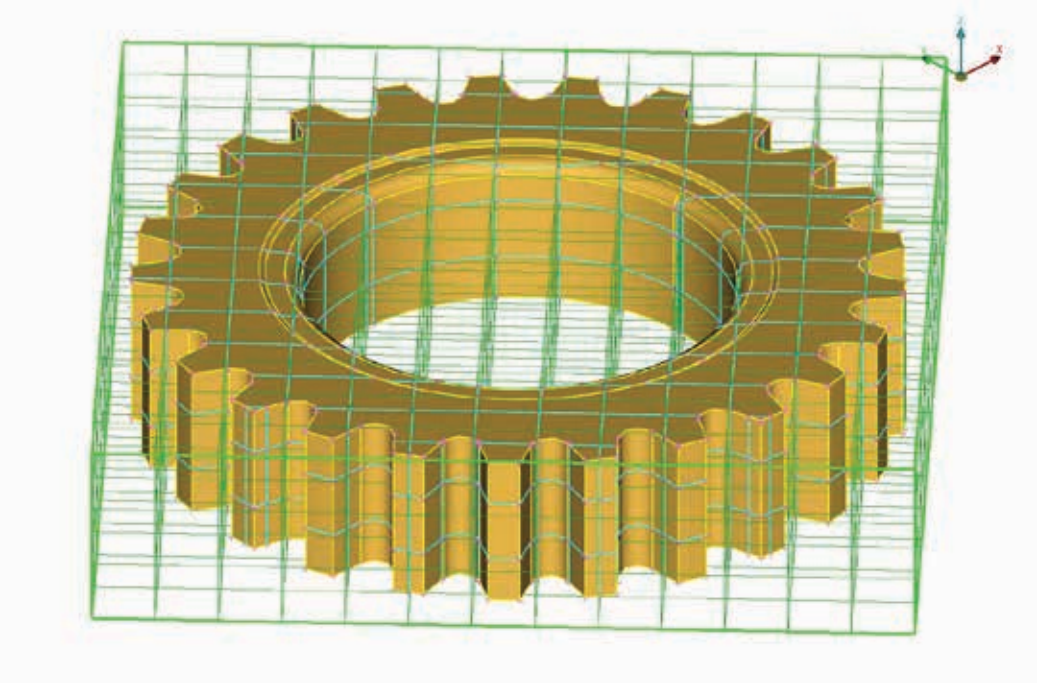
## Conversion of IGA geometry to CAD

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

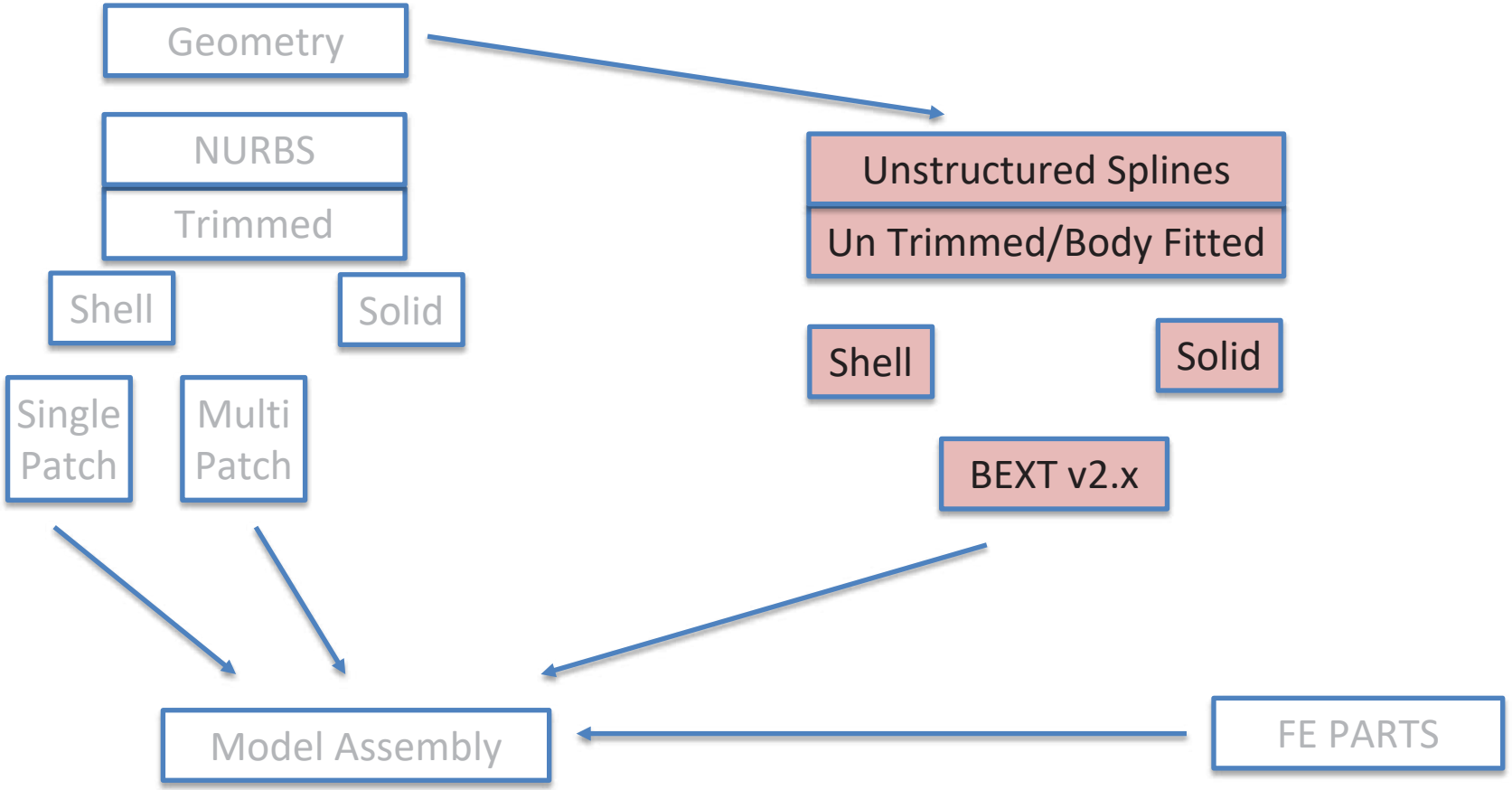
# How to Build an IGA Model, Solids



## Current IGA developments - Solids



- Support of Trimmed and Untrimmed solids for pre-processing (3d-NURBS)
- Creation of Trimmed solid descriptions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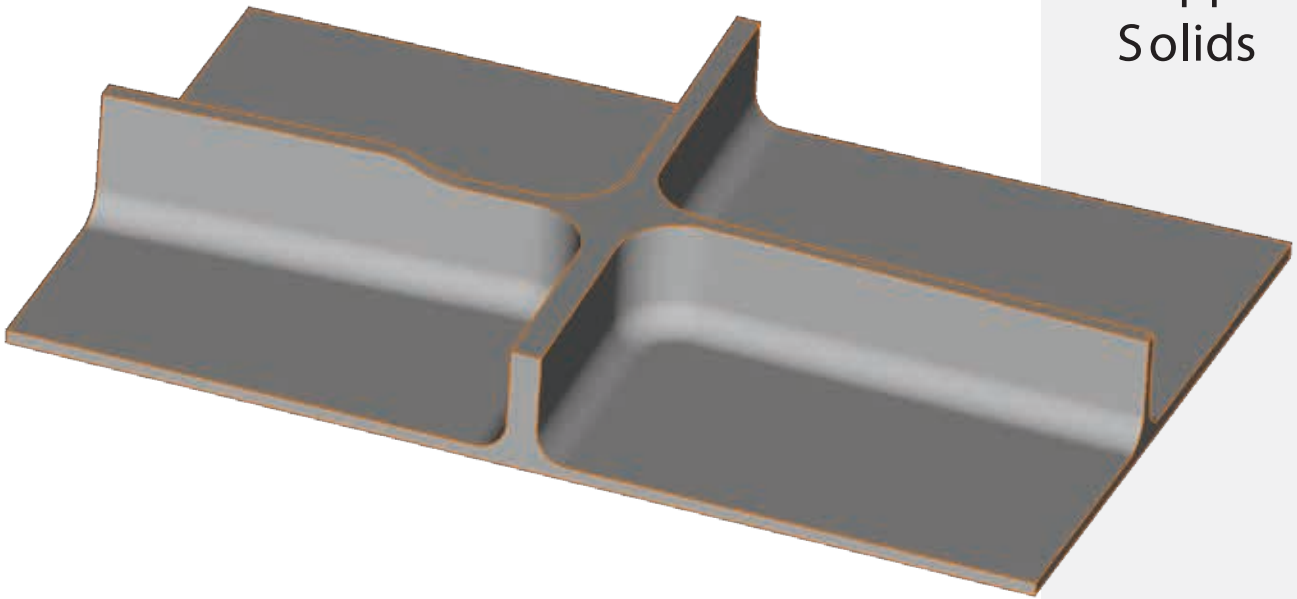
## BEXT Support - *IGA_3D_BEZIER_XYZ



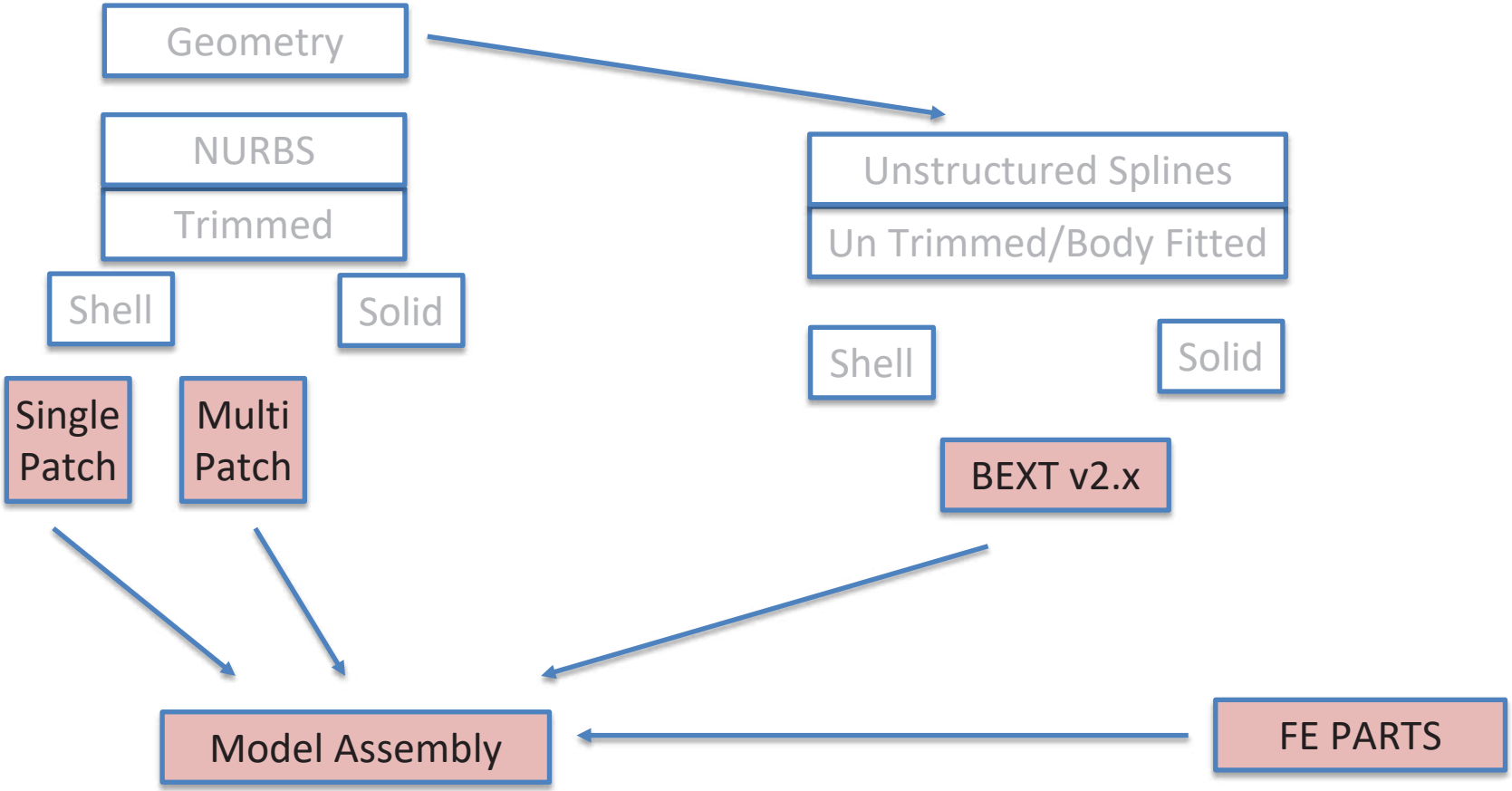
- Support BEXT for Solids

## BEXT Support - *IGA_2D_BEZIER_XYZ

*Hugo Casquero, University of Michigan*

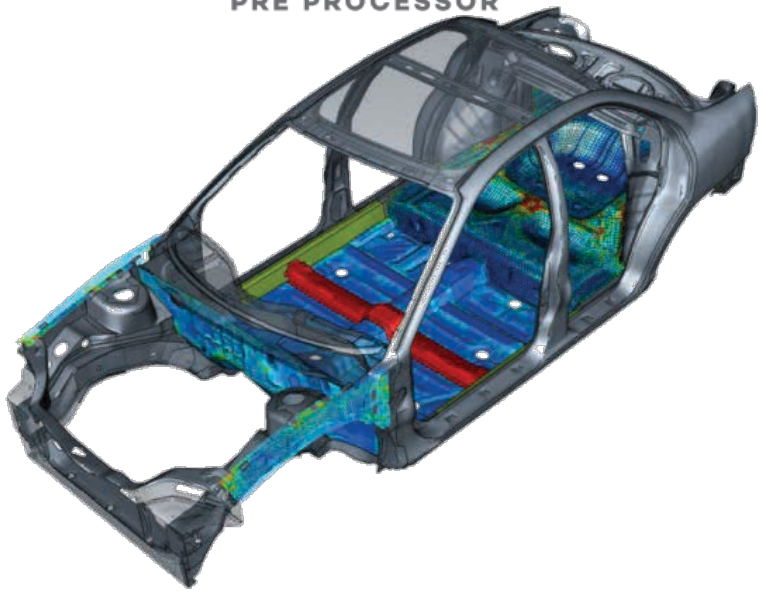
- Support of other spline technologies through BEXT

## How to Build an IGA model, Bring everything together



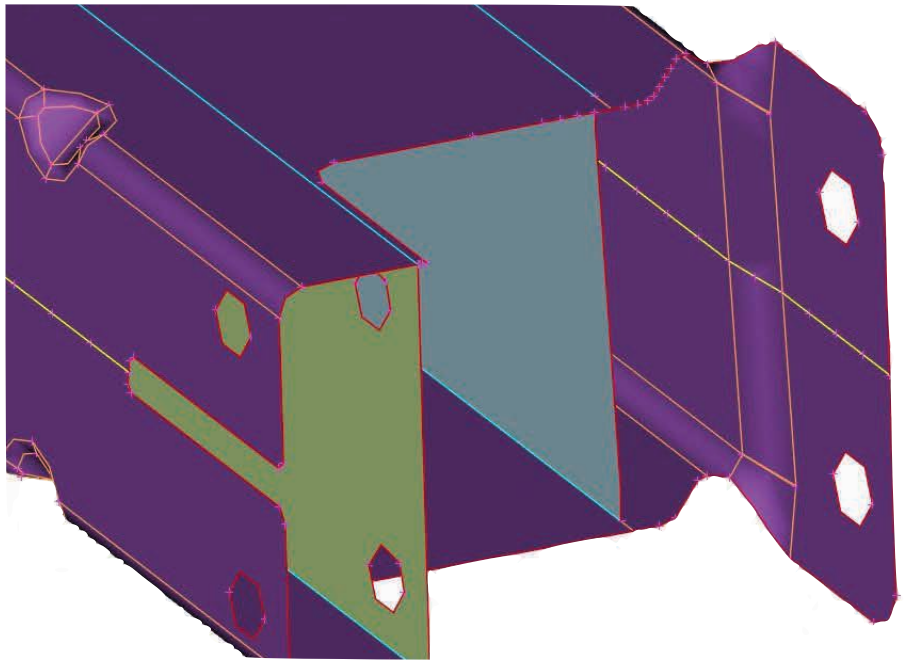
ANSA

PRE PROCESSOR



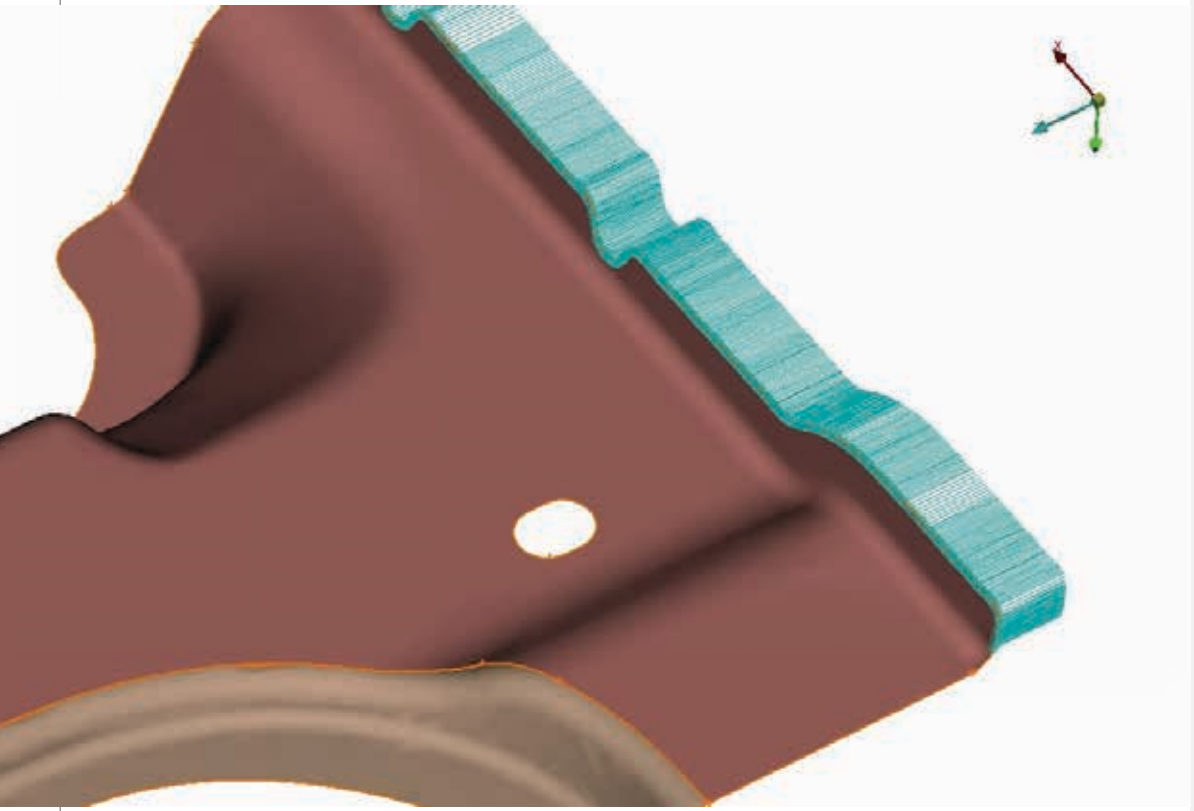
## Automotive BIW Model Build w IGA

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



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

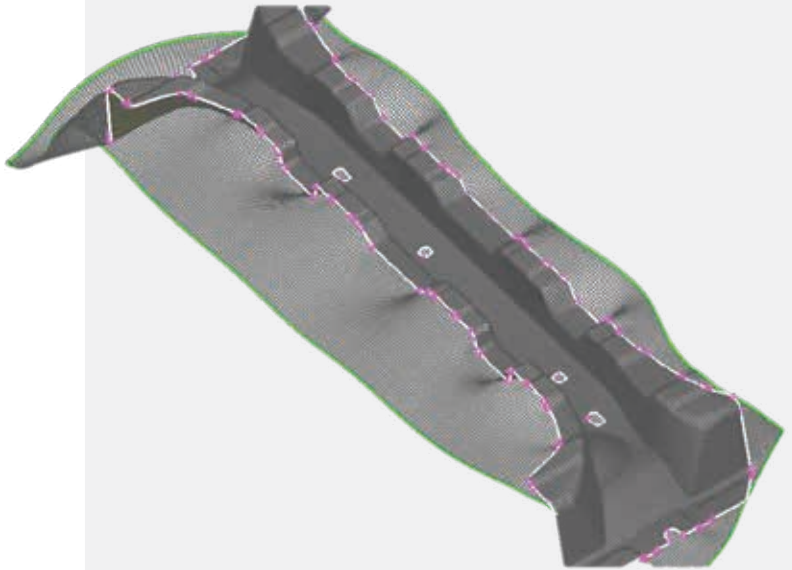
## Current IGA Status - Assembly

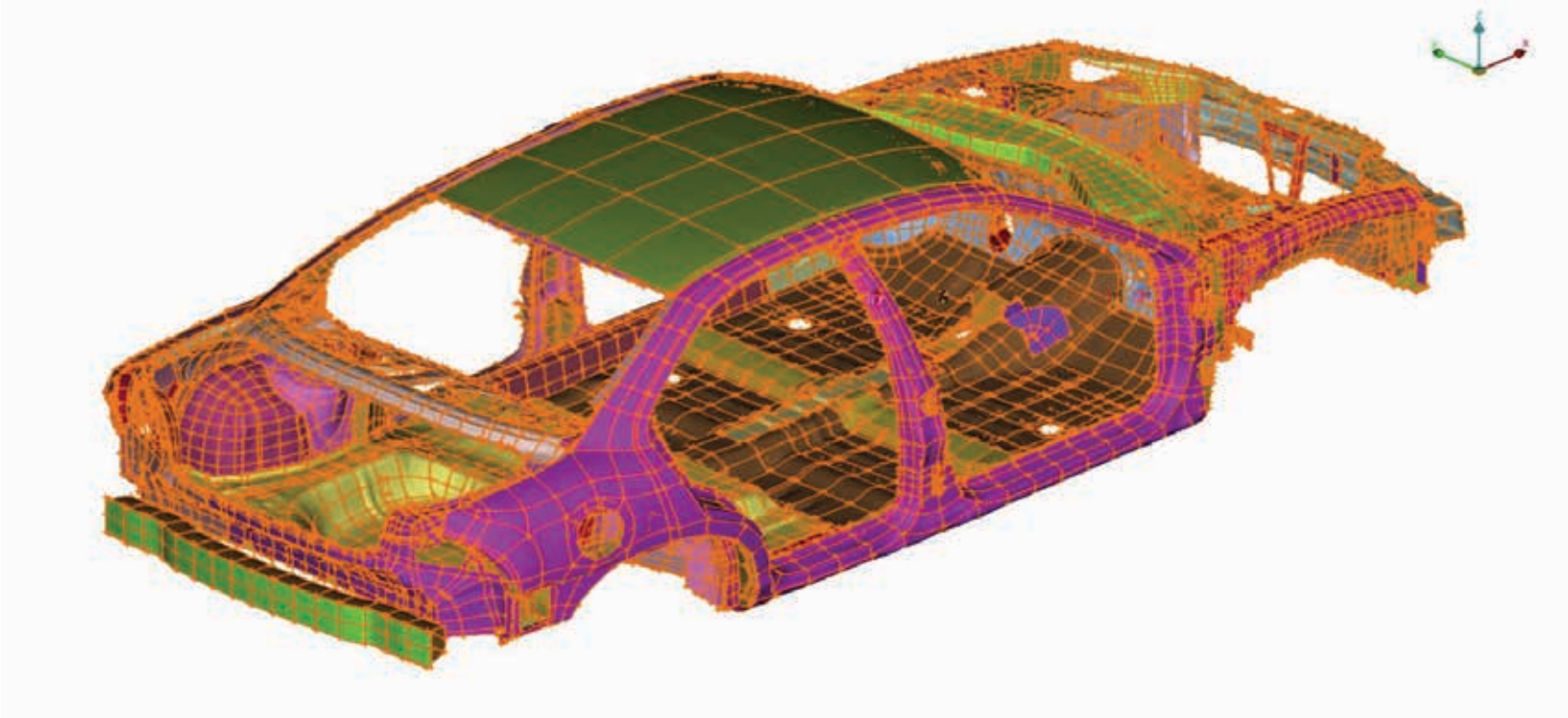


- * IGA_POINT_UVW
- Multi projection of nodes to patches
- Spotwelding
- Assembly
- BCs on Geometric Entities

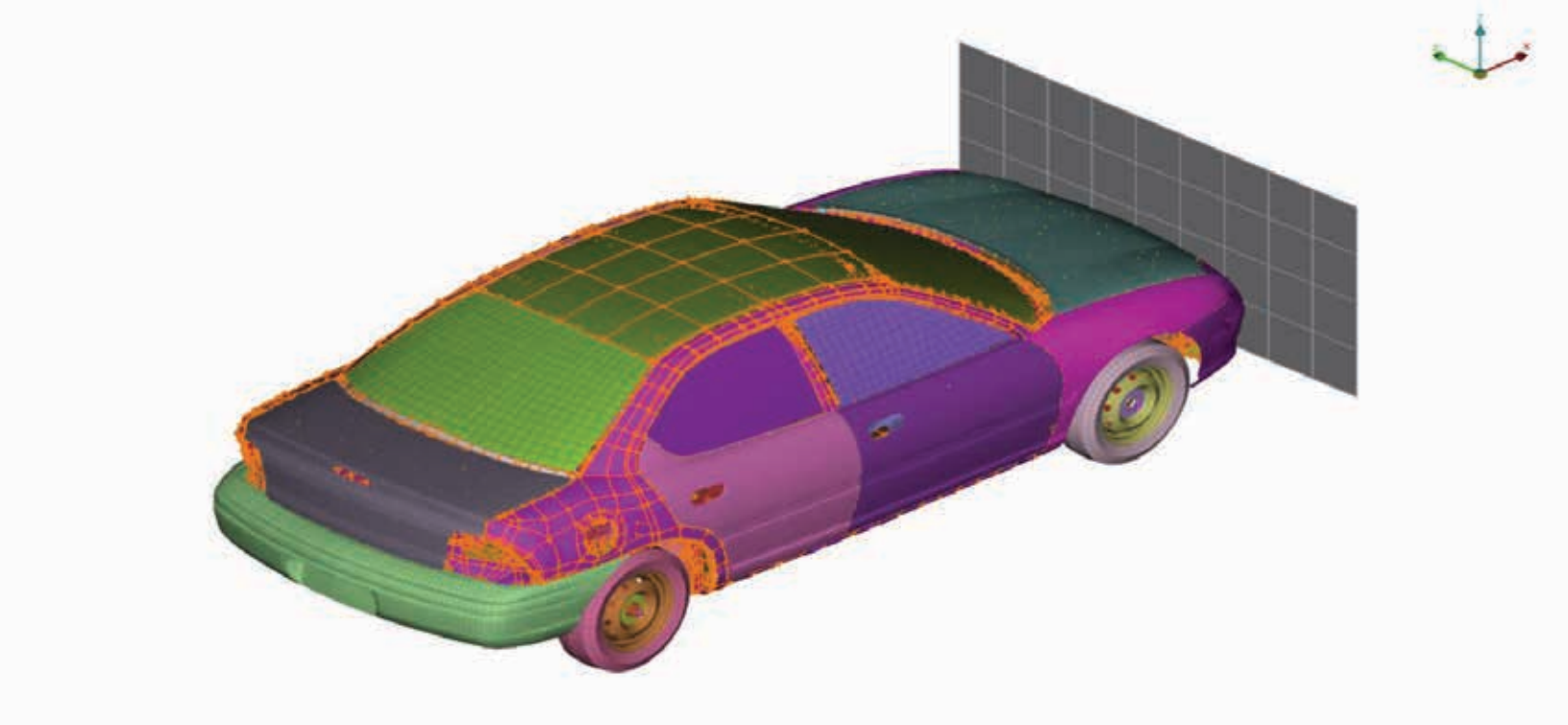
- Assembly either though Mesh Independent
- Or Mesh Dependent
- Application of Boundary conditions
- Most ANSA tools IGA aware

- Next steps
  - Variable Thickness
  - Initial Stress etc.





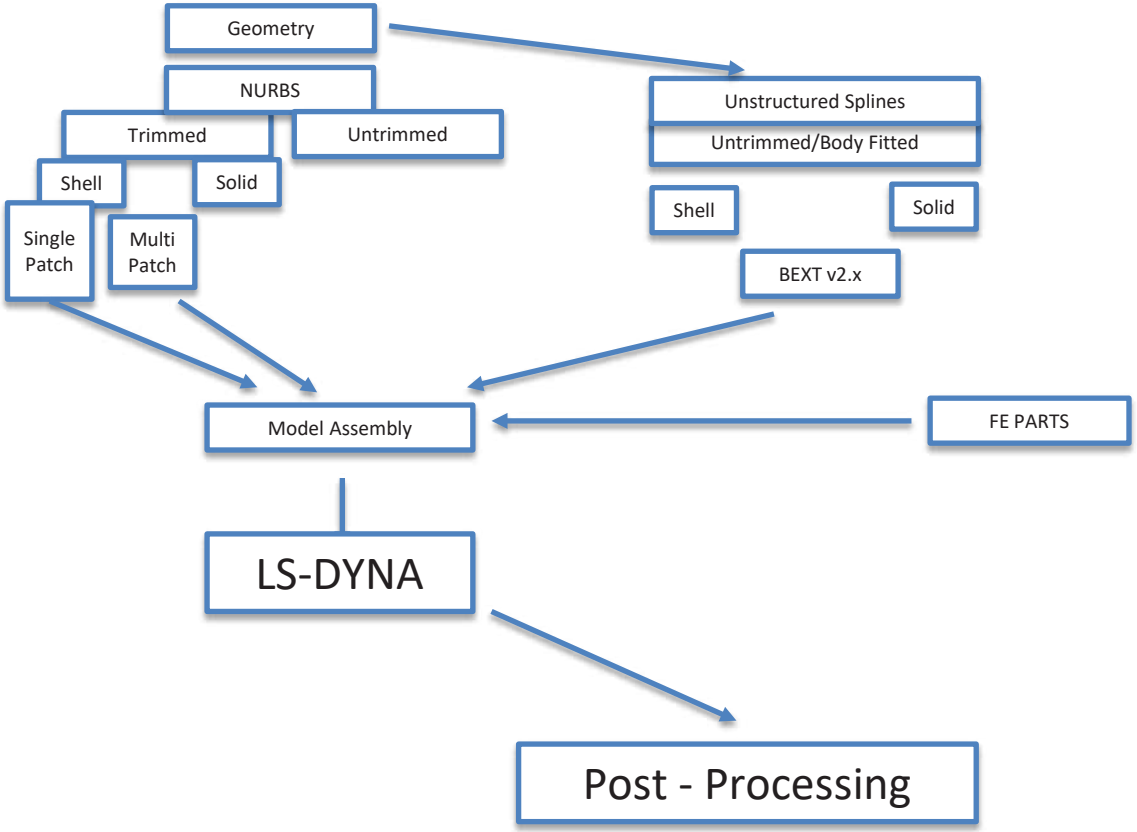
*Kendrick Shepherd, Brigham Young University*



*Kendrick Shepherd, Brigham Young University*

# Adapting a legacy model

*Kendrick Shepherd, Brigham Young University*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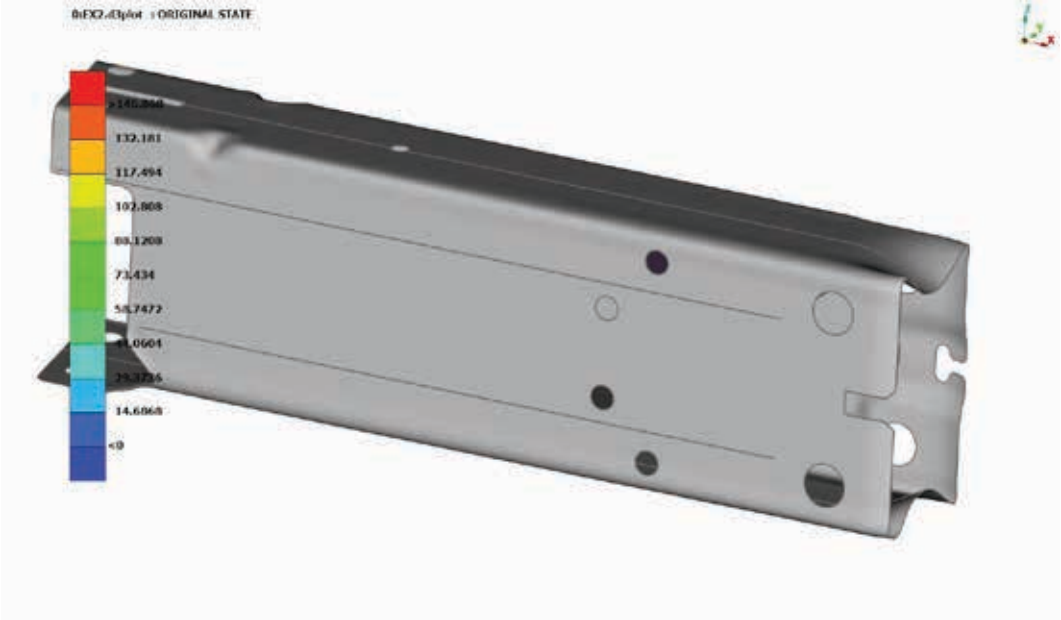
META
POST PROCESSOR




*Courtesy of BMW Group*

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

BETA
SIMULATION SOLUTIONS

## Stay connected