CAE DRIVEN MULTI DISCIPLINARY OPTIMIZATION OF VEHICLE SYSTEMS

--Niju Nair, Account manager

DEP

Smarter Solutions. Delivered.

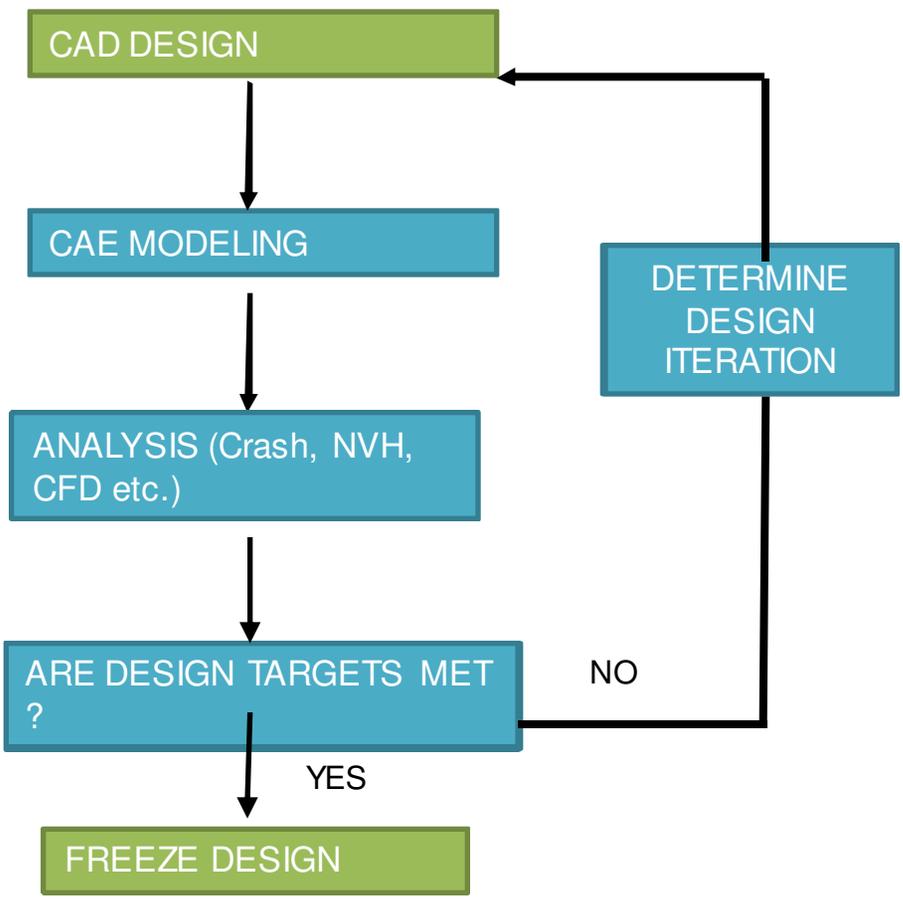*Smarter Solutions. Delivered.*

Contents

- Possible solutions for the engineering & Optimization challenges.

- Transformed Product development & MDO.

- Parametrization Techniques.

- Case study : Full vehicle optimization.

- Meshworks.

2

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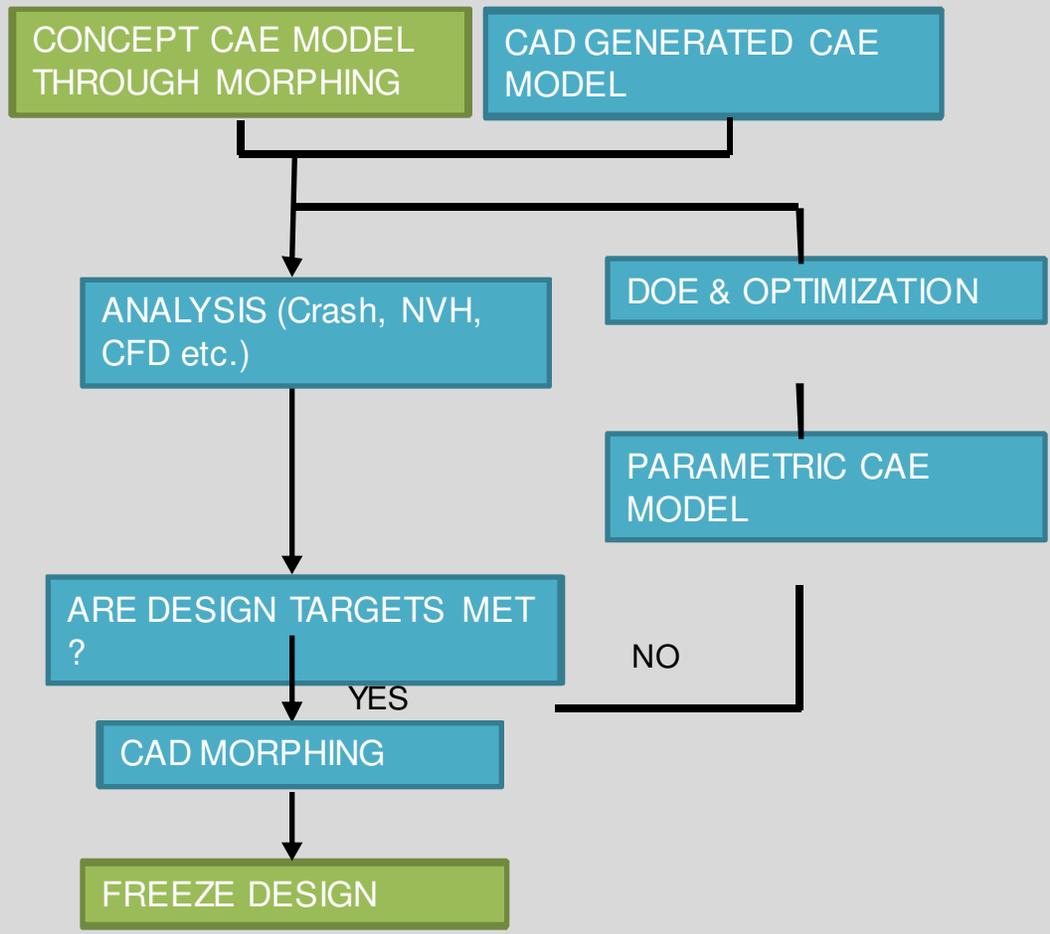
Engineering Challenges in today's automotive market

- Faster time to market

- Newer variants

- Weight optimization

- Environment & regulations

- Energy management

- Many more...

3

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Possible solutions for the engineering challenges:

- Optimization during the stage of vehicle development.

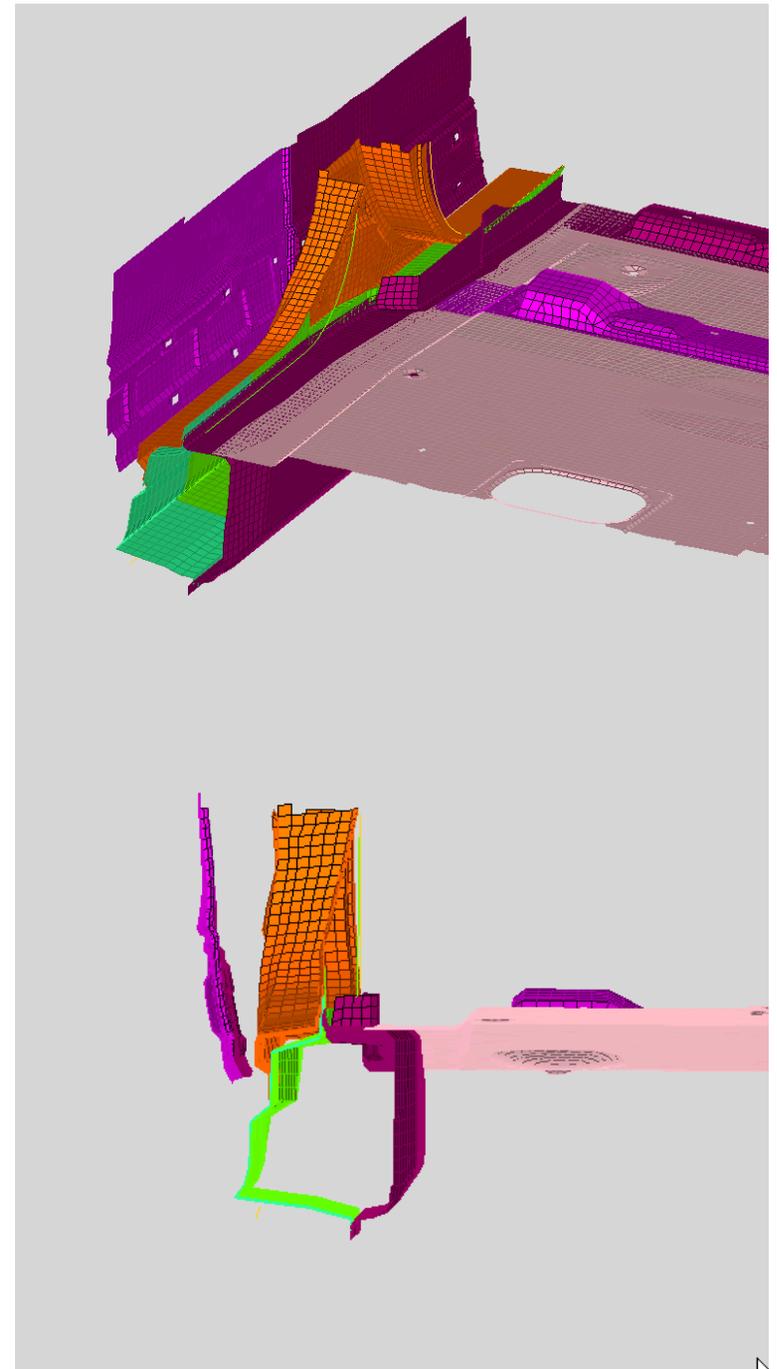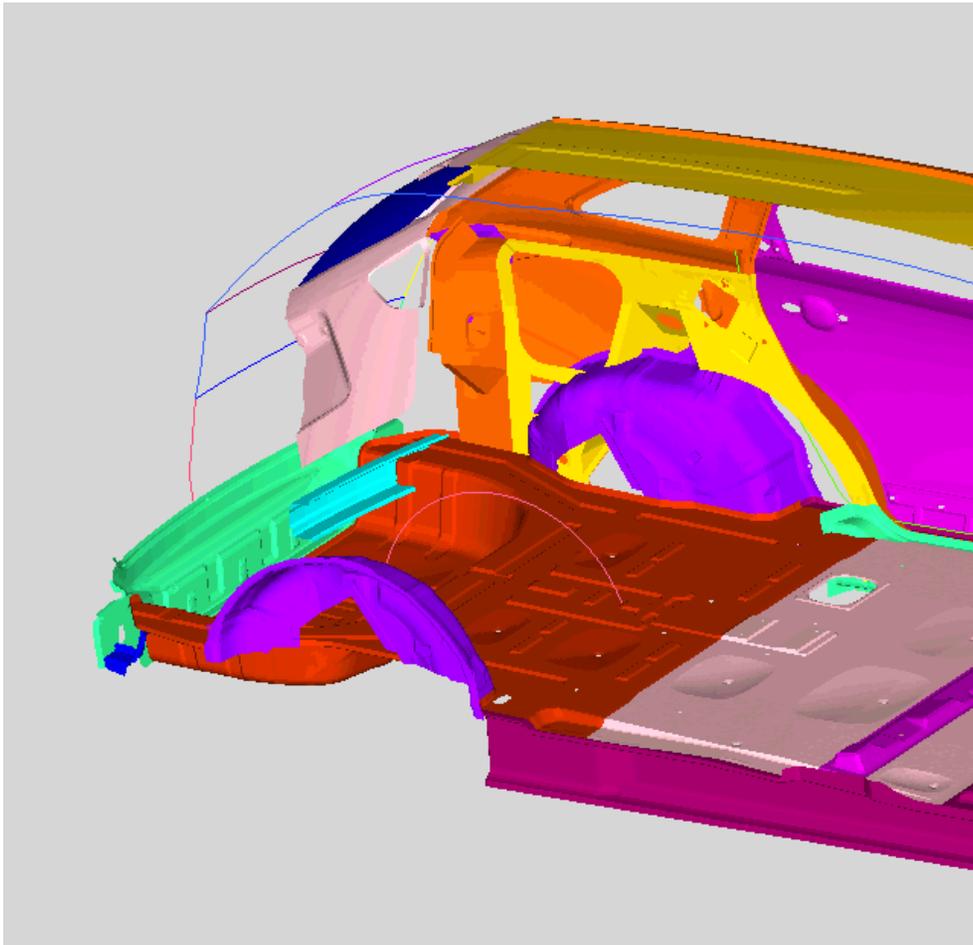- Rapid generation of designs

- Parametric models

CAD DESIGN

CAE MODELING

ANALYSIS (Crash, NVH, CFD etc.)

DETERMINE DESIGN ITERATION

ARE DESIGN TARGETS MET ?

NO

YES

FREEZE DESIGN

CAD IN THE LOOP IN THE ABOVE PROCESS

CAE MODELS NEED TO BE REBUILT EVERY ITERATION

NO. OF DESIGN ITERATIONS LIMITED

CONCEPT CAE MODEL THROUGH MORPHING

CAD GENERATED CAE MODEL

ANALYSIS (Crash, NVH, CFD etc.)

DOE & OPTIMIZATION

PARAMETRIC CAE MODEL

ARE DESIGN TARGETS MET ?

NO

YES

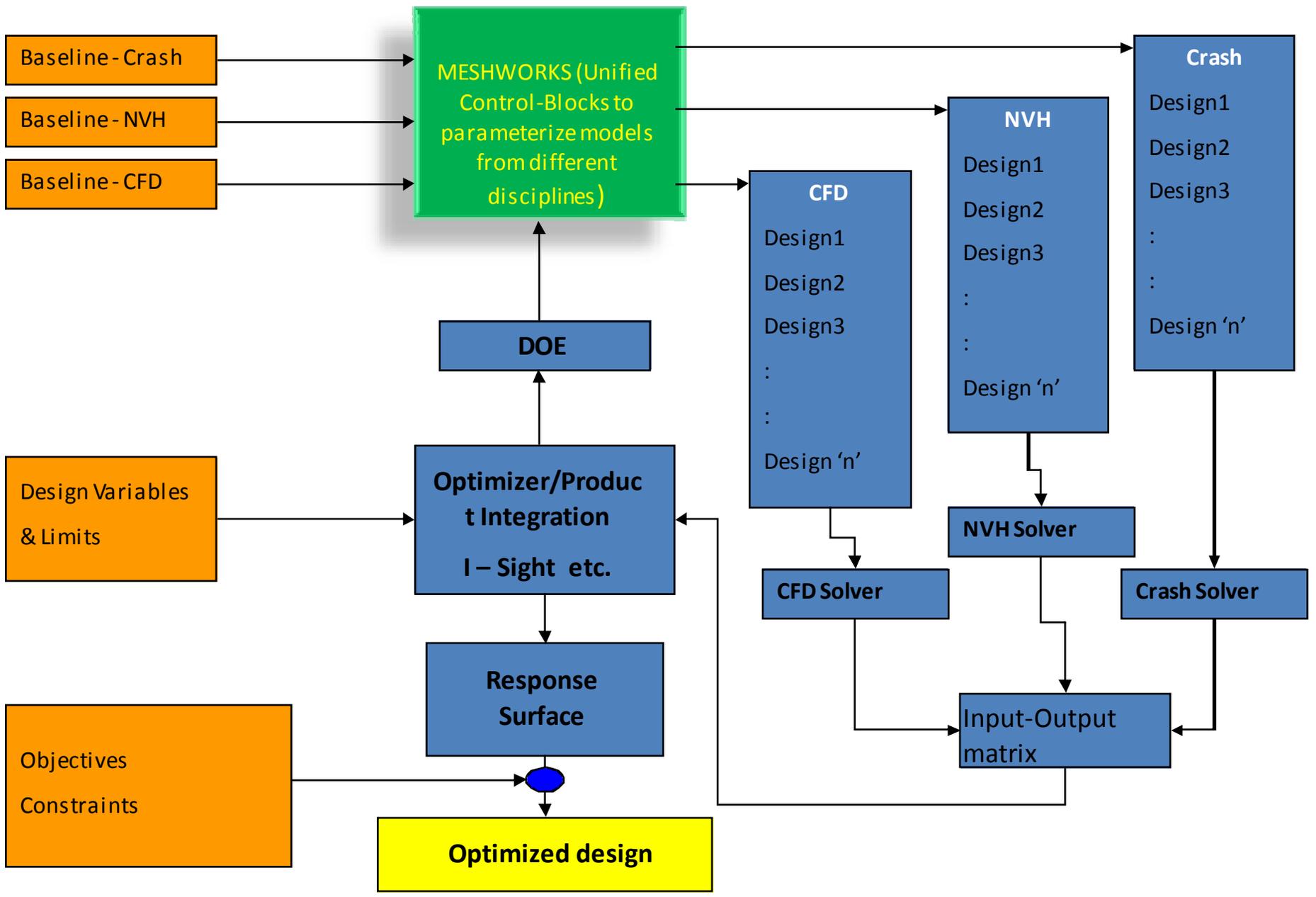CAD MORPHING

FREEZE DESIGN

VERY FAST AND ROBUST

RUNNABLE CAE MODELS AUTOMATICALLY GENERATED

HUNDREDS OF ITERATIONS POSSIBLE IN A WEEK

CAD MORPHING PROVIDES DESIGN DATA OF OPTIMIZED DESIGN

Smarter Solutions. Delivered.

DEP

PRECISE MATCHING TO CARRY OVER UNDERBODY

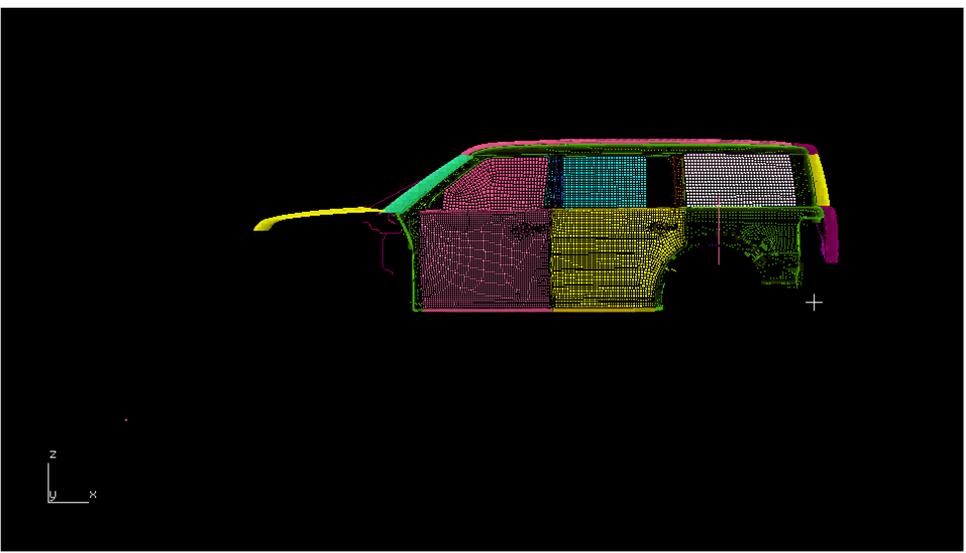*Smarter Solutions. Delivered.*

MULTI DISCIPLINARY OPTIMIZATION FLOW CHART

Smarter Solutions. Delivered.

Ford FLEX

MESHWORKS MORPHING

Lincoln MKT

DURABILITY

Smarter Solutions. Delivered.

NVH

Smarter Solutions. Delivered.

CRASH

Smarter Solutions. Delivered.
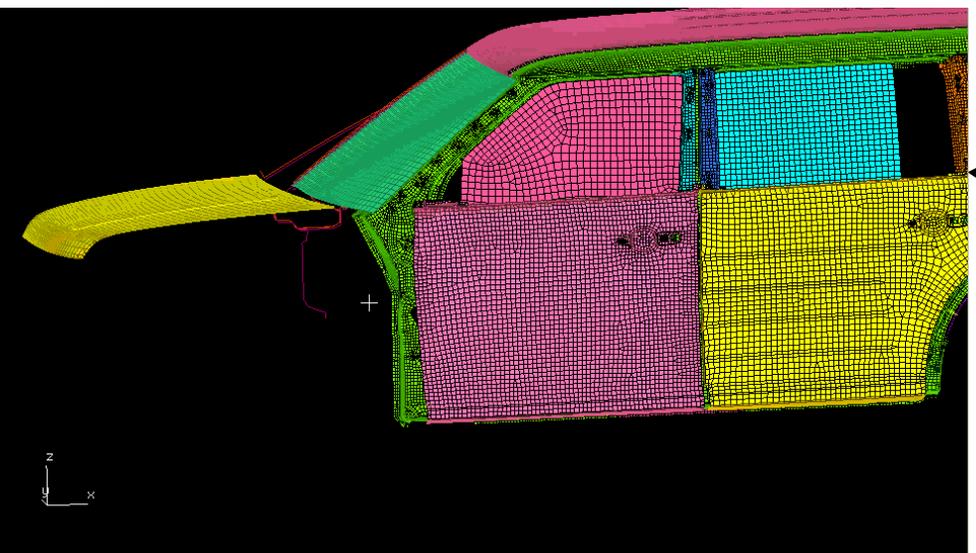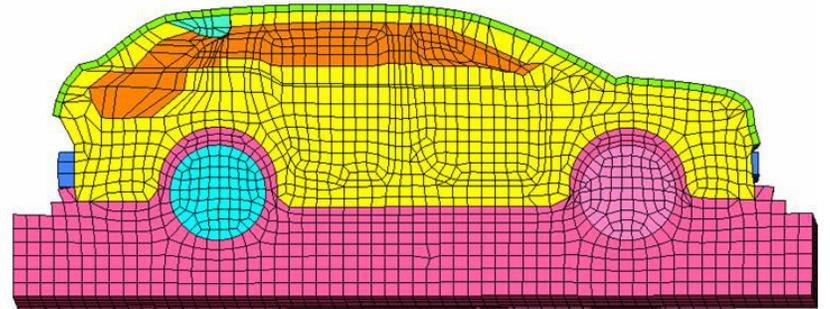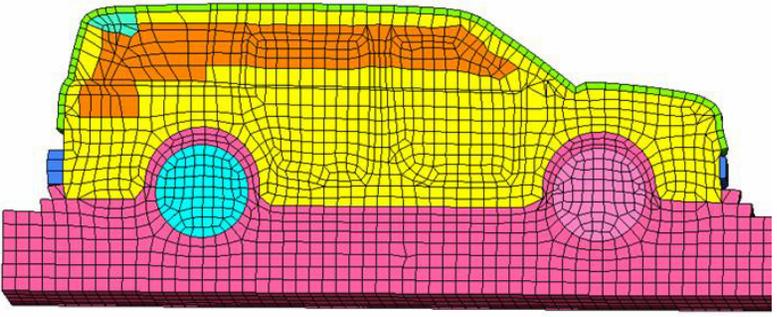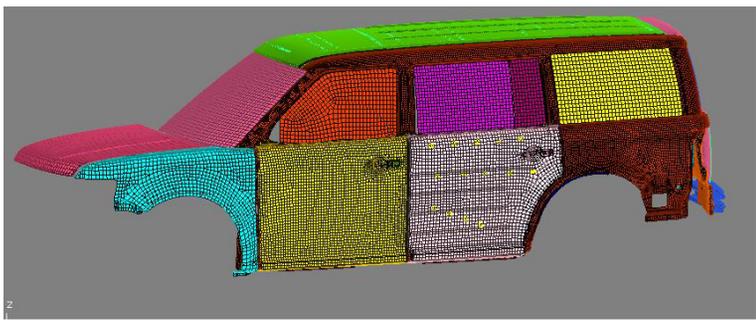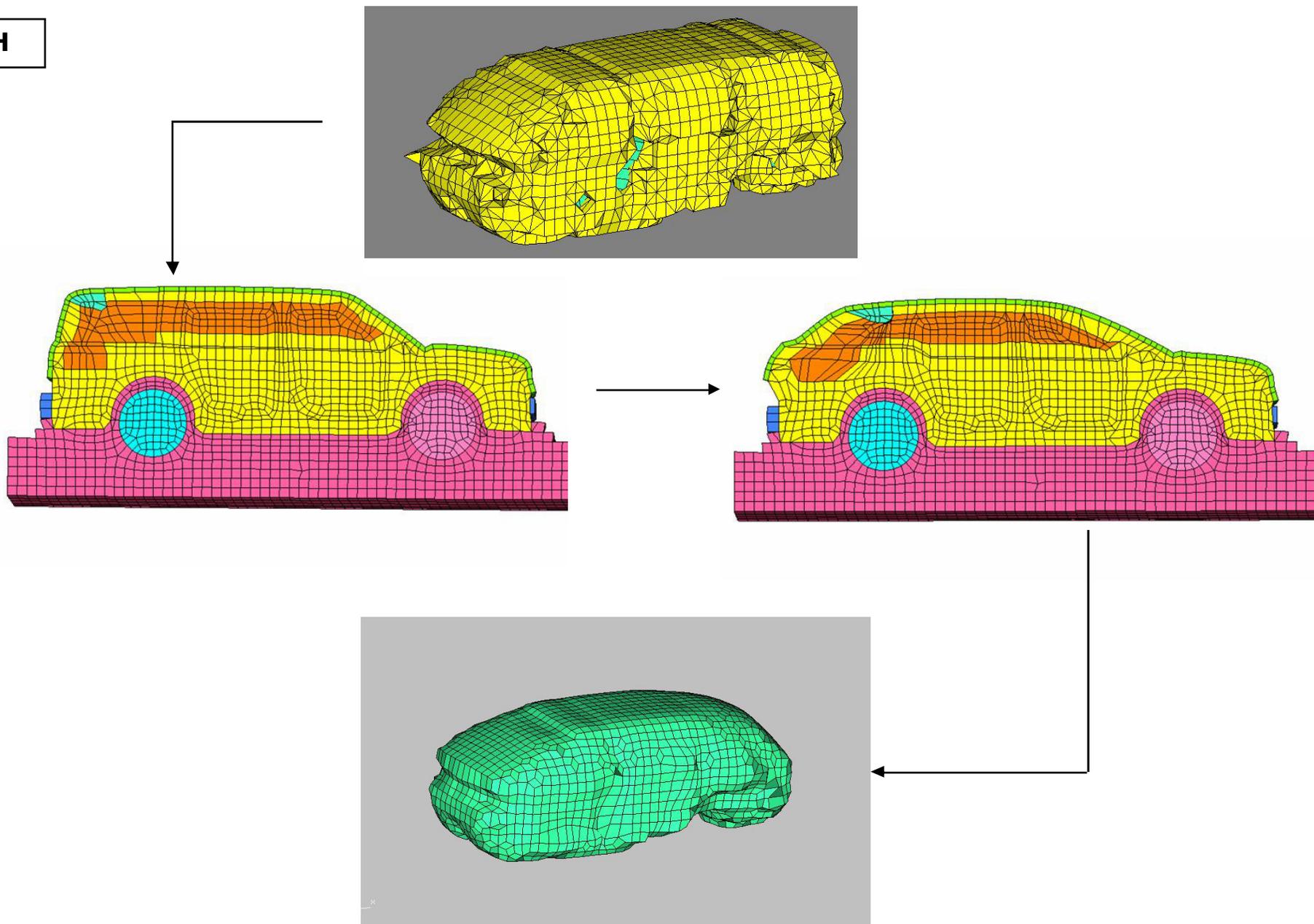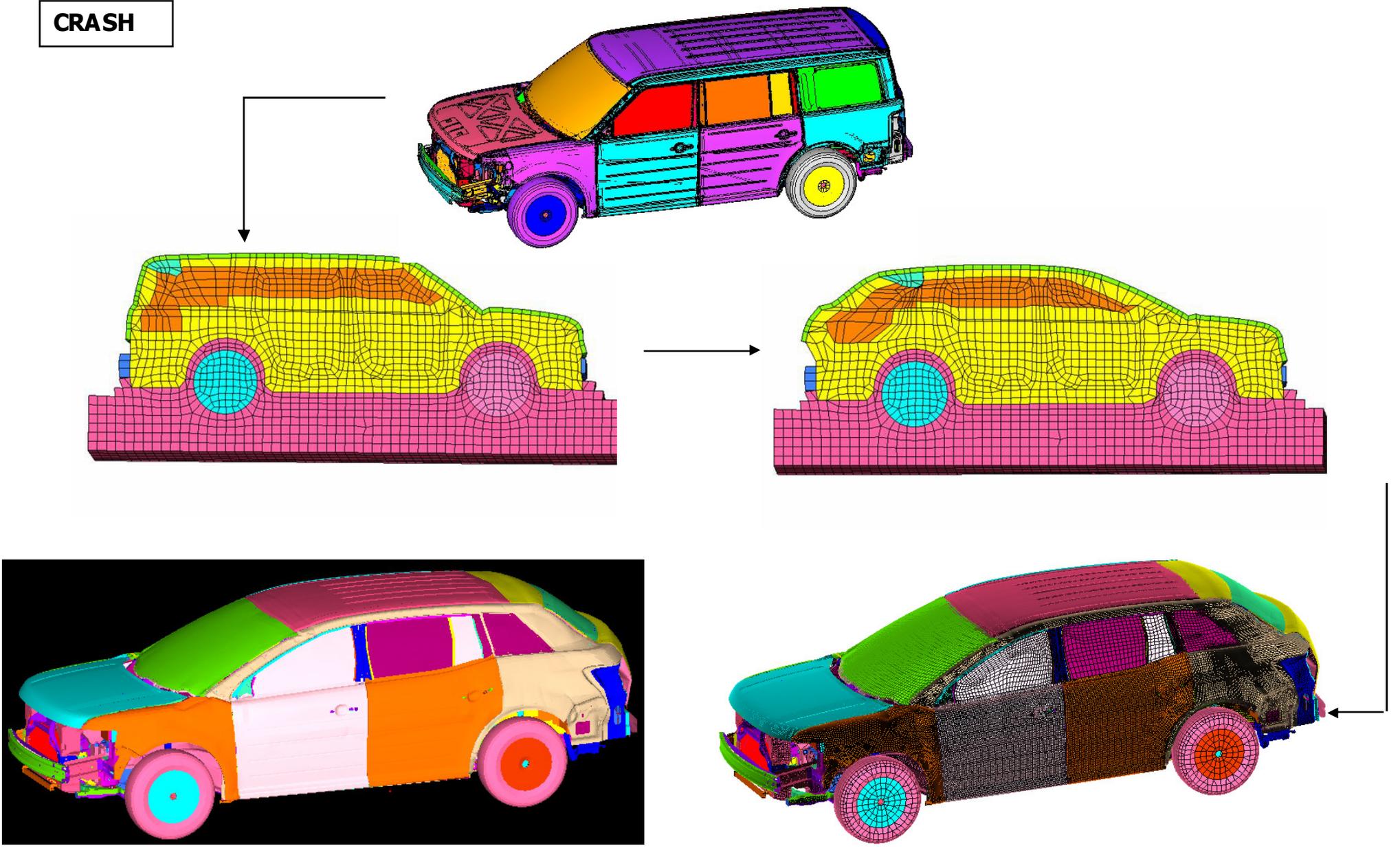
PARAMETRIZING CAE MODELS

Vehicle Dynamics
Model (ADAMS)

Crash Model
(LS-Dyna)

NVH Model
(Nastran-MD)

Durability Model
(Abaqus)

CFD Model (Fluent)

PARAMETRIZE THE MODELS

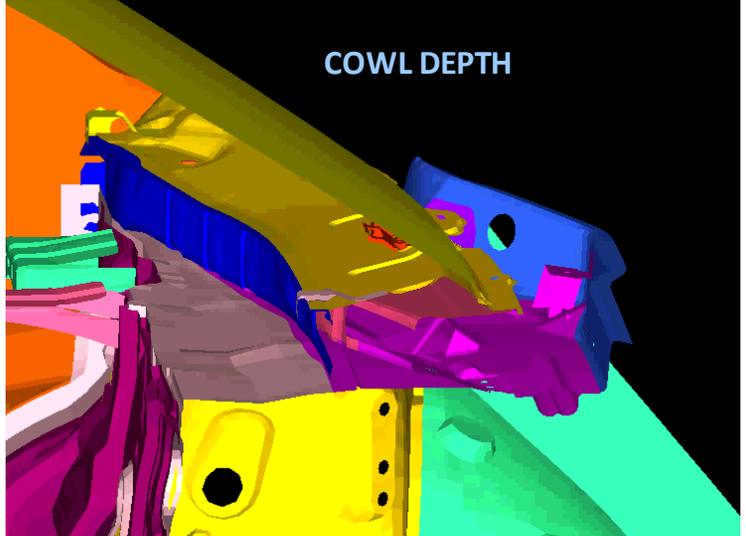- **SHAPE PARAMETERS**
- **STRUCTURAL PARAMETERS**
- **TOPOLOGY PARAMETERS**
- **WELD PARAMETERS**
- **FEATURE PARAMETERS**
- **GENERAL PARAMETERS**

UNIFIED
PARAMETRIC
CAE MODELS

Smarter Solutions. Delivered.

DEP
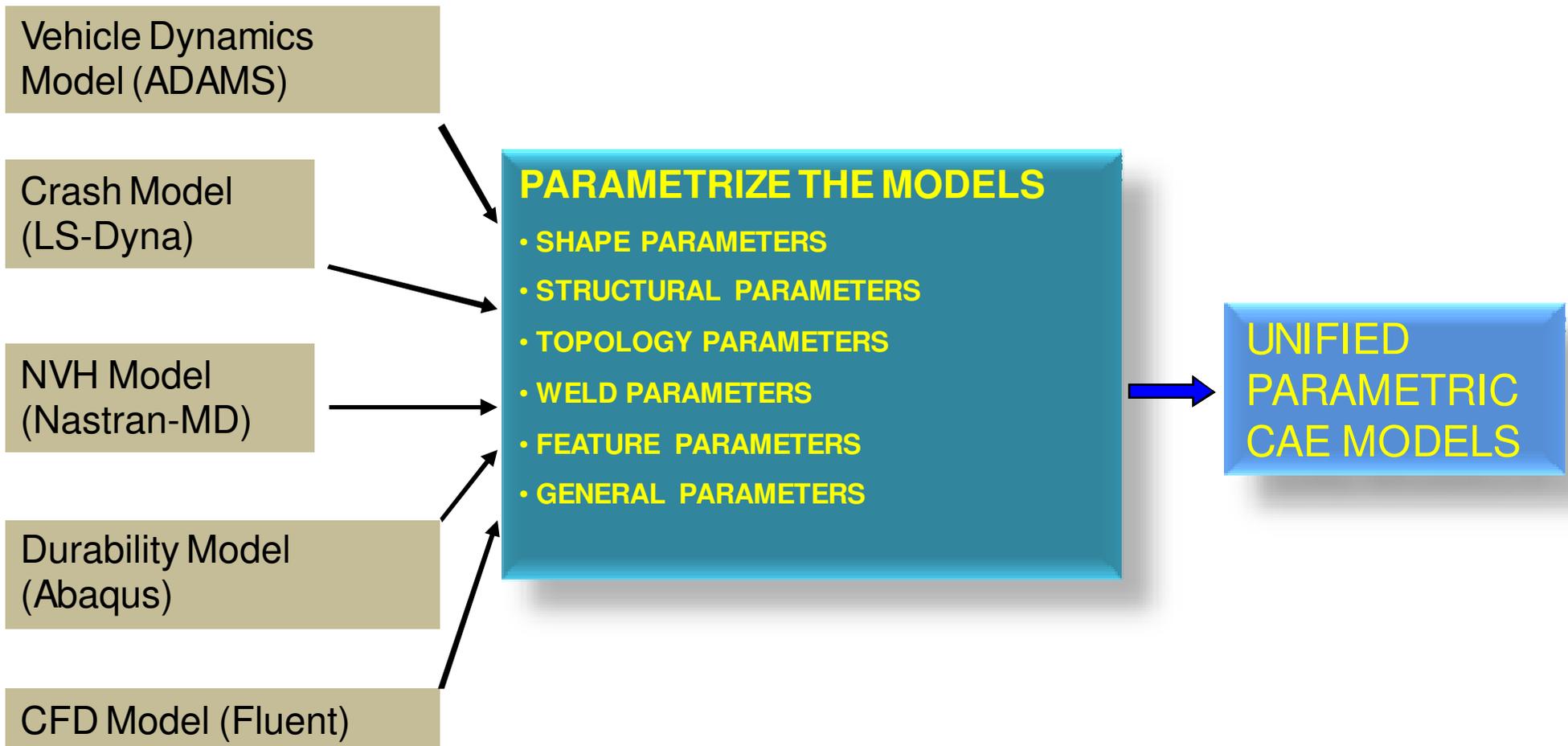
Shape parameters representing every section of the vehicle

FRONT RAIL WIDTH

B PILLAR WIDTH

COWL DEPTH

RAIL DEPTH

ROCKER WIDTH

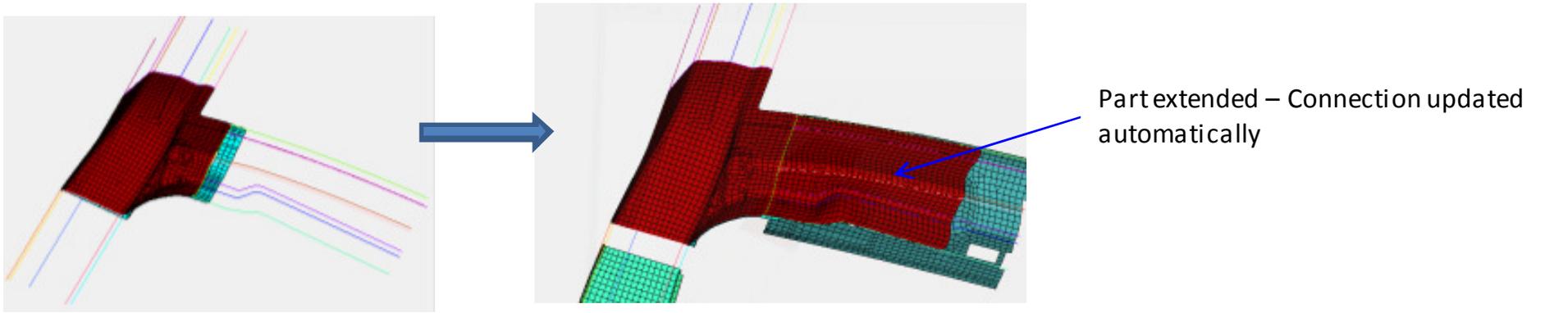*Smarter Solutions. Delivered.*

DEP
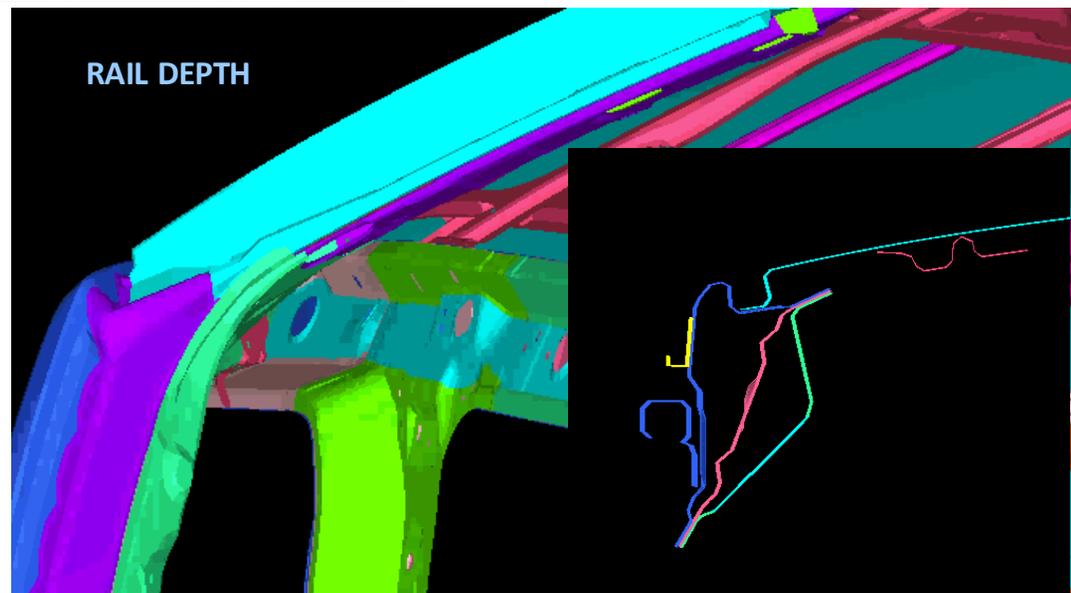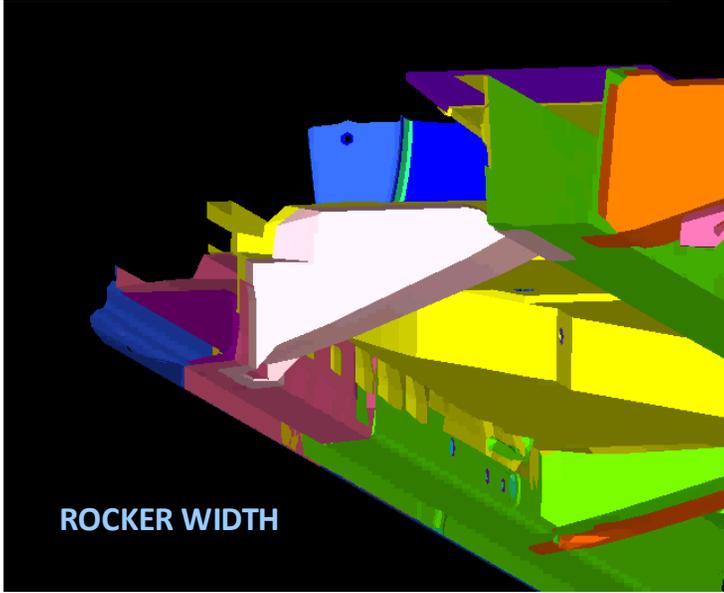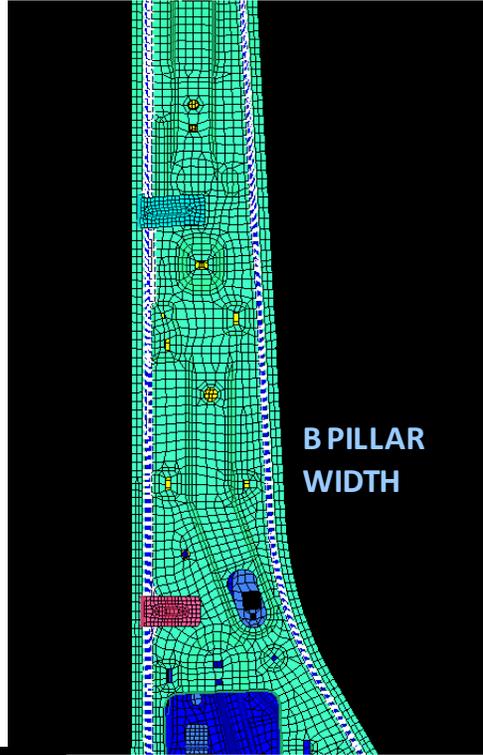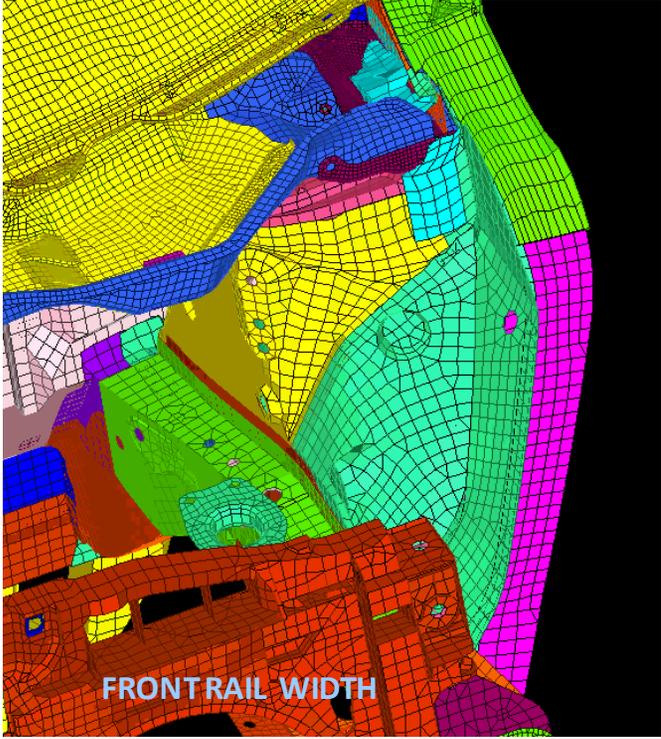
MeshWorks Design Enabler Tools
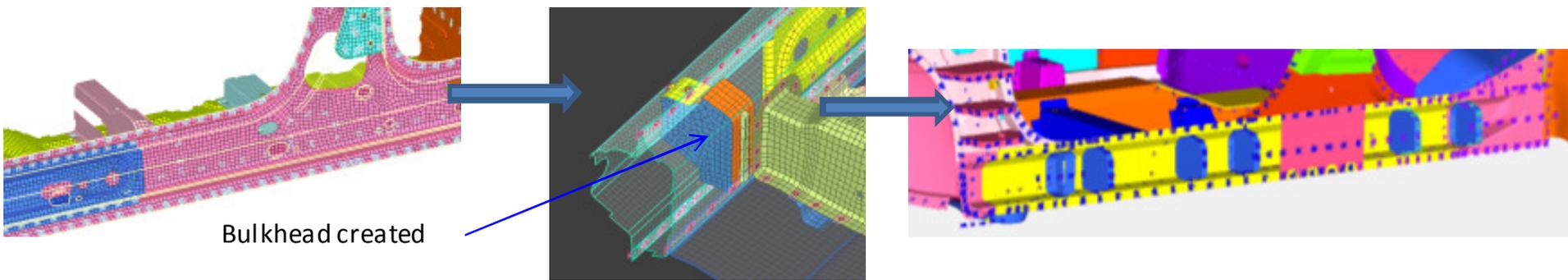
Bulkhead created

BIW / Chassis : Bulkhead creation – Location and Number of bulkheads can be a parameter. No CAD required
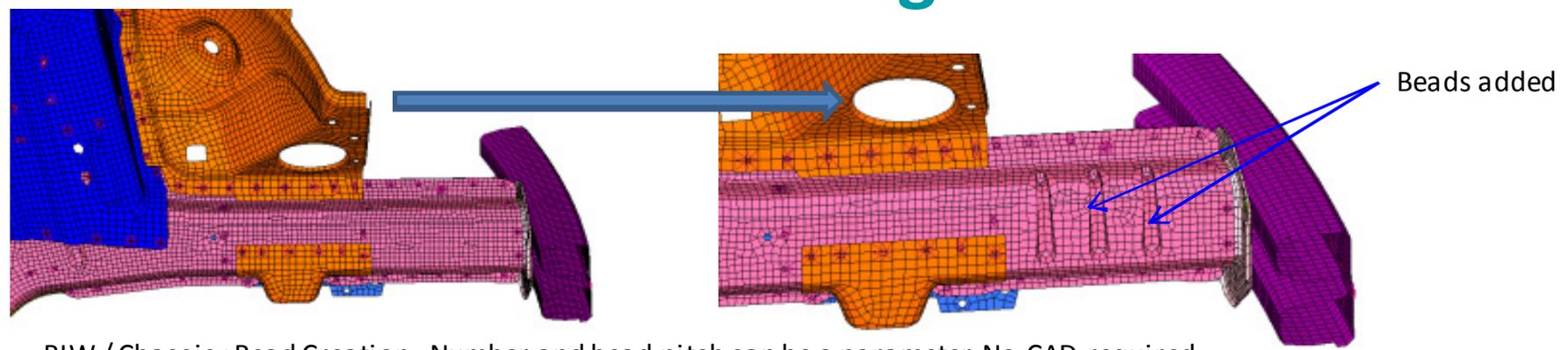

Doubler w/flange or w/o flange
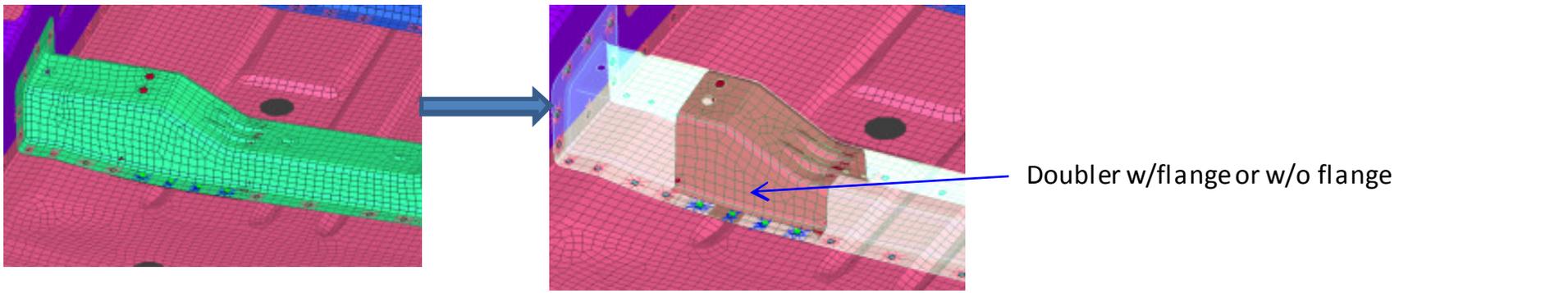
BIW / Chassis : Creation of Doubler – Length and number of doubler is a parameter. No CAD required

Part extended – Connection updated automatically

BIW (Joint) : Part Extension – Length/Span of extension is a parameter. No CAD required.
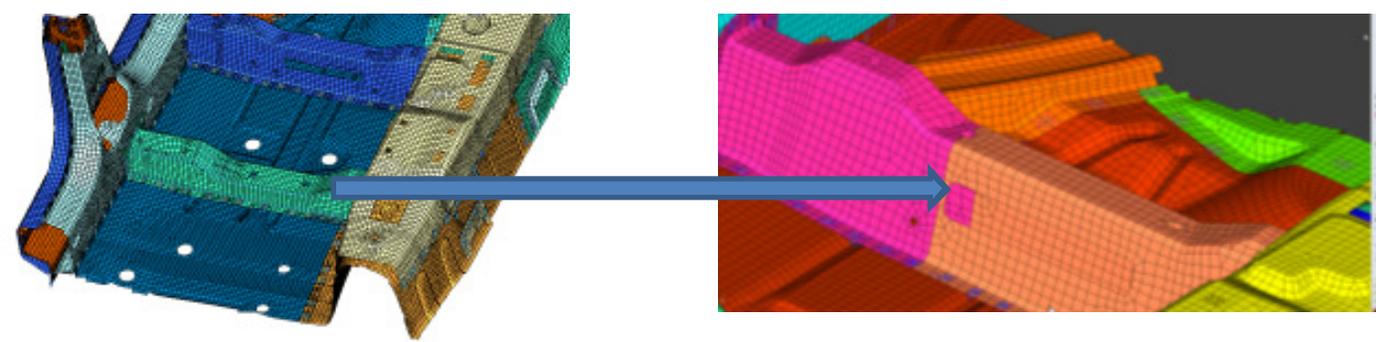
Smarter Solutions. Delivered.

DEP

MeshWorks Design Enabler Tools

Beads added

BIW / Chassis : Bead Creation–Number and bead pitch can be a parameter. No CAD required

Cross member moved and connections updated automatically
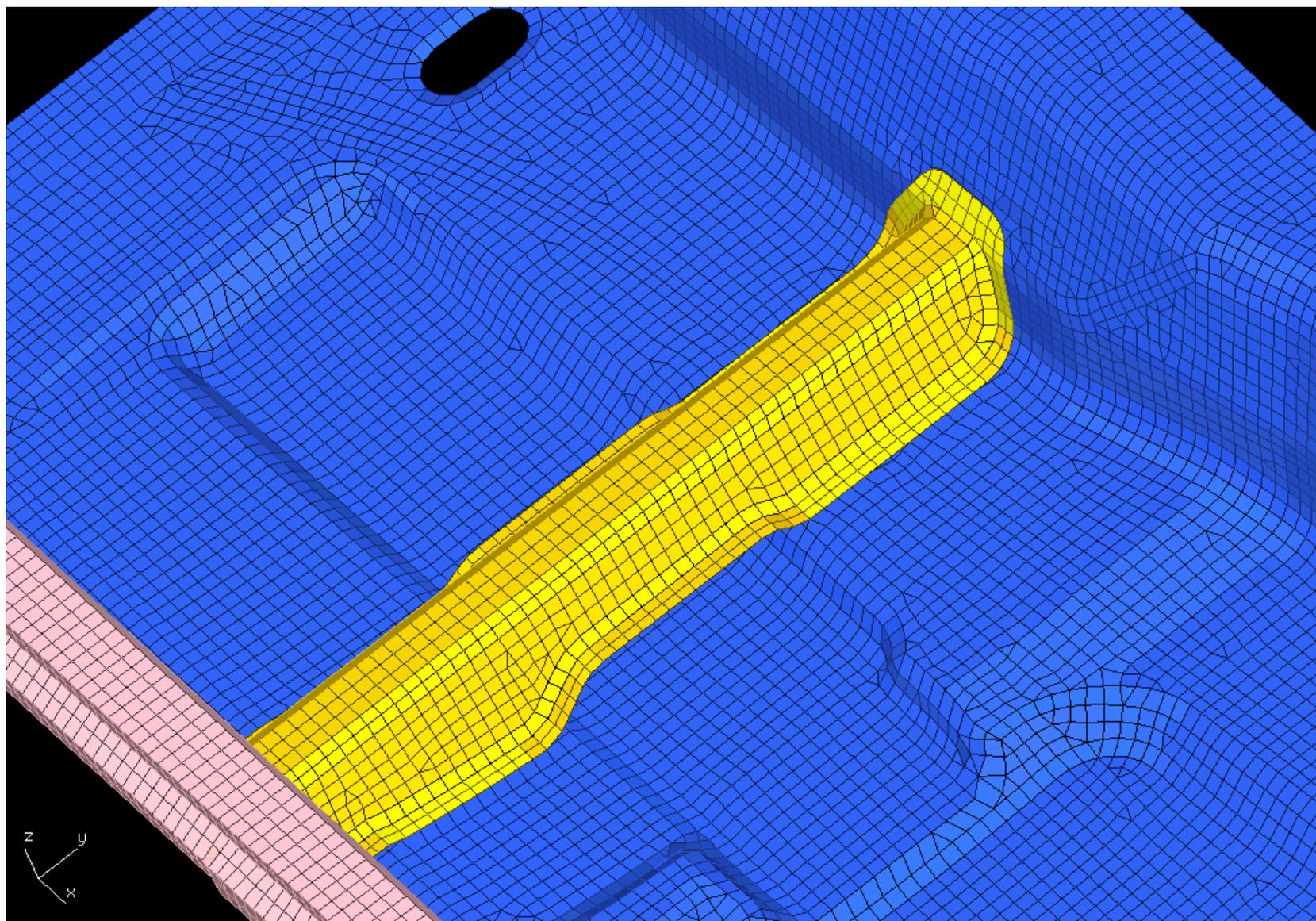
Insert new cross member
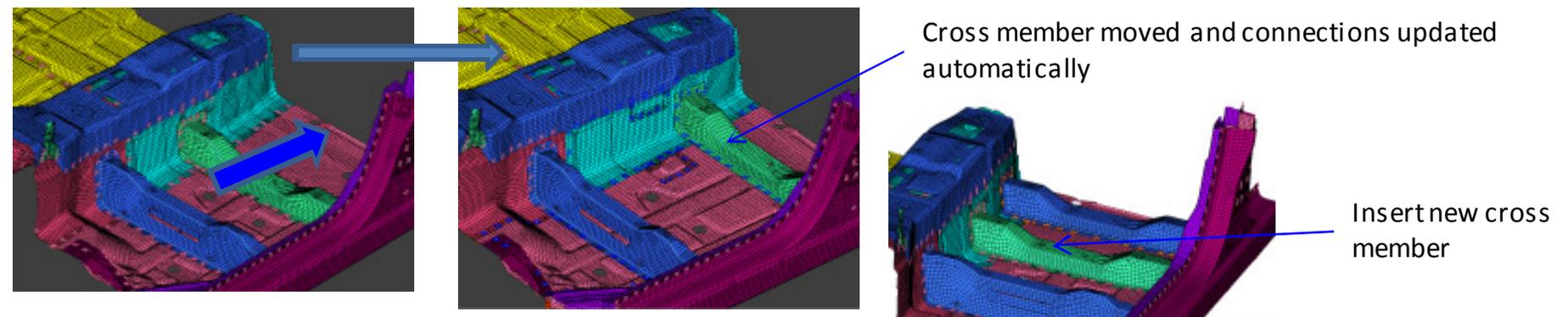
BIW / Chassis : Topology Parameter – Location of cross member can be a parameter. No CAD required
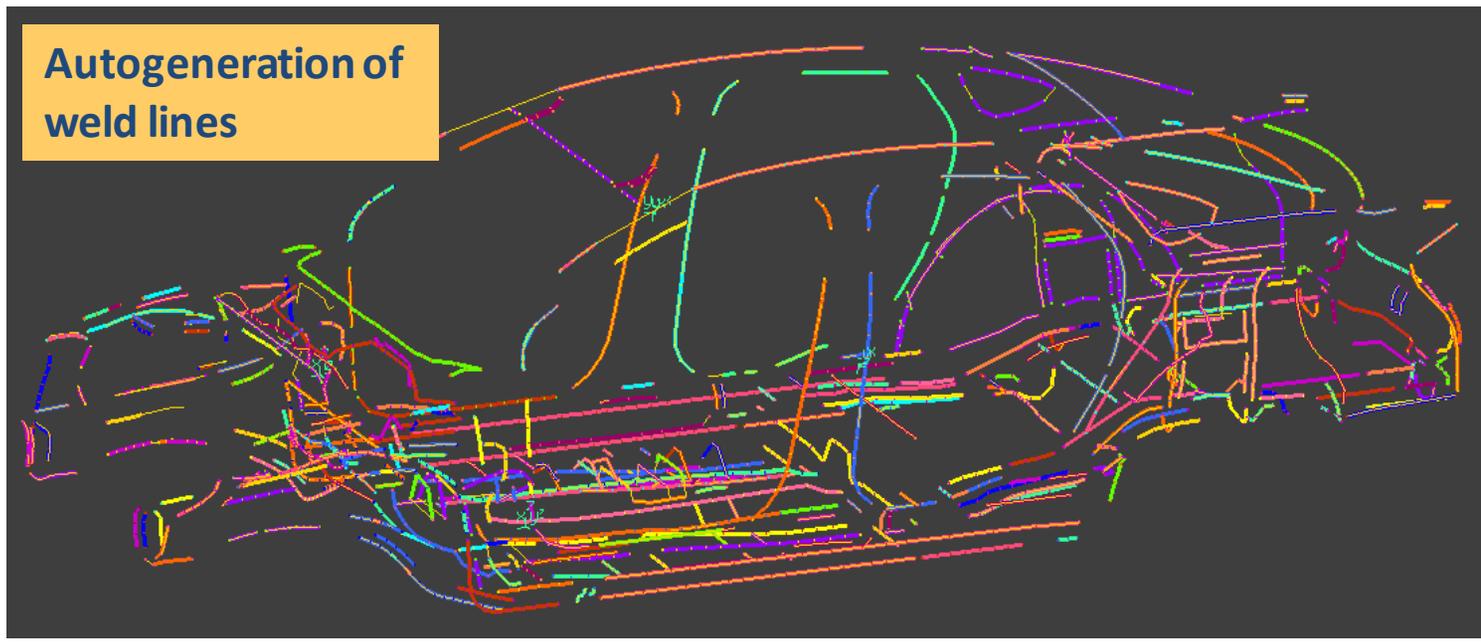
BIW / Chassis : Tailor Welded (TW) Parameter – Existing Cross member to TW and parameterize the span. No CAD required
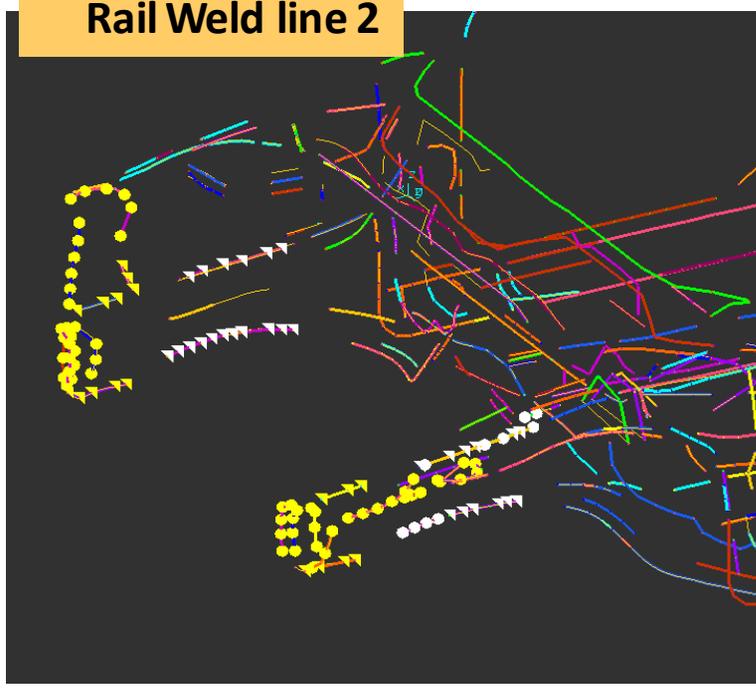
Smarter Solutions. Delivered.
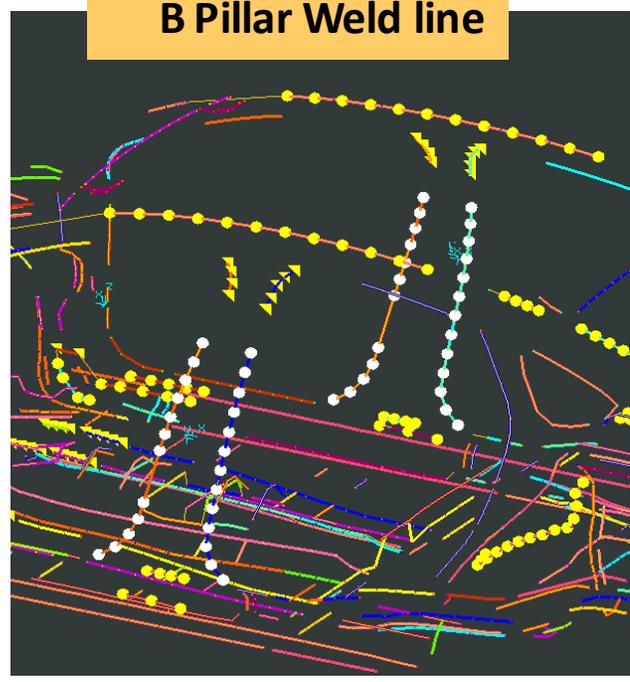
DEP

Topology Parameter

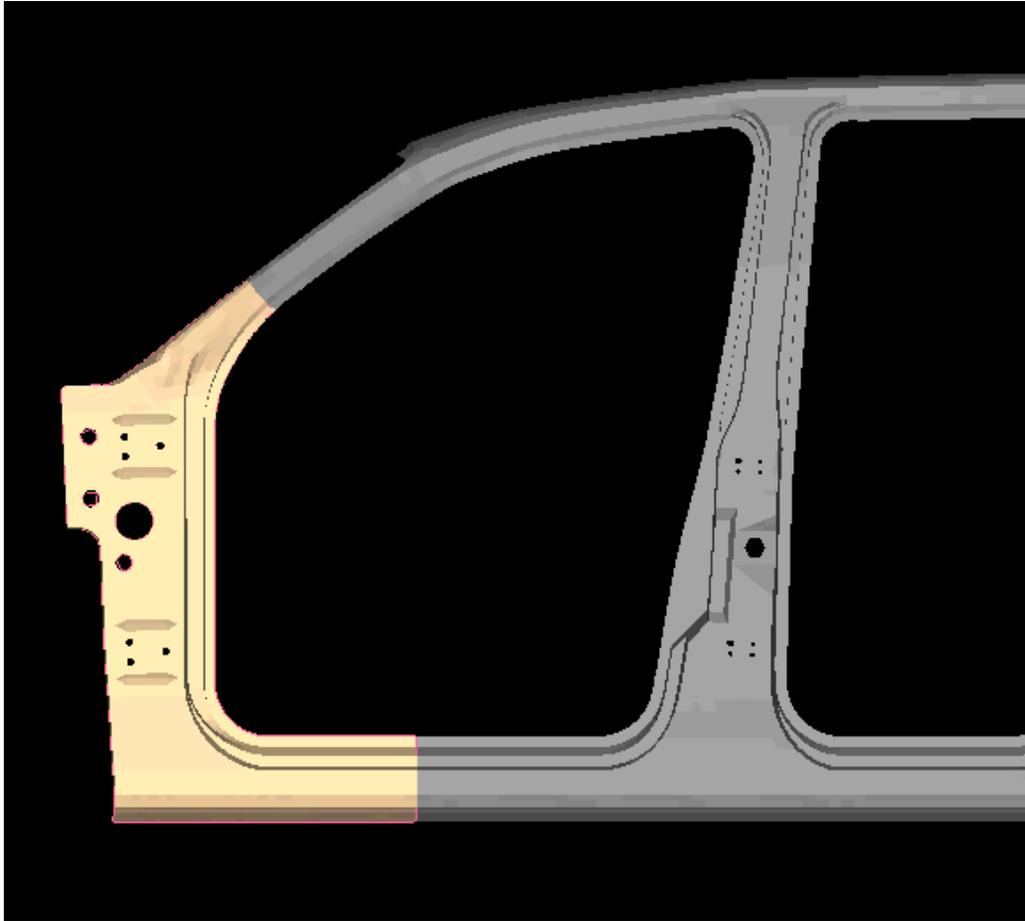*Smarter Solutions. Delivered.*

Autogeneration of weld lines

Rail Weld line 2

B Pillar Weld line

Rear Wheel well

Smarter Solutions. Delivered.

DEP
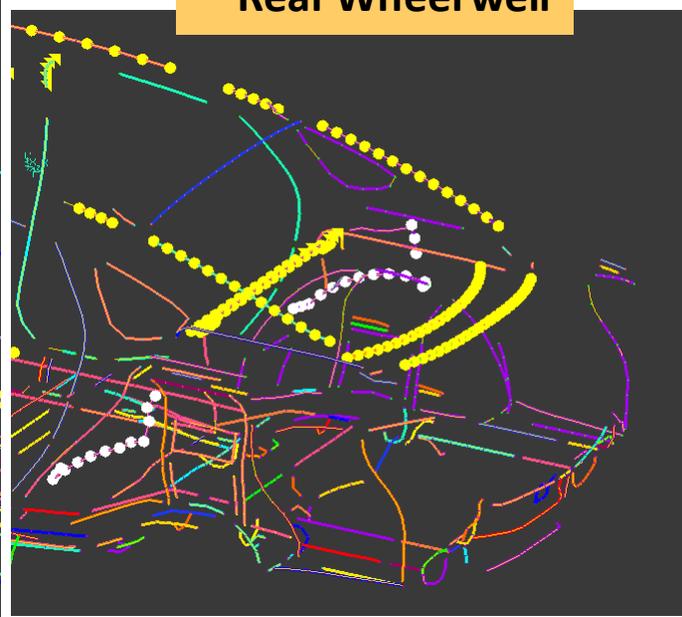
Tailor Welded blank line location as a parameter

Part Extension as a parameter

Smarter Solutions. Delivered.
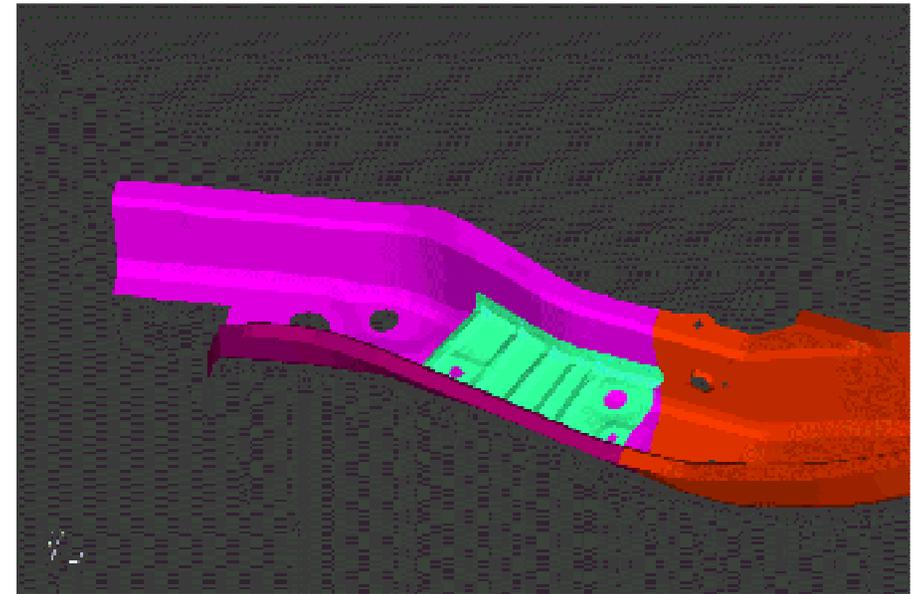
'CUT, MORPH & STITCH' – EARLY STAGE CONCEPT MODELING USING MESHWORKS SEDAN TO SUV

CUT SEDAN USING CUTTER

CUT SUV USING CUTTER

MORPH CUT SUV TO MATCH CUT SEDAN

AUTO-STITCH & AUTO-REMESH

Smarte

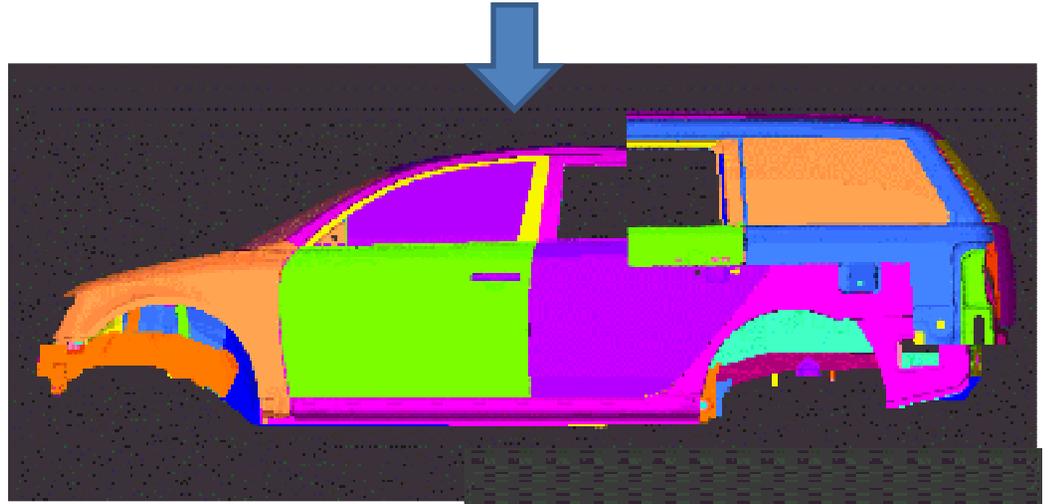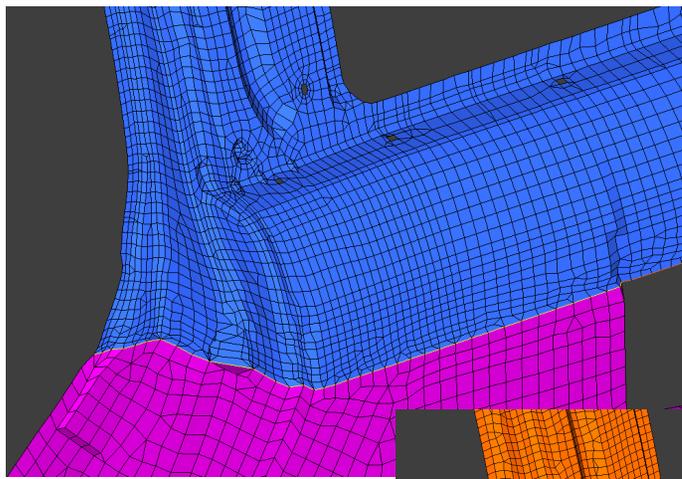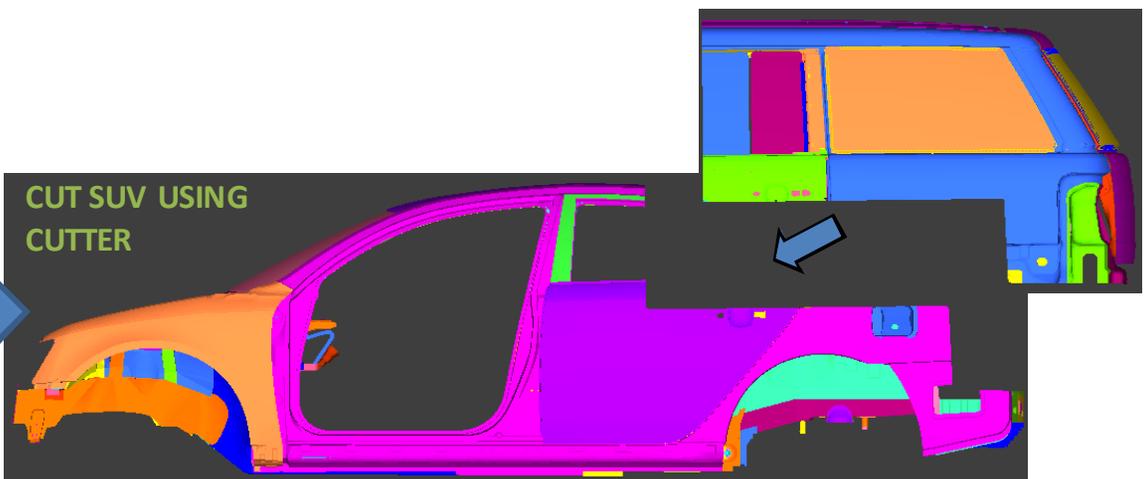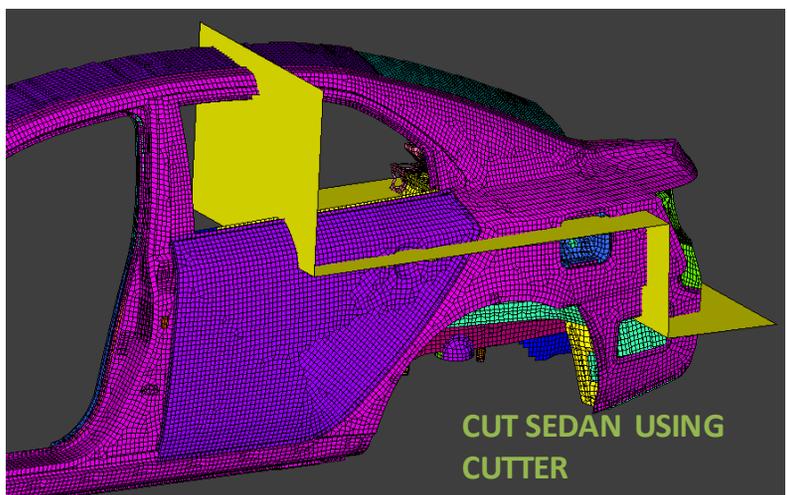# MeshWorks Application - Automotive – Power train
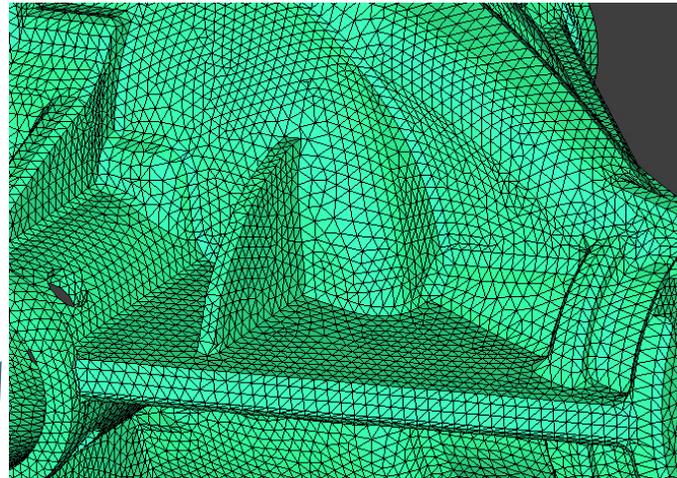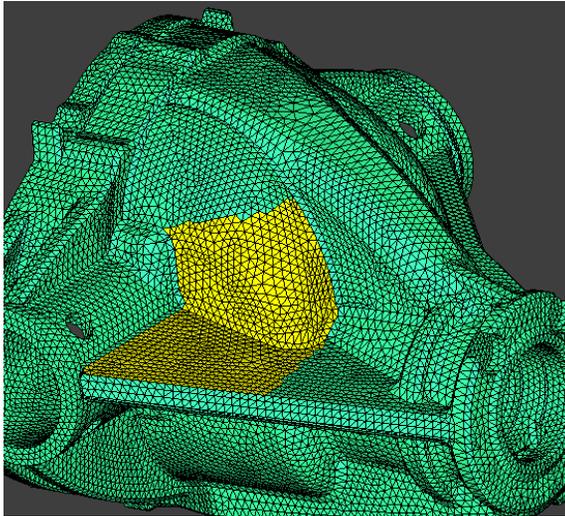
Tetra Rib without Fillets created in MeshWorks without CAD
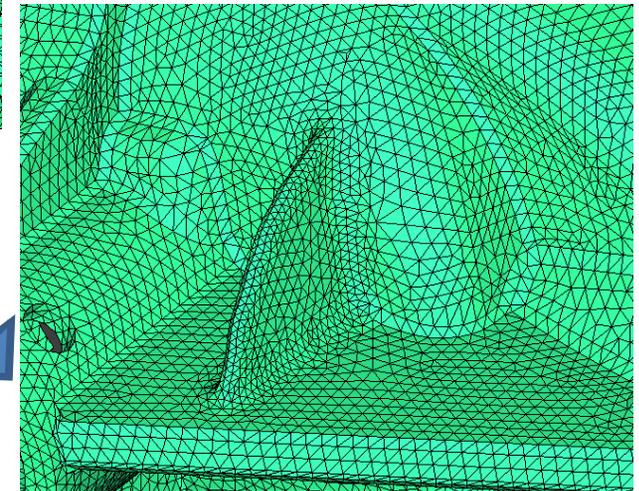
Tetra Rib inserted With Fillets

❖ Rib inserted directly in a FEA model

❖ "User" can sketch the rib "on screen".

❖ Possible to Control "mesh size" at fillet

❖ No input CAD required, works on higher order tetra mesh

❖ Number of ribs can be a "Parameter"..

Smarter Solutions. Delivered.

DEP

MeshWorks Application - Automobile
- Power train
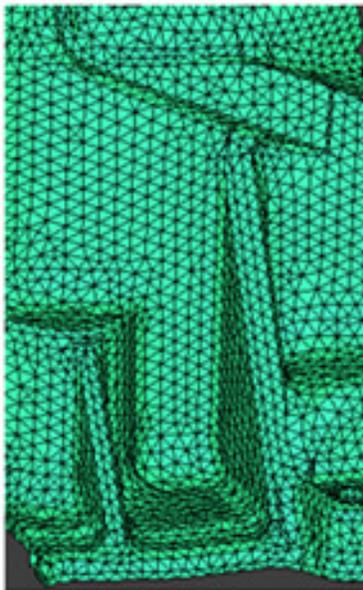
Input
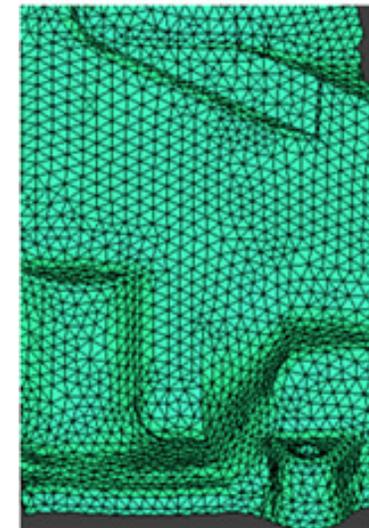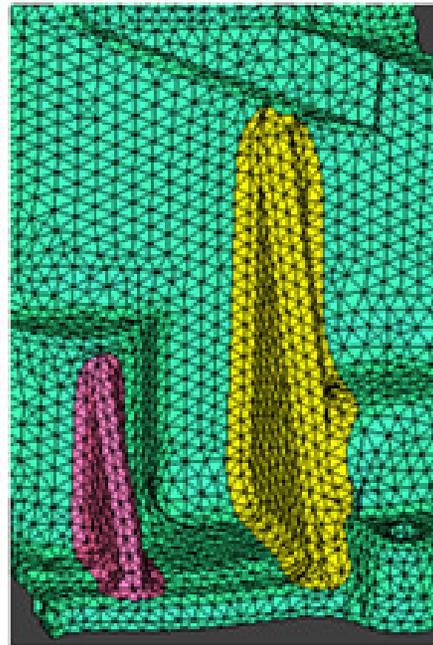
Output

❖ Selected Stiffener removed from the FE model

❖ Plastered and Tetrahedral mesh recreated

❖ No CAD input needed. Works on higher order tetra mesh

Smarter Solutions. Delivered. **DEP**

CAD MORPHING TO HAND SHAKE WITH DESIGN GROUP

Smarter Solutions. Delivered.
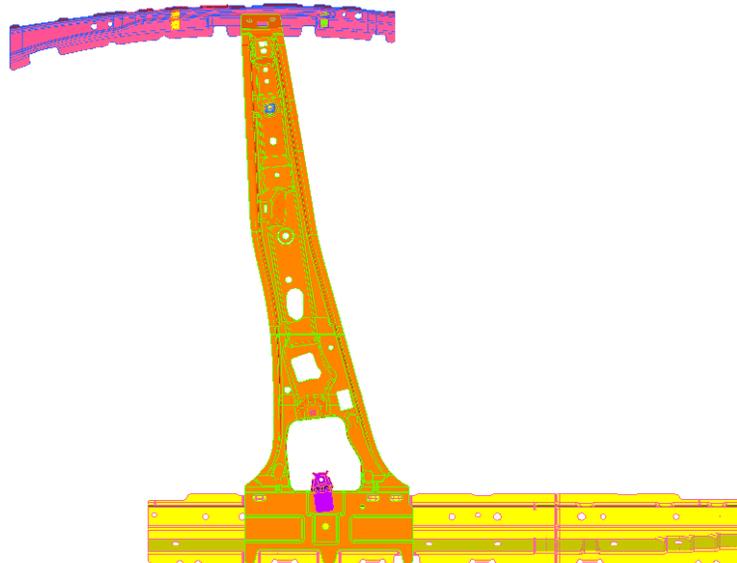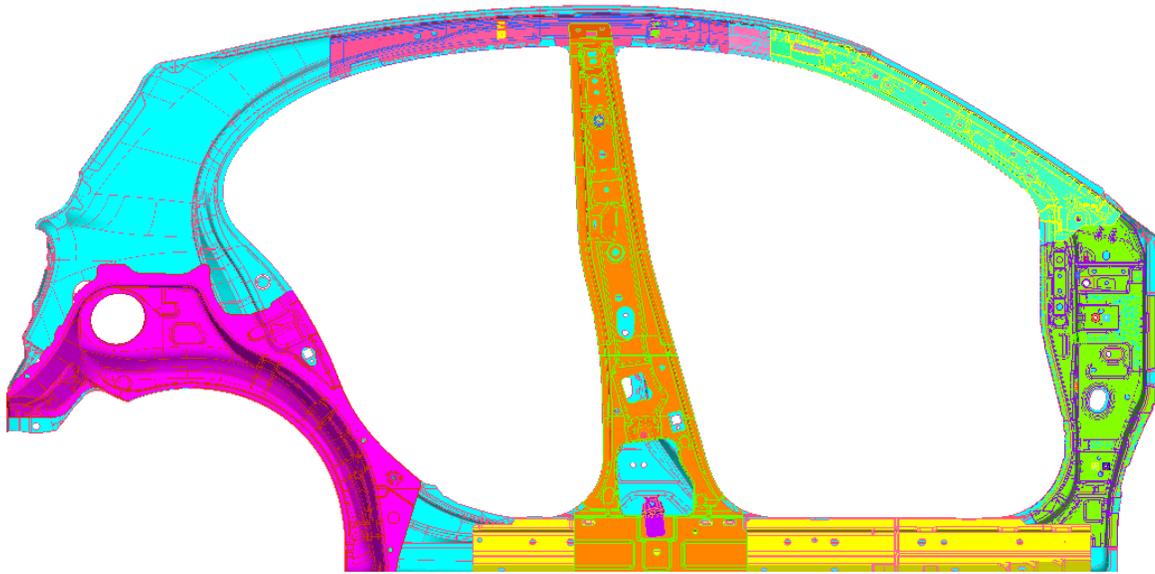
FULL VEHICLE OPTIMIZATION

Objective :

Mass reduction without performance degradation

Outcome:

35 kg weight reduction while meeting all constraints from full vehicle. Most reduction from Body In White (BIW).

Performance Comprehended :

Crash Analysis
Normal Modes
Stiffness
Frequency Response
Aero drag

DoE, RSM and Optimization.

Role of MeshWorks:

Parameterize Crash, NVH, Aero models.
Parameters included Shape and Gage for Body In White Structure.

Smarter Solutions. Delivered.

DEP
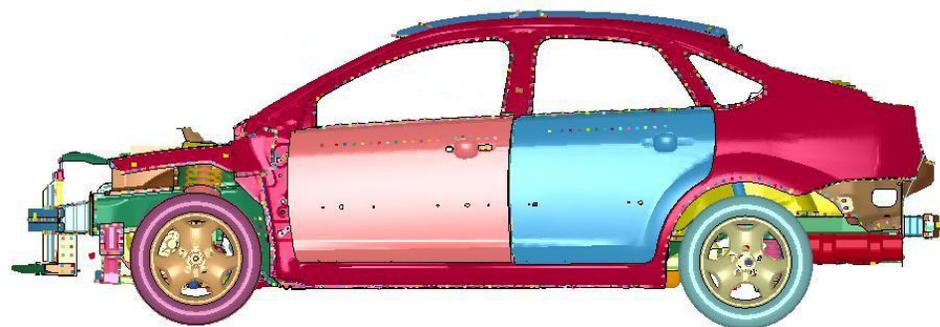
DEP MeshWorks

- Over **50% reduction** in Finite Element Model building time

- Rapid conversion of FE models to intelligent parametric FE models

- Parameter and non parametirc based optimization studies.

- Multi-Disciplinary Optimization to reduce significant **WEIGHT** and **COST**

- Rapidly Morphed CAD models representing optimized designs
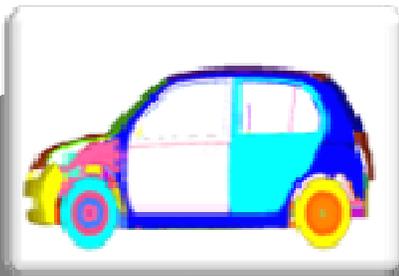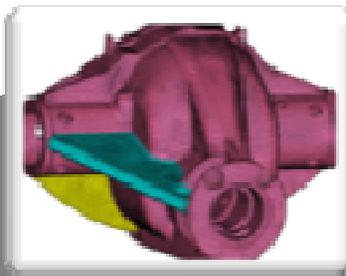
Rapid Morphing   **Parameterization / Topology**   **M D O**   **CAD Morphing**

Conv. Process

Pre-Production Design Engineering | Production Engineering

| 6 Mo* | 6 Mo | 1Mo | 6 Mo | 12 Mo | 18 Mo |

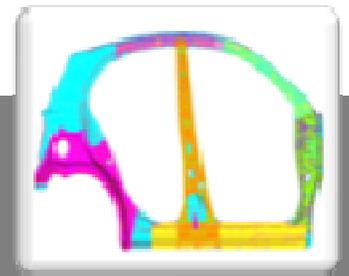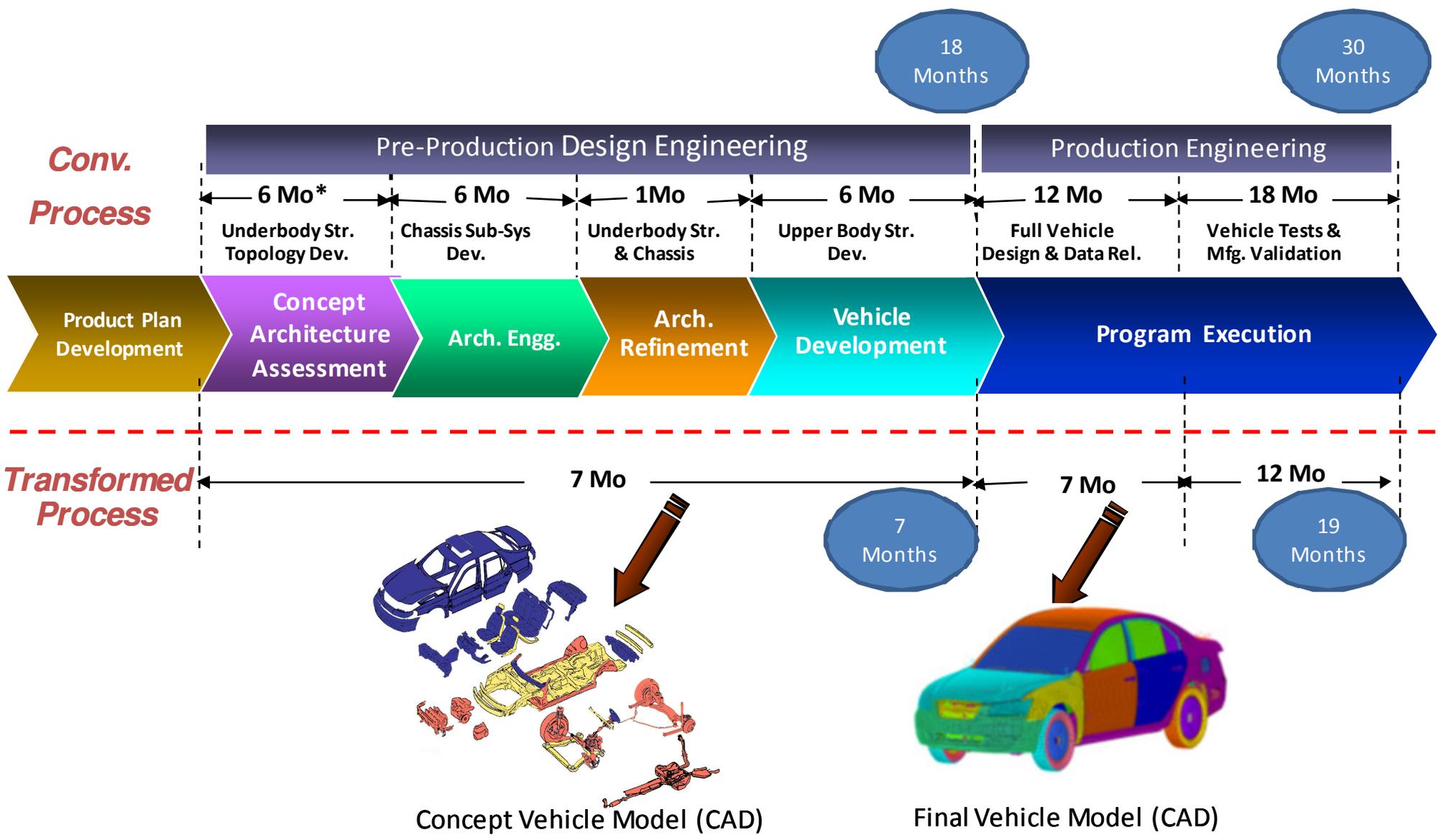Underbody Str. Topology Dev. | Chassis Sub-Sys Dev. | Underbody Str. & Chassis | Upper Body Str. Dev. | Full Vehicle Design & Data Rel. | Vehicle Tests & Mfg. Validation

Product Plan Development → Concept Architecture Assessment → Arch. Engg. → Arch. Refinement → Vehicle Development → Program Execution

18 Months | 30 Months

Transformed Process

7 Mo | 7 Mo | 12 Mo

7 Months | 19 Months

Concept Vehicle Model (CAD)

Final Vehicle Model (CAD)

45 % - 50% time savings compared to traditional approach.

Smarter Solutions. Delivered.

DEP

Niju Nair

Account Manager

Detroit Engineered Products

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Email   :   niju_n@depusa..com

Web   :   www.depusa.com

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