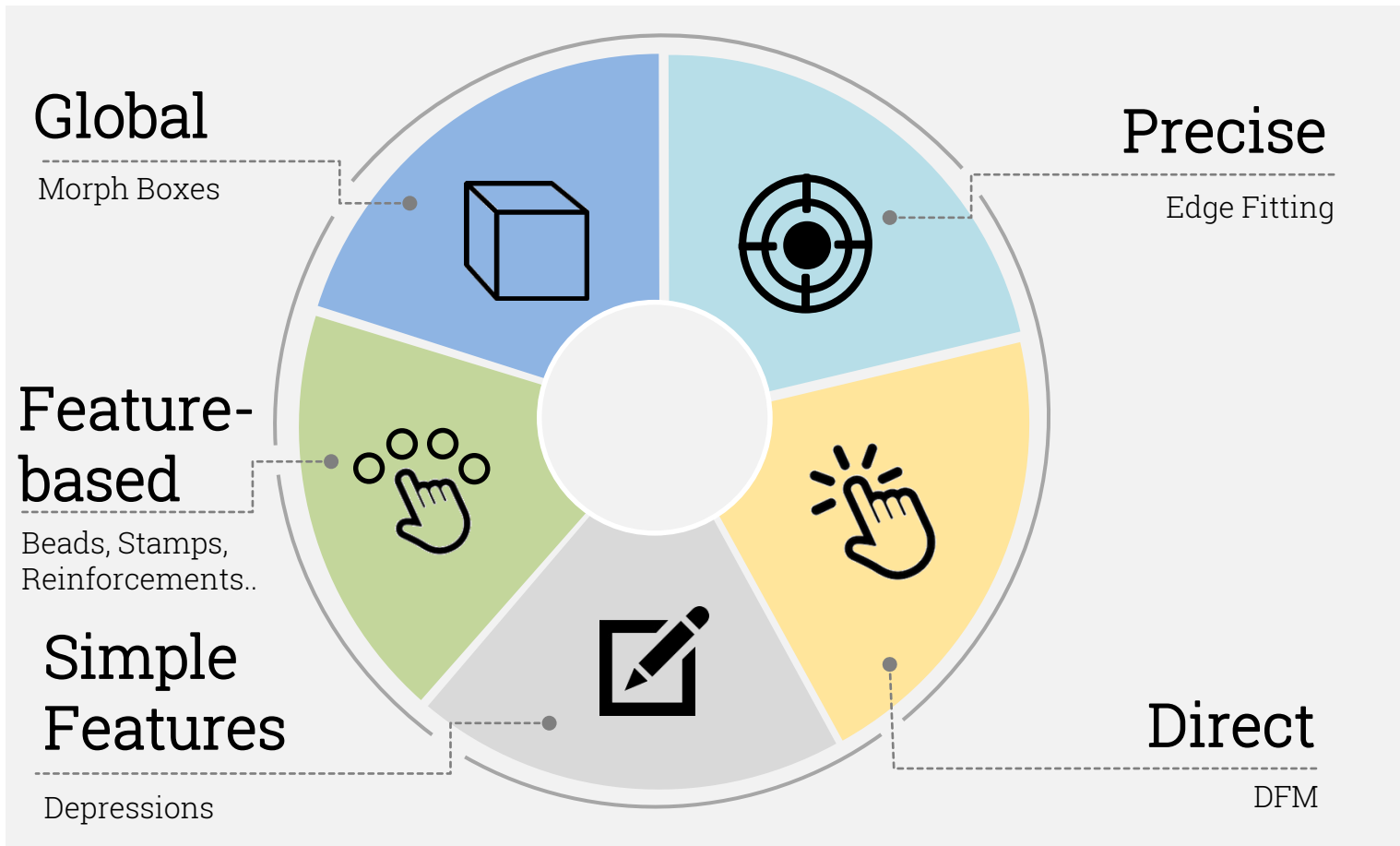


Feature based morphing: A radical change in concept and detailed modeling

Eva Ioannou, George Korbetis
BETA CAE Systems SA

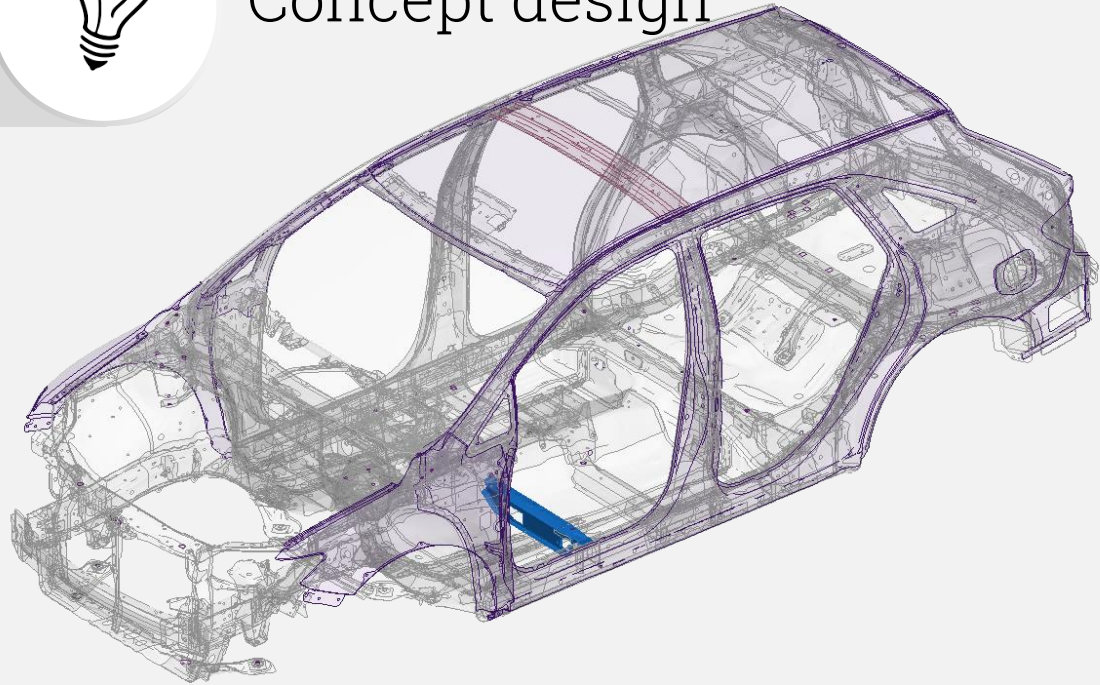
Lifeline



01



Concept design

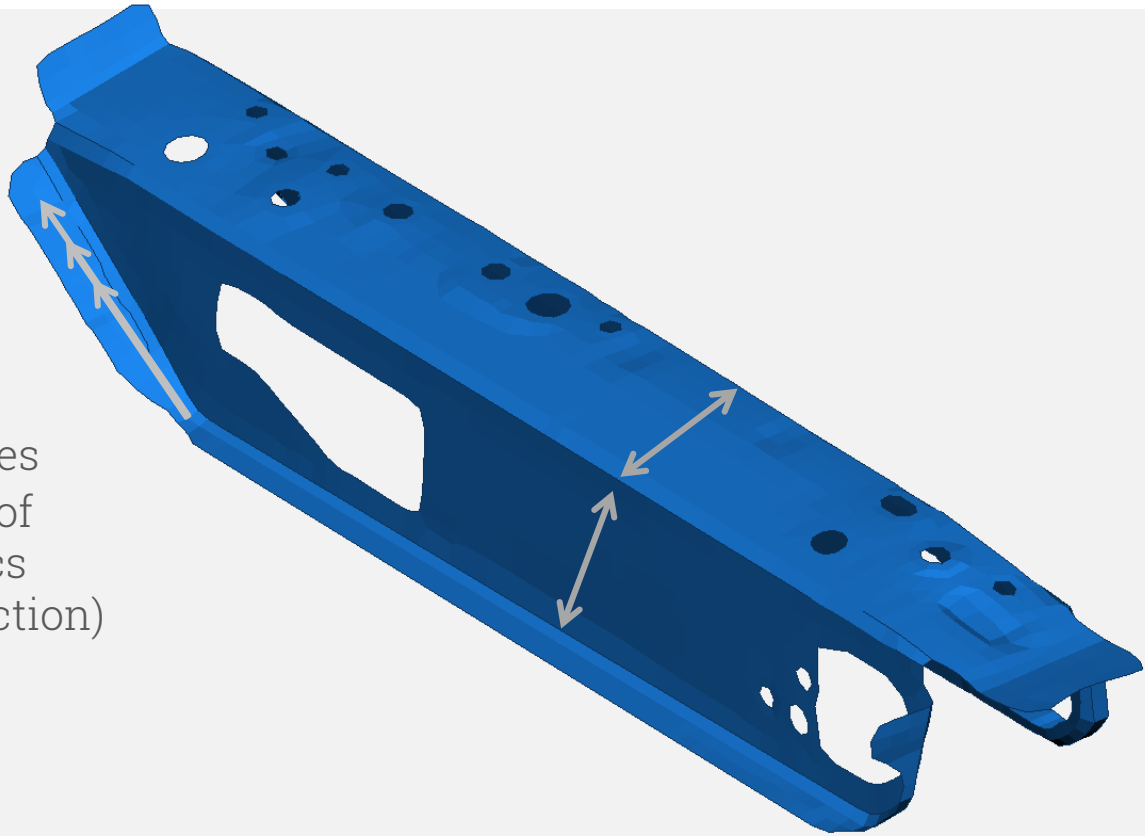


Applications



Needs

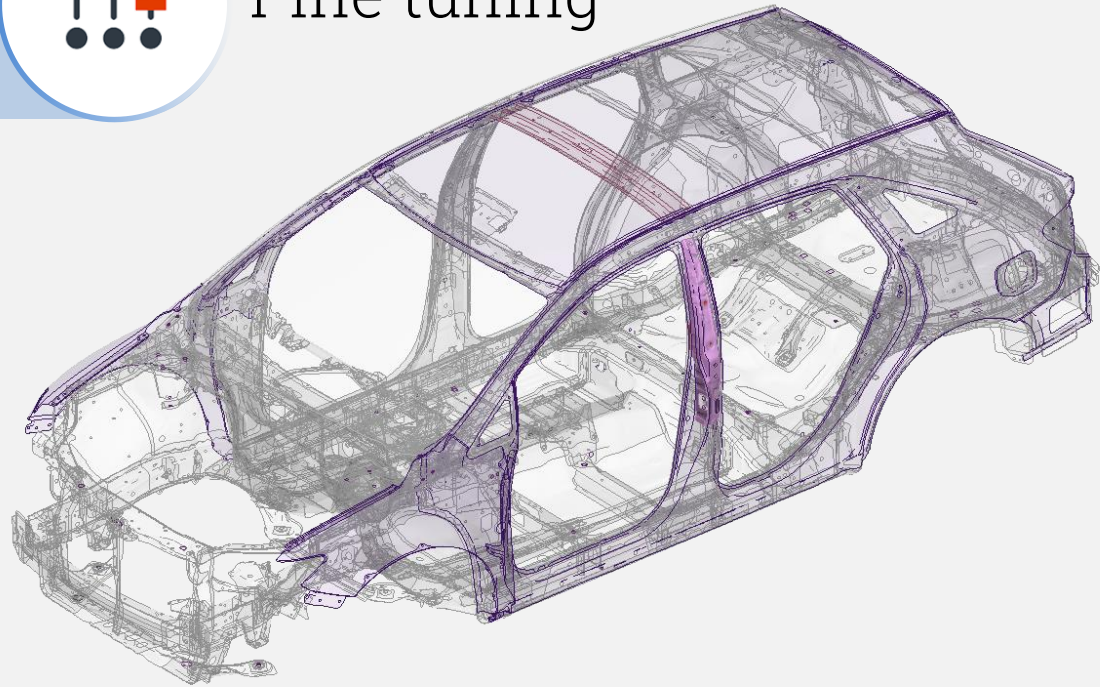
- › Global Changes
- › Preservation of characteristics (Flanges direction)



02



Fine tuning

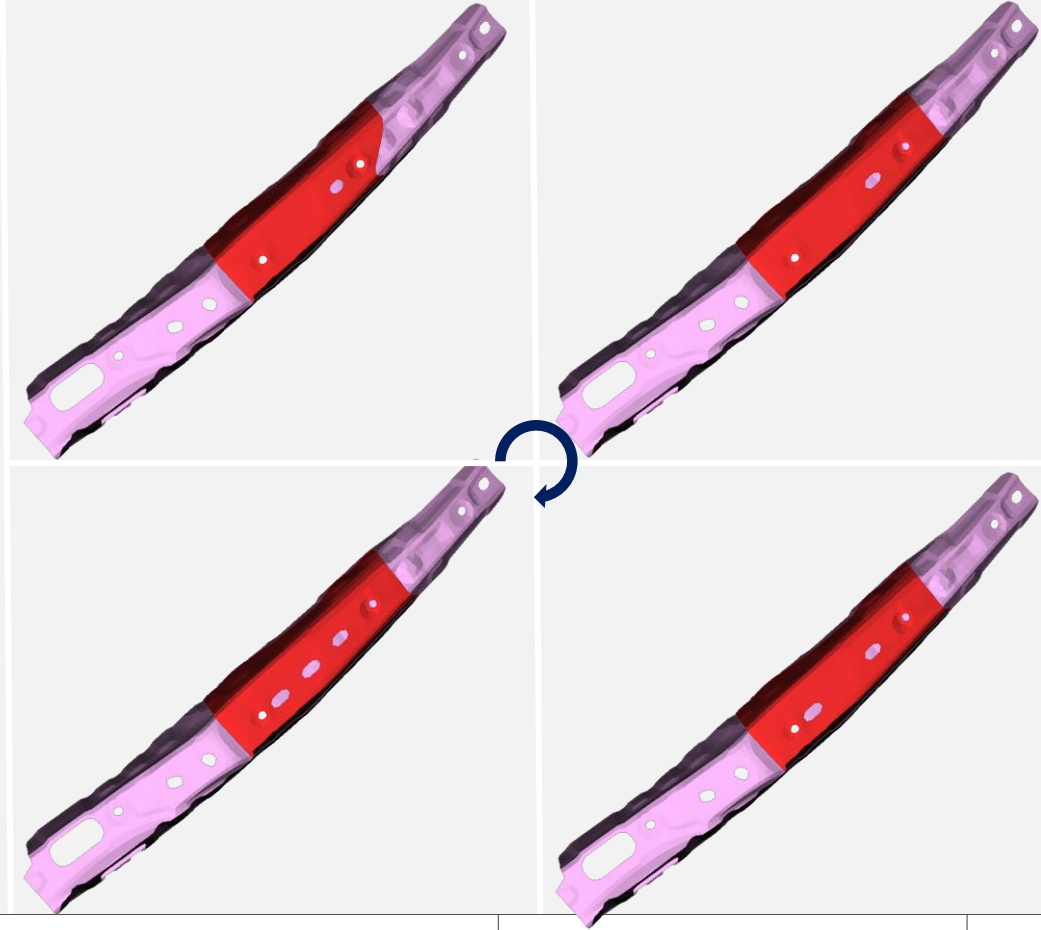


Applications



Needs

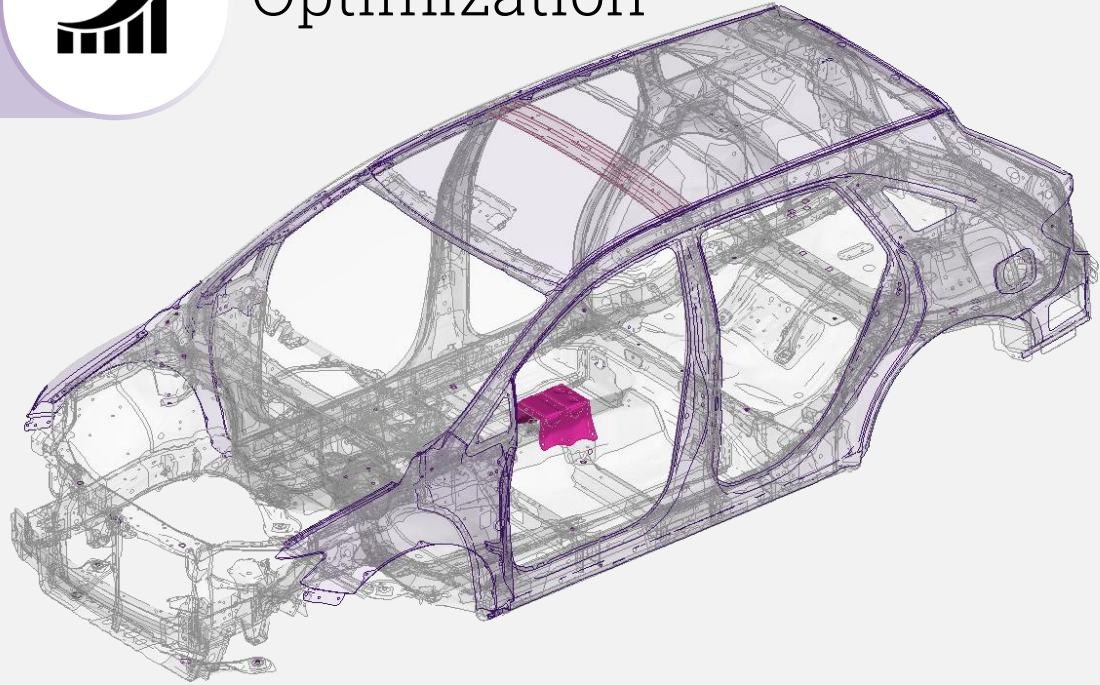
- › Global Changes (Feature line)
- › Local Changes (Features copying, relocation etc)



03



Optimization

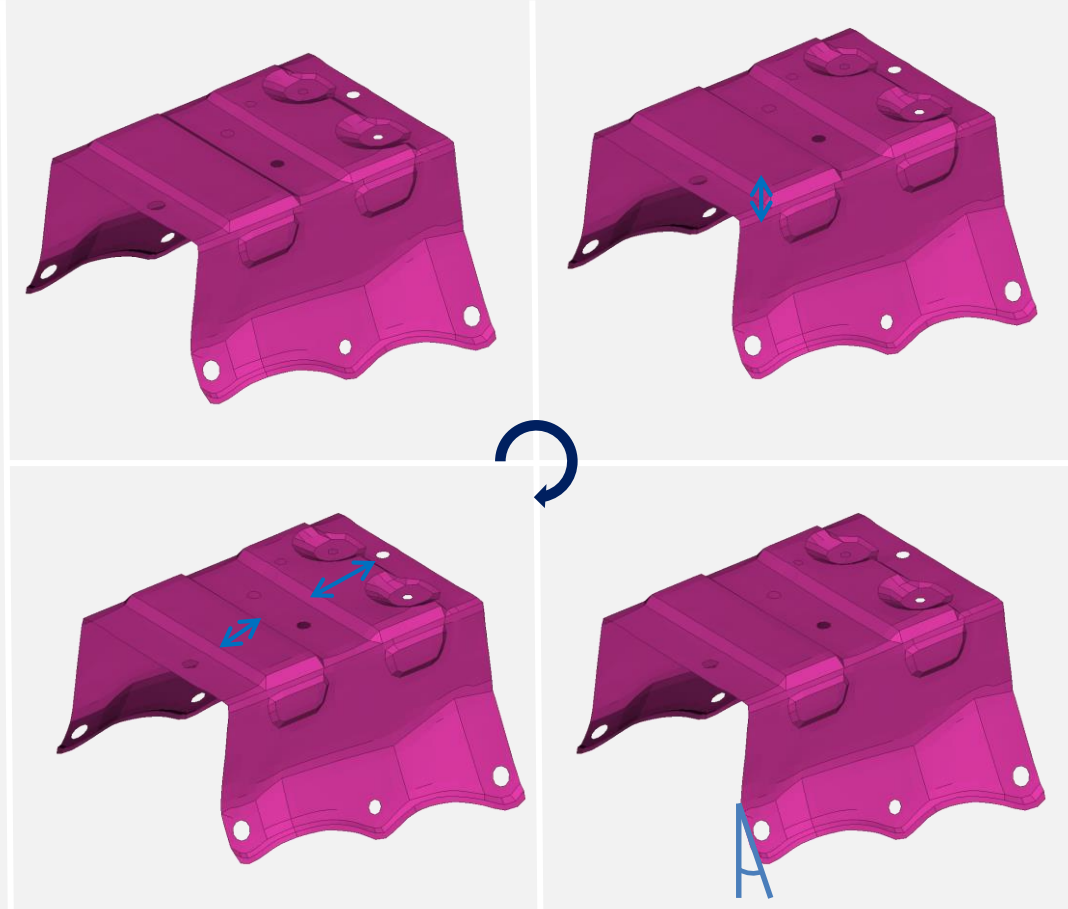


Applications



Needs

- › Parametrization of Features (Dimensions, Position, Defeaturing etc)



Tools



Welding Bead

Bead Parameters

Shape

Straight

Straight rounded

Width

Height

Angle

Radius R1

Radius R2

Invert direction

Bead Length

Nodes

OK Cancel

Feature creating tool

Parameters
Movement
Confirmation

Parameters

Feature type: Bead

Straight rounded

Width (W)

Height (H)

Angle (A)

Radius (R1)

Radius (R2)

Top view

Flat bottom

Section view

Invert direction

Select entities from visible FE

Create Bulkhead

Cross section

Type

Open

Closed

Enclosed

Flanges

Direction

Grids

Geometry

Width

Thickness

Align Flanges

Create Translate Parameter

Select area

OK Cancel

Feature Manager

Parameters Edit Update Clear All

Fillets
Stamps
Flanges 2D

Id	Height	Size	Treatment
1	2.	48.68	...
2	2.	48.68	...
3	2.	45.03	...
4	2.	45.03	...
5	2.93	8.71	...
6	5.43	24.5	...
7	5.43	24.5	...
8	2.98	15.1	...
9	2.98	15.1	...
10	2.9	8.29	...
11	5.6	28.55	...

PARAMETERS

Id Name

12 Feature_translate_at_X

13 Feature_translate_at_Y

Parametric Movement

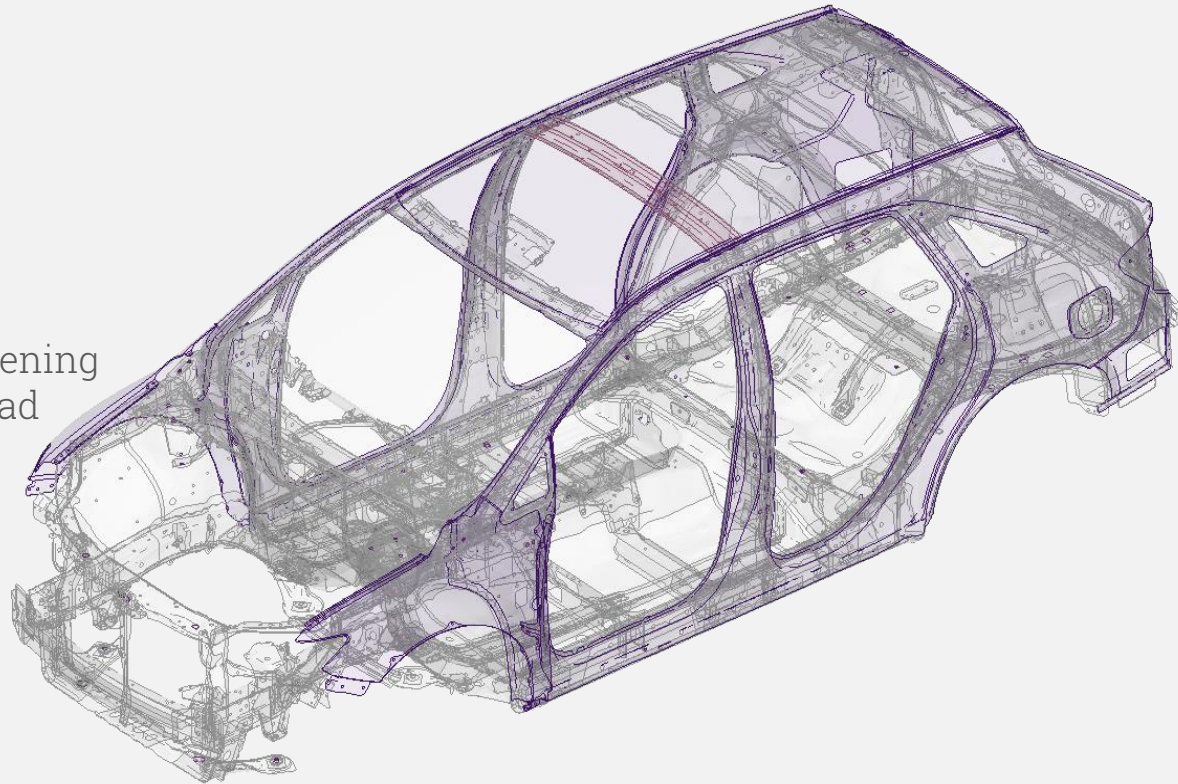
Origin 0.00000000

-100 100

Tools



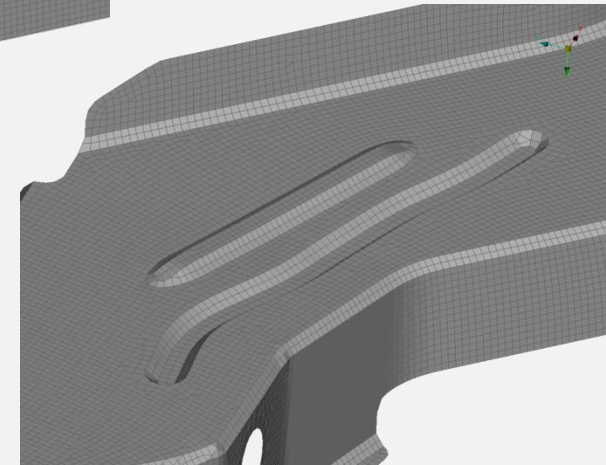
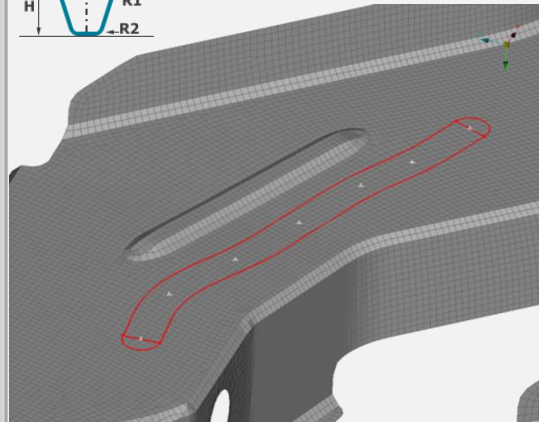
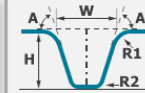
- › Create
 - › Bead
 - › Opening
 - › Flanged Opening
 - › Welding Bead
 - › Rib
 - › Stamp



Tools



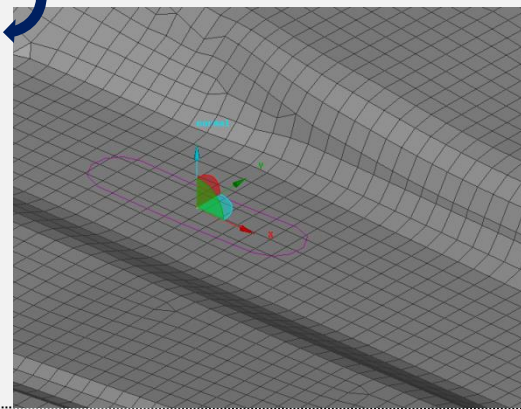
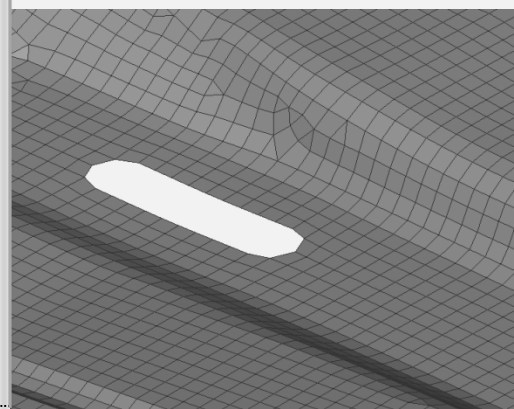
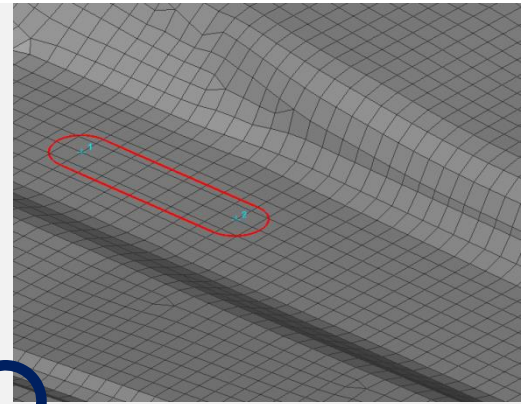
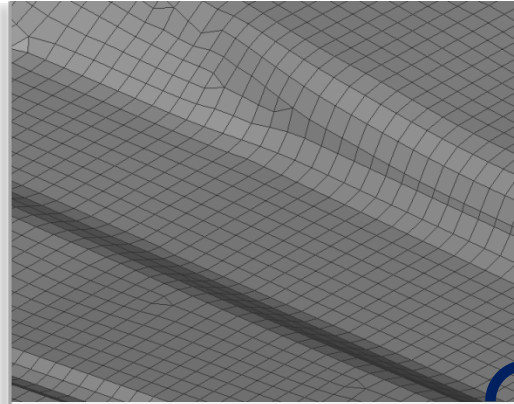
- › Create
 - › Bead
 - › Opening
 - › Flanged Opening
 - › Welding Bead
 - › Rib
 - › Stamp



Tools



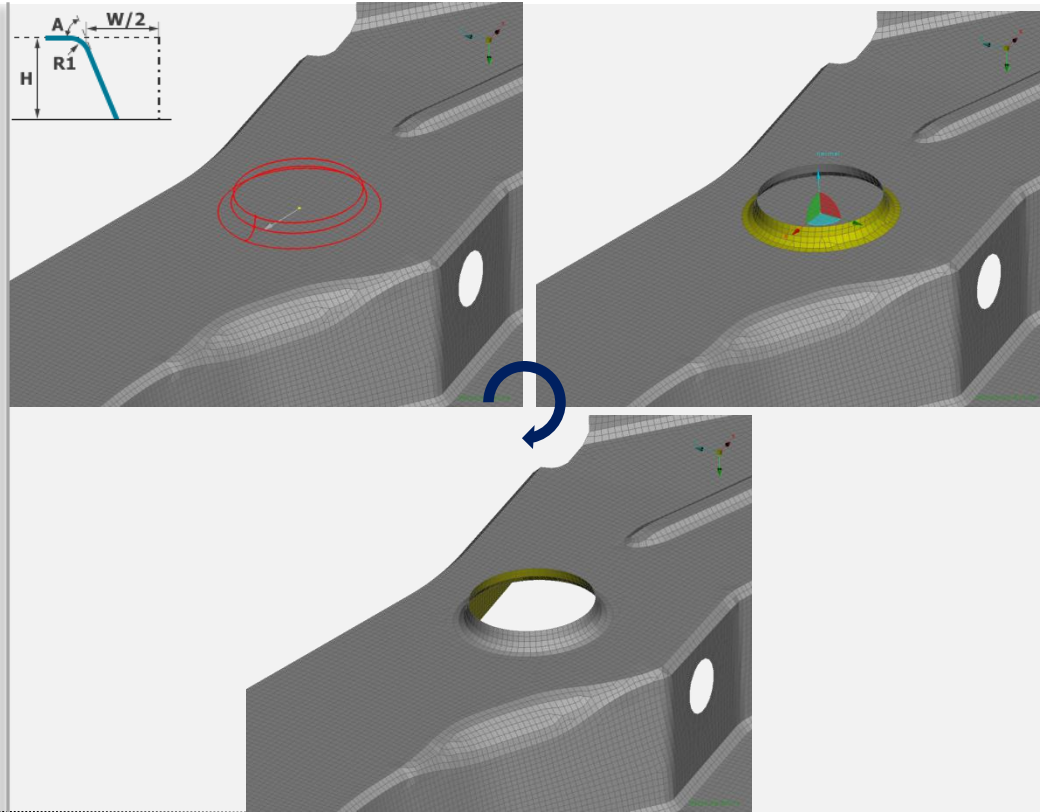
- › Create
 - › Bead
 - › **Opening**
 - › Flanged Opening
 - › Welding Bead
 - › Rib
 - › Stamp



Tools



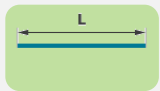
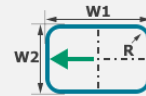
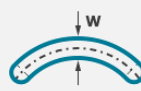
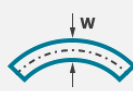
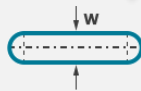
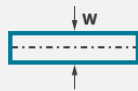
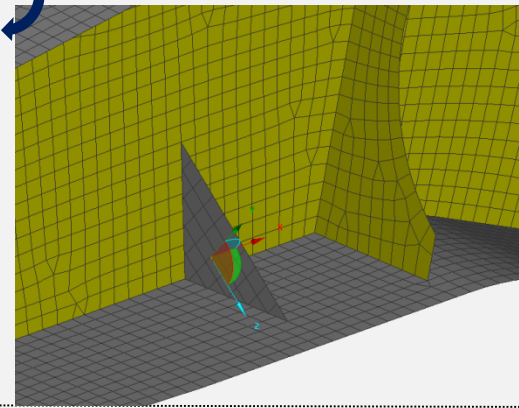
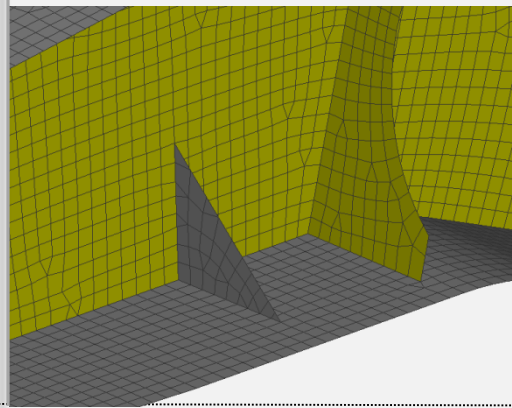
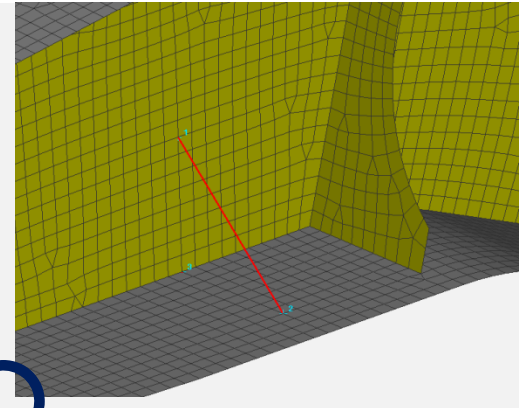
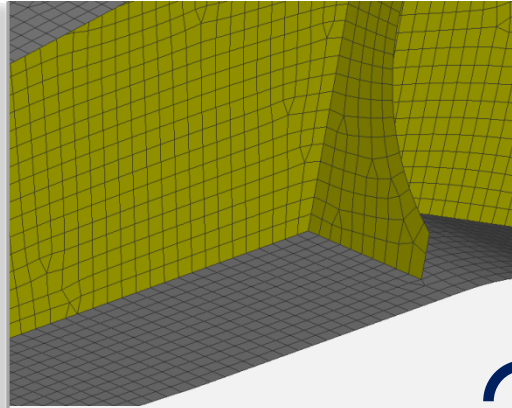
- › Create
 - › Bead
 - › Opening
 - › Flanged Opening
 - › Welding Bead
 - › Rib
 - › Stamp



Tools



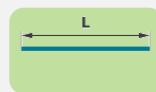
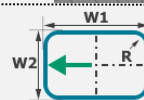
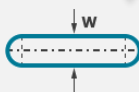
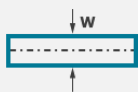
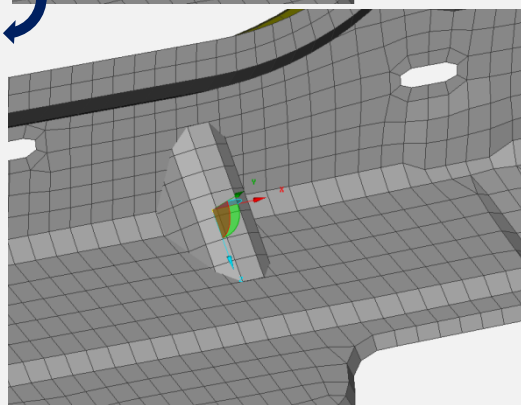
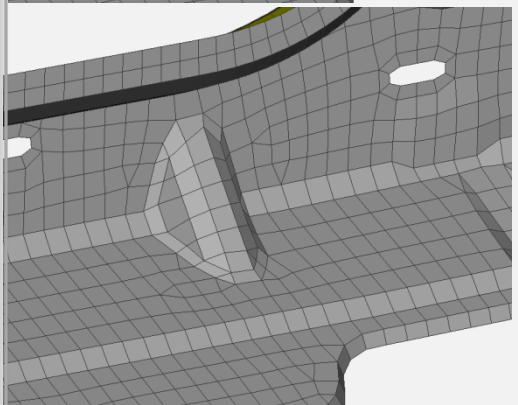
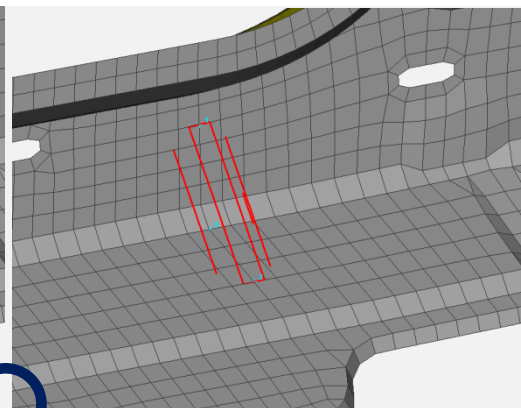
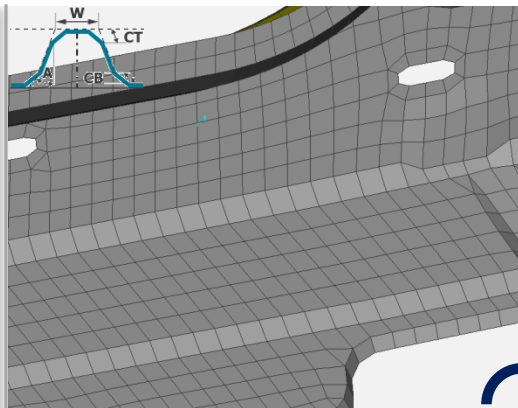
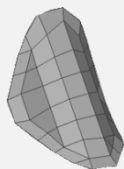
- › Create
 - › Bead
 - › Opening
 - › Flanged Opening
 - › Welding Bead
 - › Rib
 - › Stamp



Tools



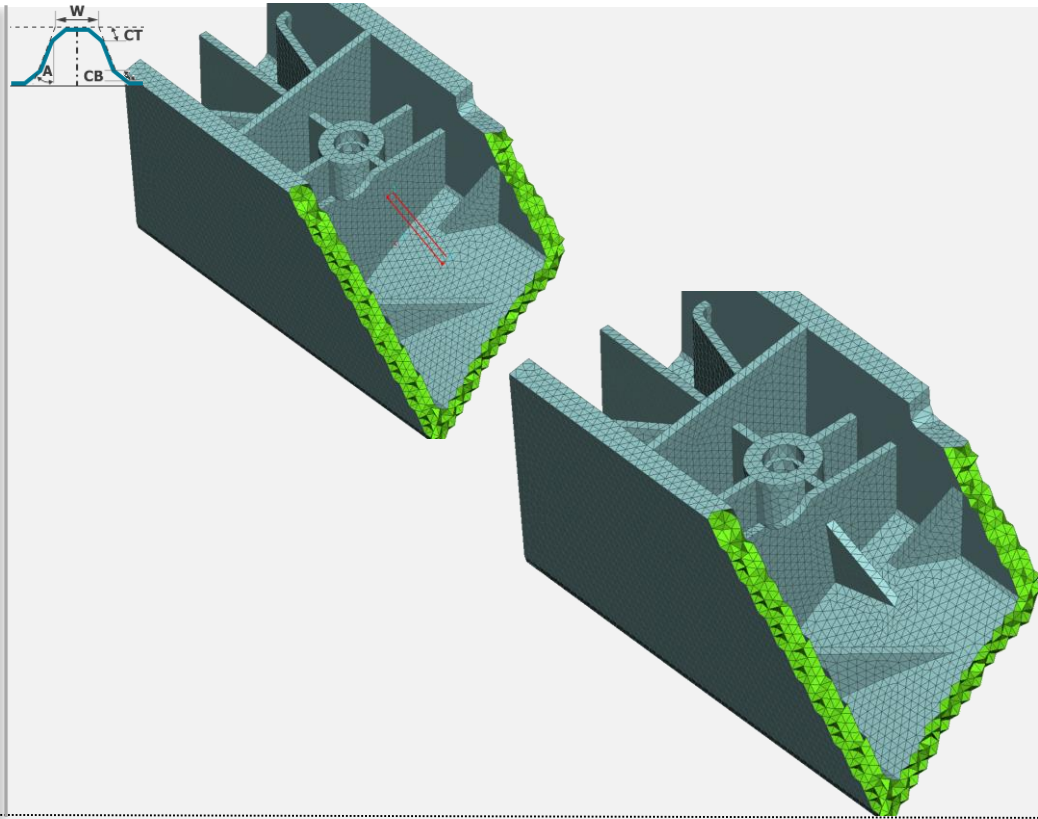
- › Create
 - › Bead
 - › Opening
 - › Flanged Opening
 - › Welding Bead
 - › Rib
 - › Stamp



Tools



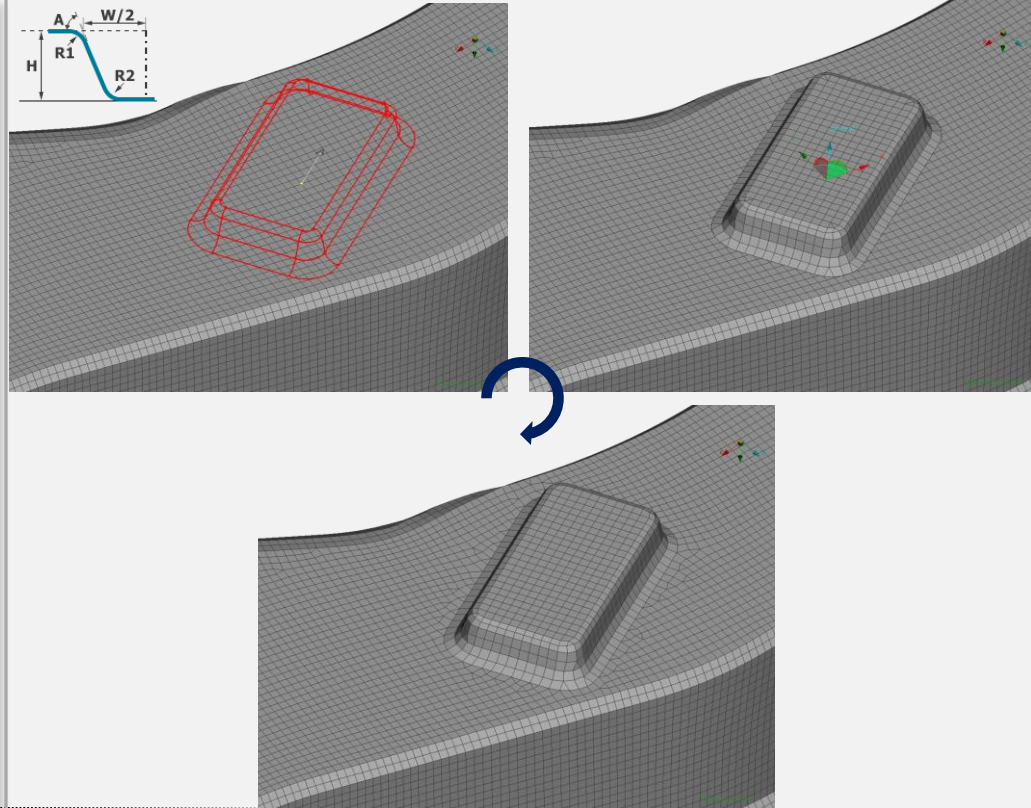
- › Create
 - › Bead
 - › Opening
 - › Flanged Opening
 - › Welding Bead
 - › Rib
 - › Stamp



Tools



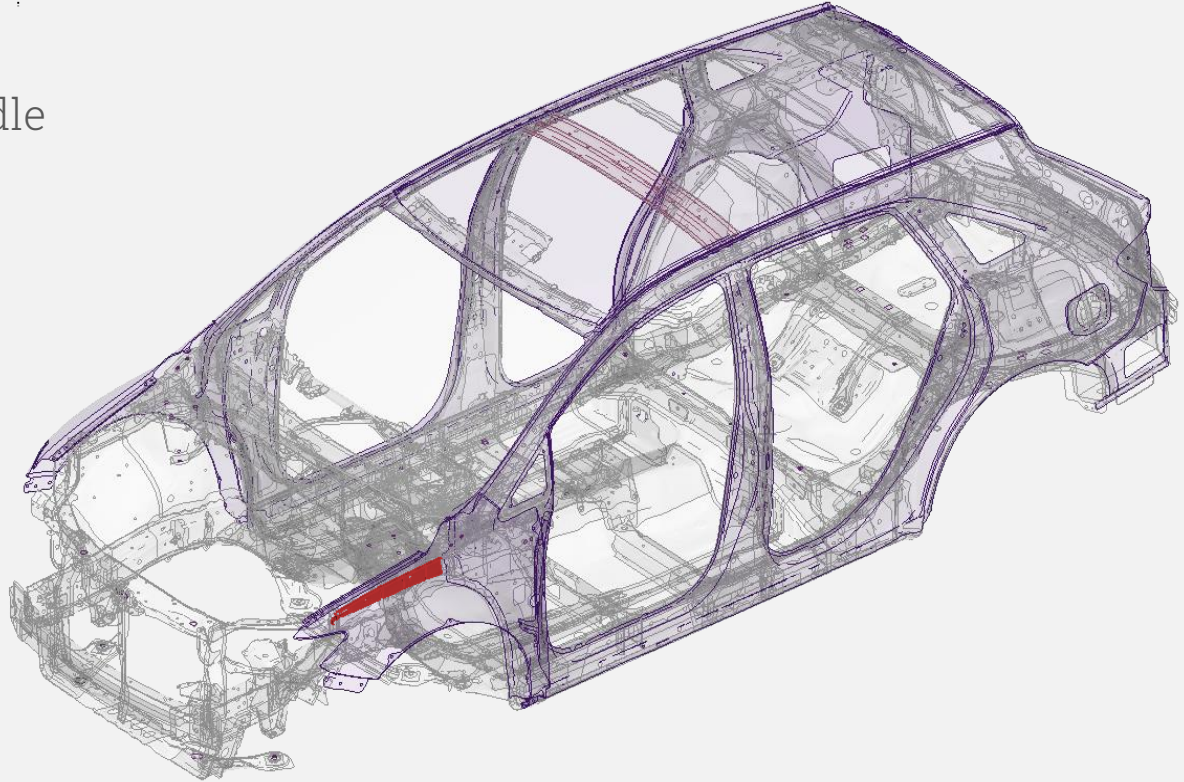
- › Create
 - › Bead
 - › Opening
 - › Flanged Opening
 - › Welding Bead
 - › Rib
 - › Stamp



Tools



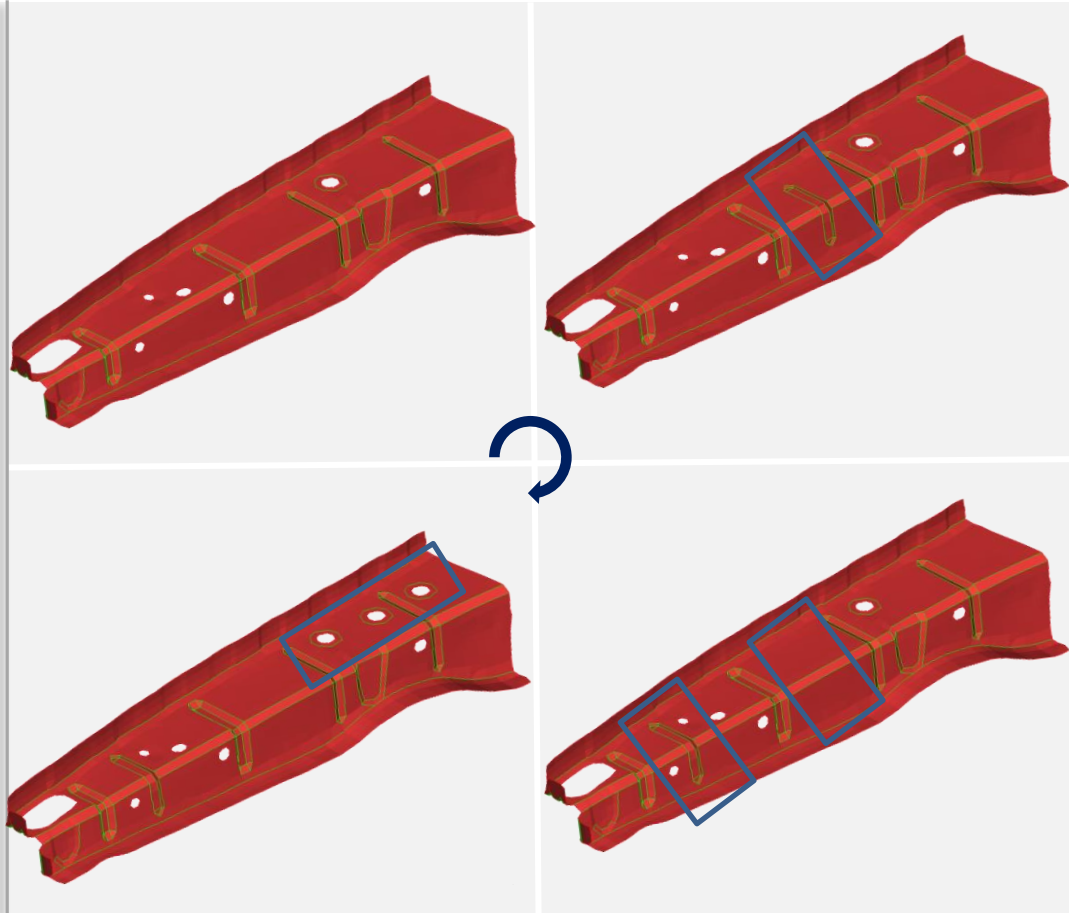
› Handle



Tools



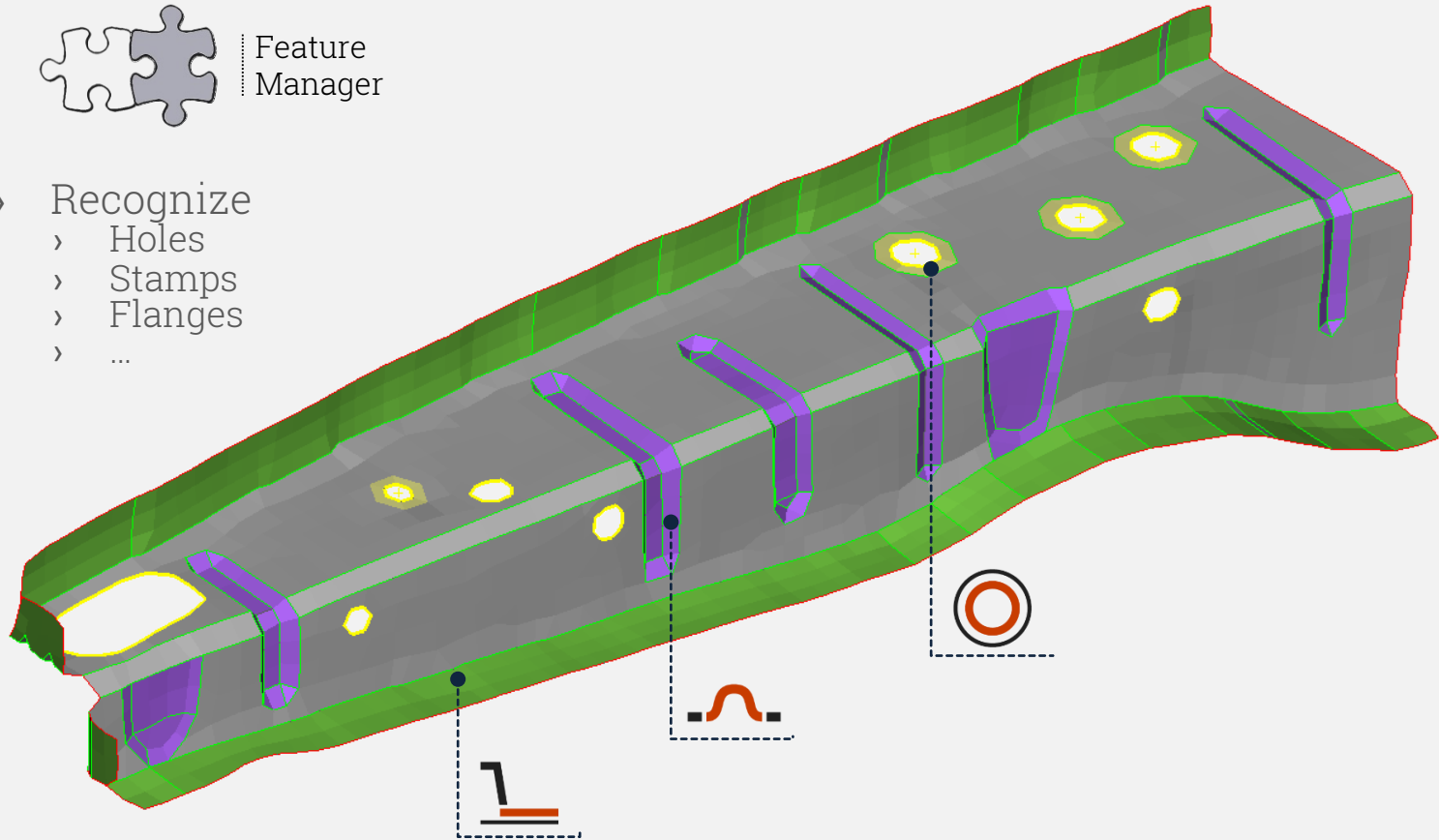
- › Handle
 - › Creation
 - › Relocation
 - › Duplication
 - › Parametrization



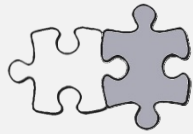
Tools



- › Recognize
 - › Holes
 - › Stamps
 - › Flanges
 - › ...

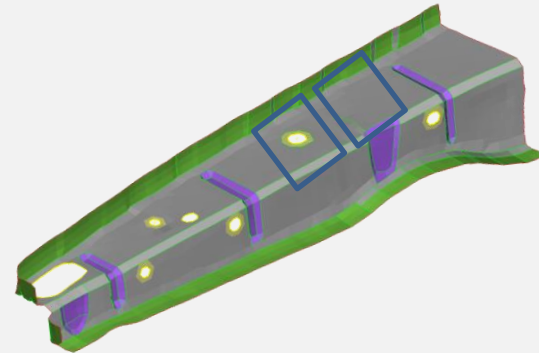
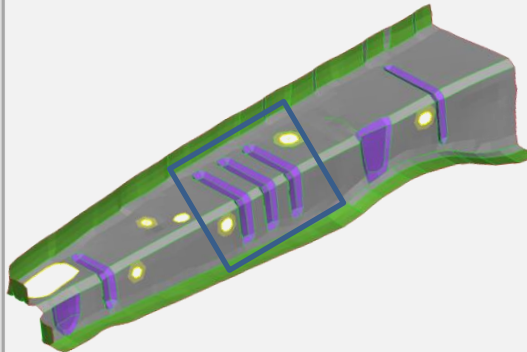
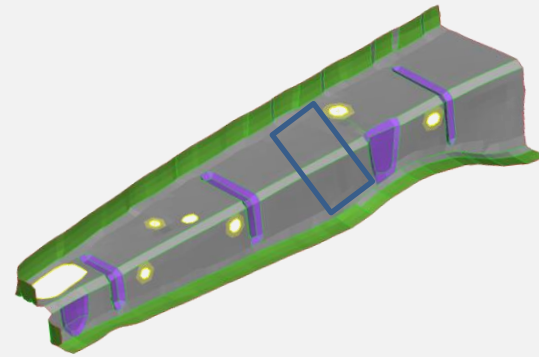
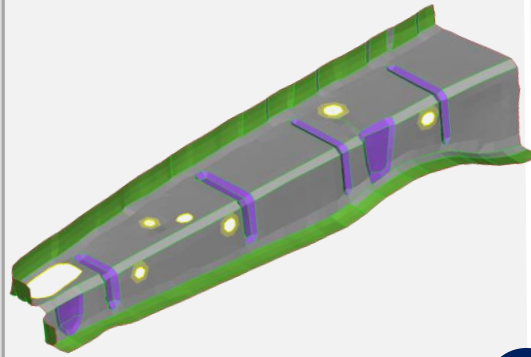


Tools

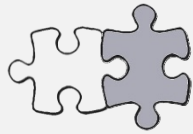


Feature
Manager

- › Recognize
- › Handle
 - › Remove
 - › Relocate
 - › Duplicate
 - › ...

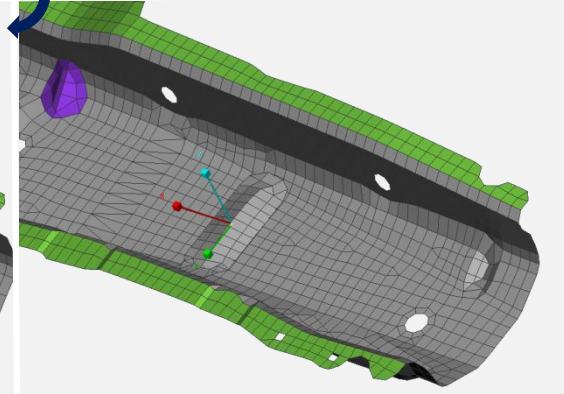
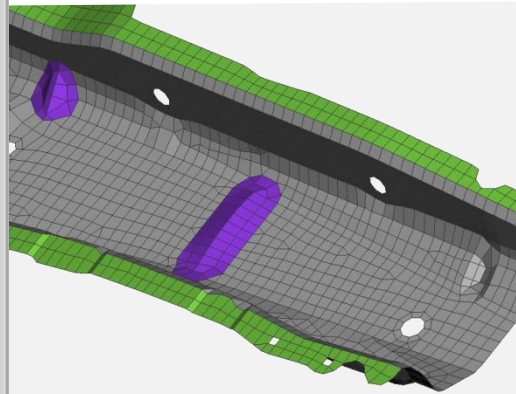
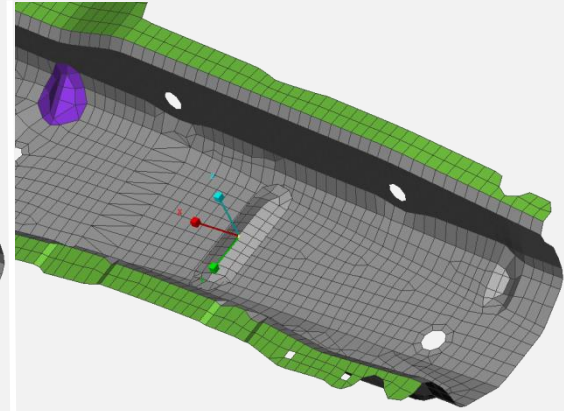
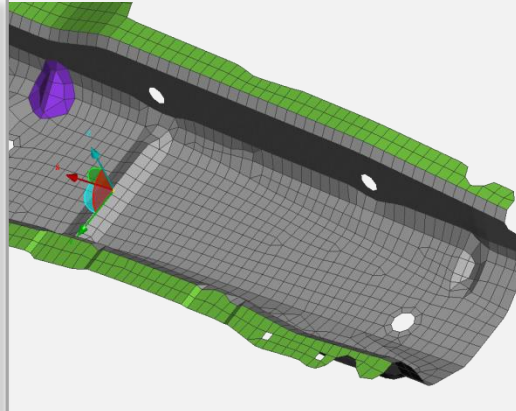


Tools

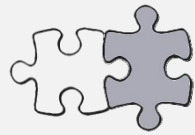


Feature
Manager

- › Recognize
- › Handle
 - › Remove
 - › Relocate
 - › Duplicate
 - › Scale

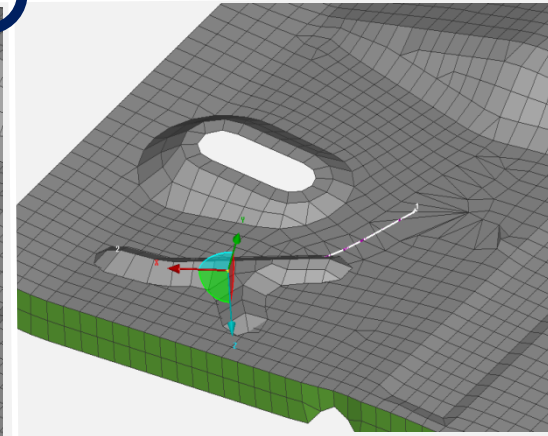
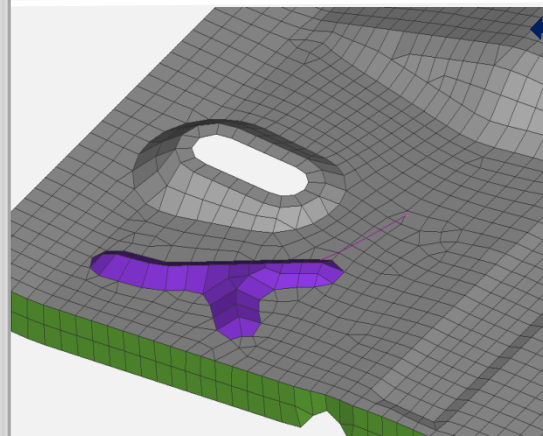
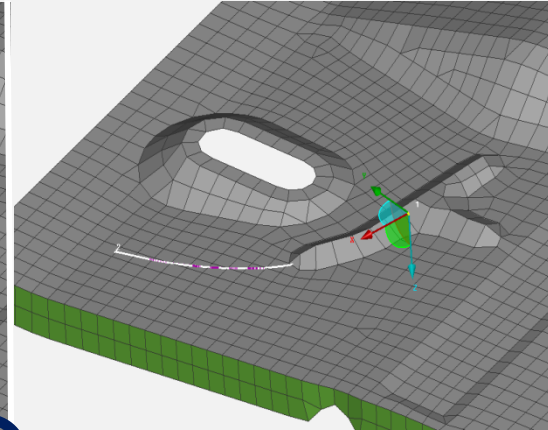
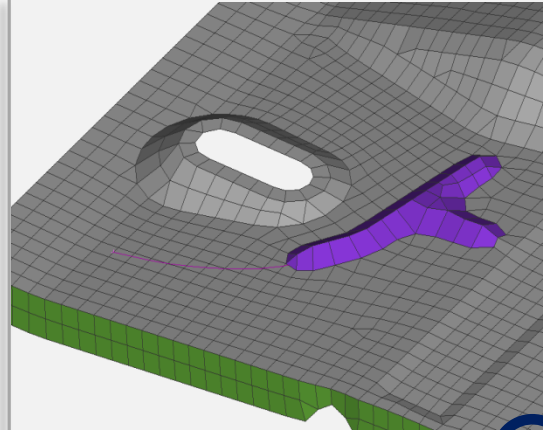


Tools

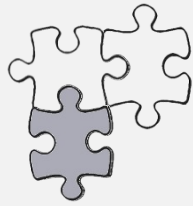


Feature
Manager

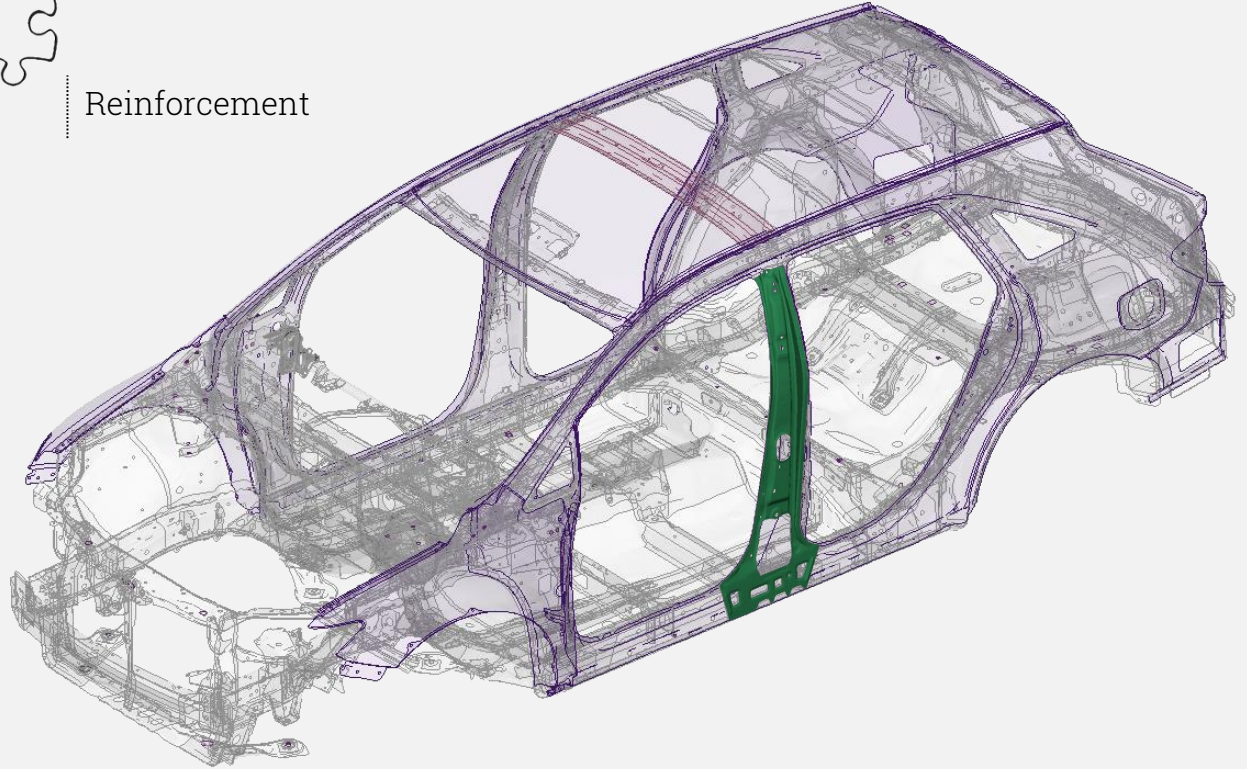
- › Recognize
- › Handle
 - › Remove
 - › Relocate
 - › Duplicate
 - › Scale
 - › **Follow Path**
 - › ...



Tools



Reinforcement

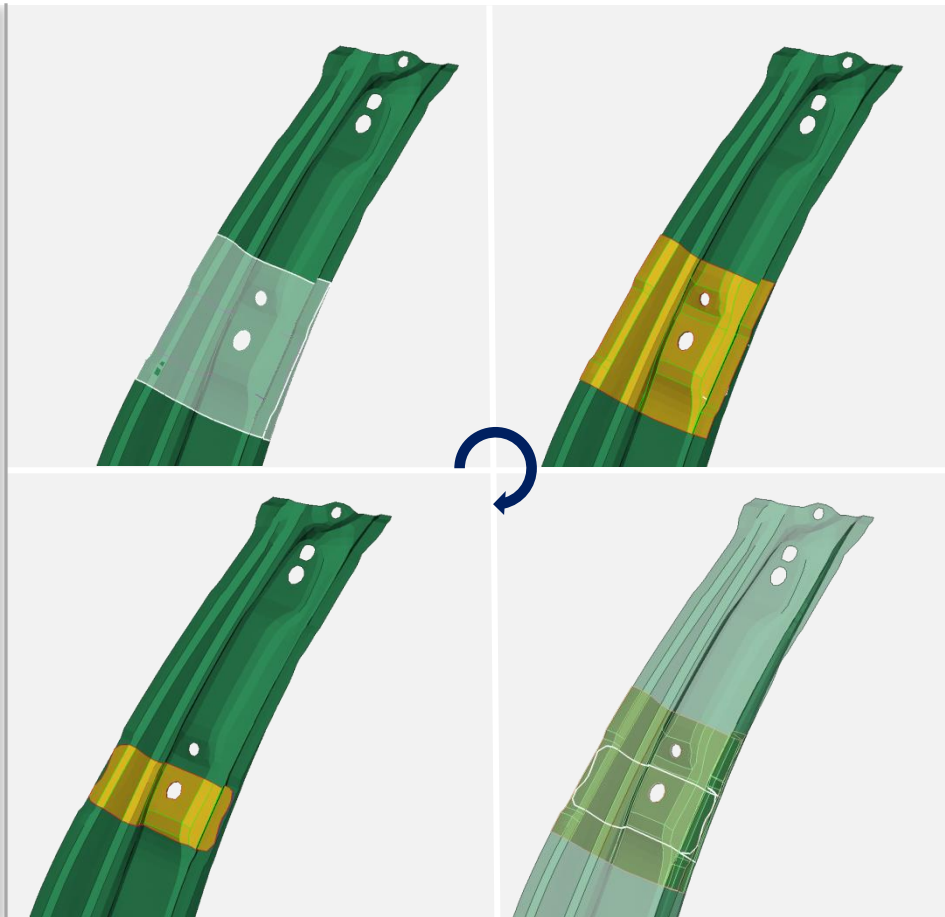


Tools

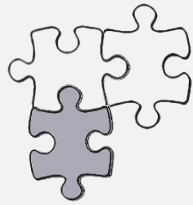


Reinforcement

- › Reinforce an area
 - › Area Selection
 - › Creation
 - › Reshape
 - › Predefined curves
 - › On-the-spot curves



Tools

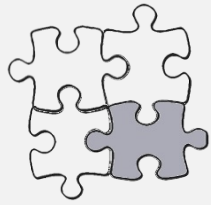


Reinforcement

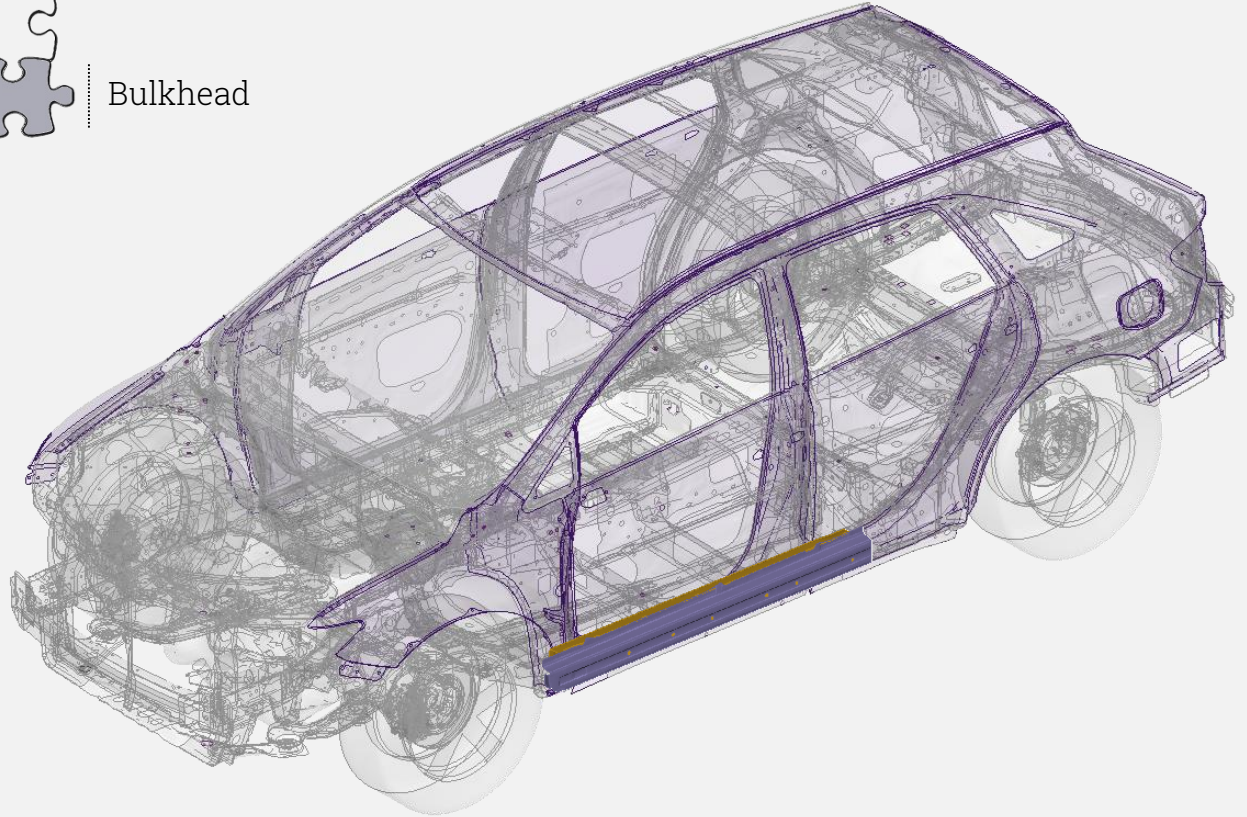
- › Reinforce an area
 - › Area Selection
 - › Creation
 - › Reshape
 - › Predefined curves
 - › On-the-spot curves
 - › Morph



Tools



Bulkhead

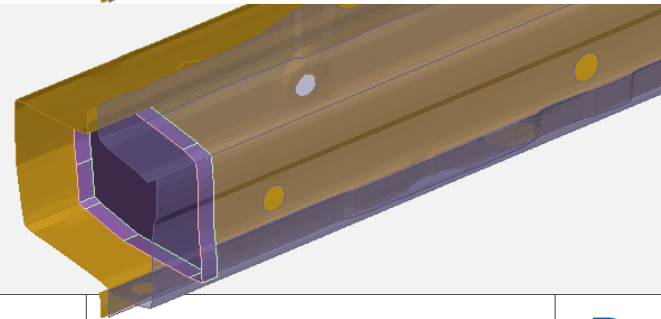
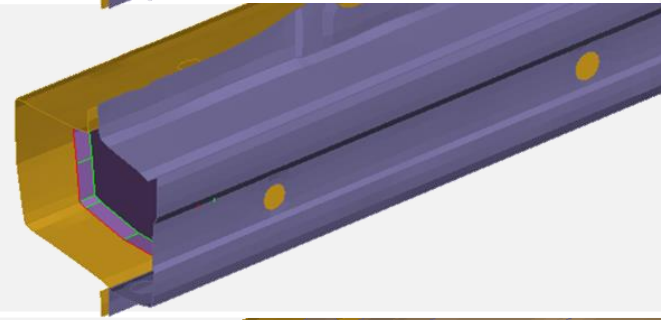
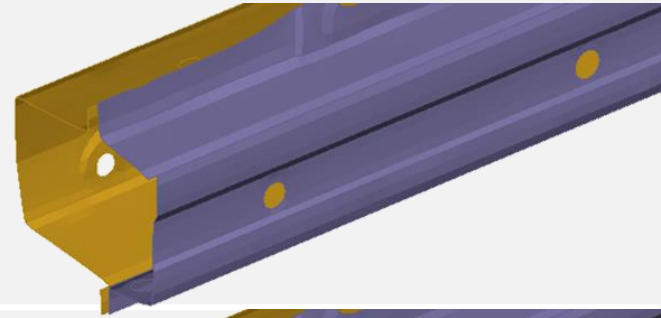


Tools



Bulkhead

- › Reinforce an area
 - › Area Selection
 - › Definition
 - › Orientation
 - › Flanges
 - › Characteristics
 - › **Creation**
 - › Tools
 - › Supported profiles



Tools

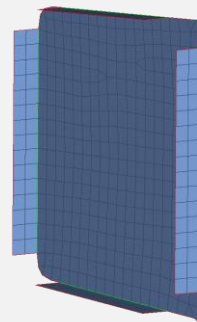
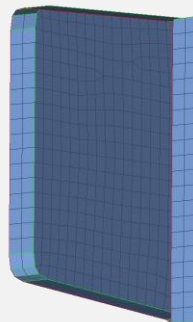


Bulkhead

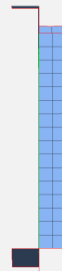
- › Reinforce an area
 - › Area Selection
 - › Definition
 - › Orientation
 - › Flanges
 - › Characteristics
 - › Creation
 - › **Tools**
 - › Supported profiles



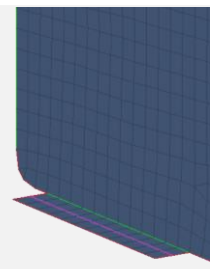
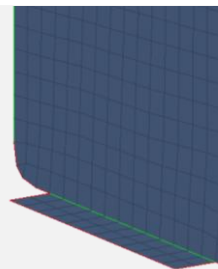
Cuts



Flanges Swap



Connections



Tools

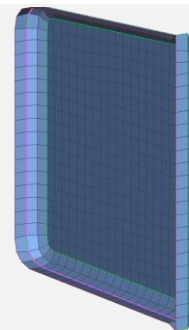


Bulkhead

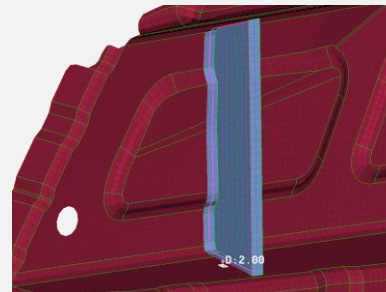
- › Reinforce an area
 - › Area Selection
 - › Definition
 - › Orientation
 - › Flanges
 - › Characteristics
 - › Creation
 - › **Tools**
 - › Supported profiles



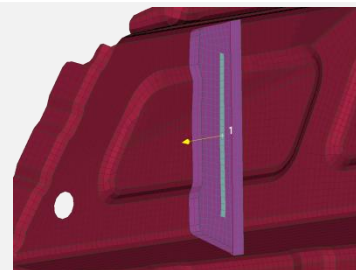
Fillet



Offset



DFM parameter



Tools

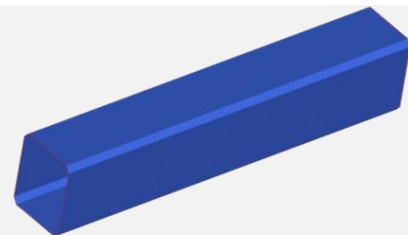


Bulkhead

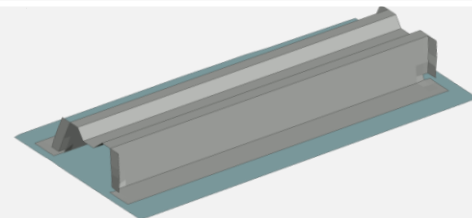
- › Reinforce an area
 - › Area Selection
 - › Definition
 - › Orientation
 - › Flanges
 - › Characteristics
 - › Creation
 - › Tools
 - › **Supported profiles**



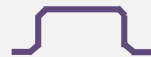
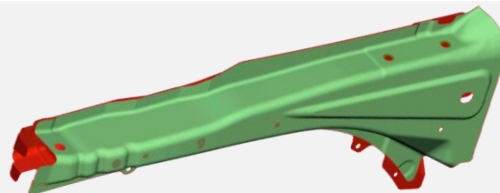
Square



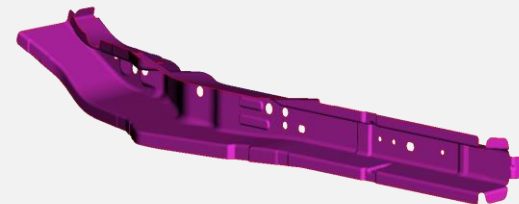
Hat-to-Plate



Hat-to-Hat



Hat



Processes & User Cases



Ideas



Collaboration

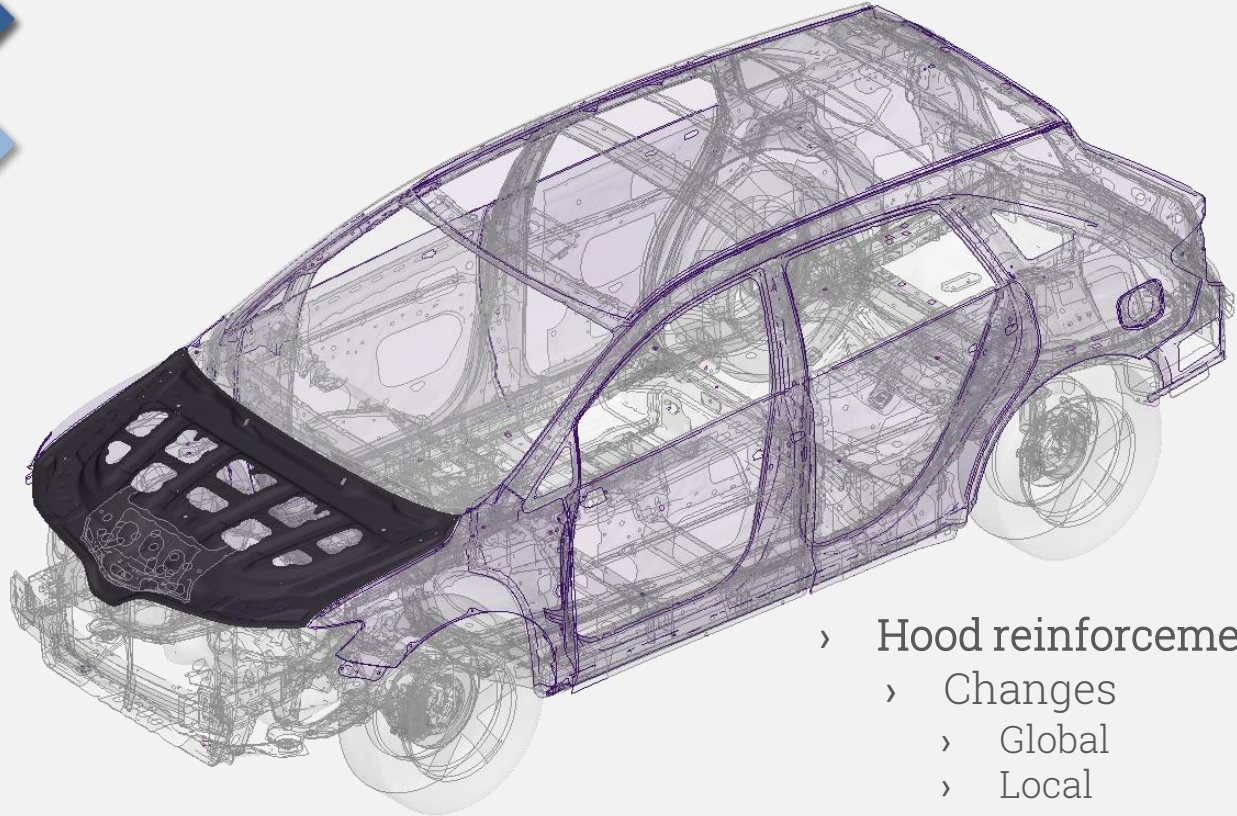


Expertize



Outcome

Processes & User Cases

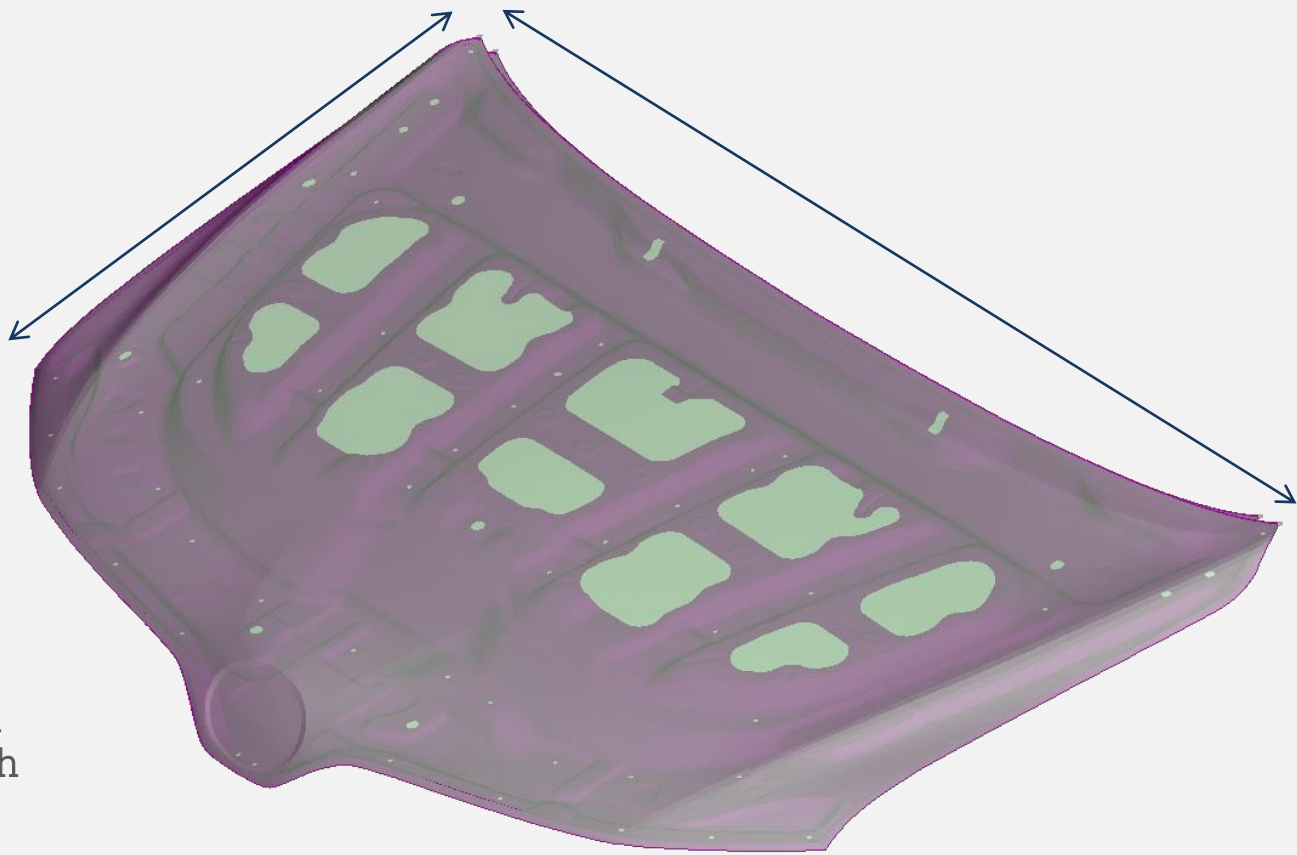


- › Hood reinforcement DoE
 - › Changes
 - › Global
 - › Local

Processes & User Cases



- › Global
 - › Width
 - › Length



Processes & User Cases



- › Global
 - › Width
 - › Length
- › Local
 - › Feature-based DoE

The screenshot shows the Optimization Tool interface with the following components:

- Workflow:** OPTIMIZATION_TASK_1
- Design variables table:**

ID	Name	TYPE	RANGE	Current Value	Min Value	Max Value
18	Members_width_1	REAL	BOUNDS	0.	0.	10.
17	Members_width_2	REAL	BOUNDS	0.	-4.	10.
31	DC_Beads_Height_1	REAL	BOUNDS	0.	0.	1.
32	DC_Beads_Width_1	REAL	BOUNDS	0.	0.	1.
25	DC_Beads_Height_2	REAL	BOUNDS	0.	0.	1.
26	DC_Beads_Width_2	REAL	BOUNDS	0.	0.	1.
19	Joints_height	REAL	BOUNDS	0.	0.	2.
21	Hood_lock_height	REAL	BOUNDS	0.	-2.	0.

- Responses Ansa & Meta:**

ID	Name	RESULT	ID	Meta response	Value
1	stress	809.22583			

- Constraints:**

Name	Expression	Operator	Limit
Constraint_1	MAX_STRESS	<	810

The workflow tree on the left shows a sequence of steps: Pre-Processing, Members_width_1, Members_width_2, DC_Beads_Height_1, DC_Beads_Width_1, DC_Beads_Height_2, DC_Beads_Width_2, **Attaching_Joints_and_Beads** (highlighted with a blue box), Joints_height, Hood_lock_height, .hood_inner.edb, Solver, and Post-Processing.

Processes & User Cases

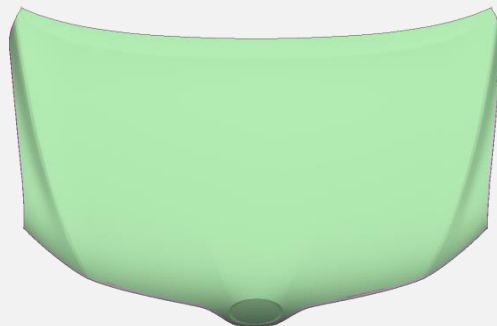


› Global

Action:
Fitting Vehicle 1 Hood
to Vehicle 2 Hood

Result:
Vehicle 2 Reinforcement

Vehicle 1 : Hood



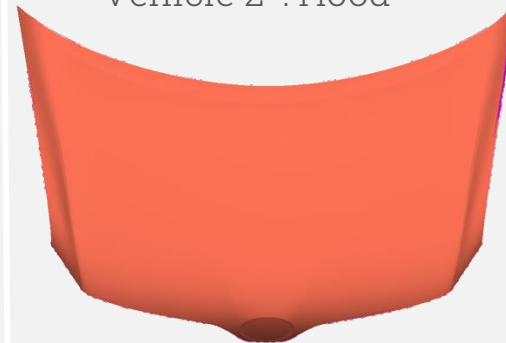
Vehicle 1 : Reinforcement



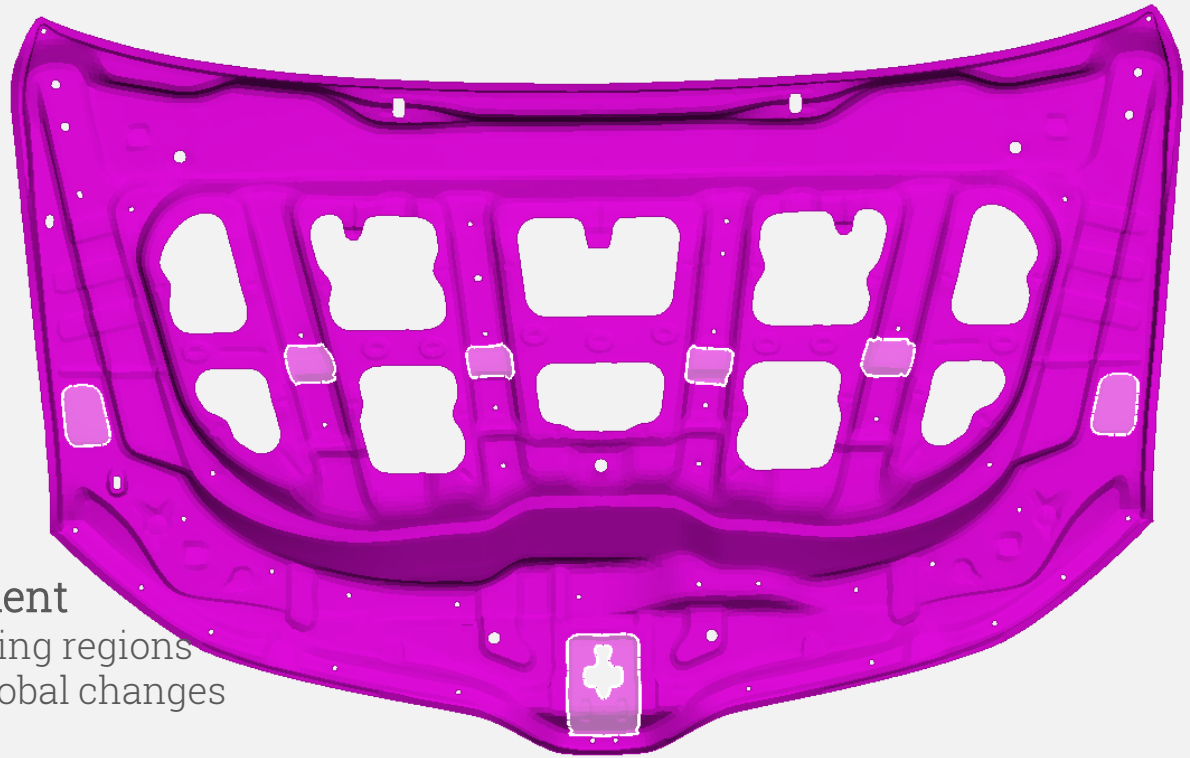
Vehicle 2 : Reinforcement



Vehicle 2 : Hood



Processes & User Cases



- › Requirement
 - › Protecting regions from global changes

Processes & User Cases



› Solution

› Detaching regions from reinforcement



› Creation a part for each region/feature



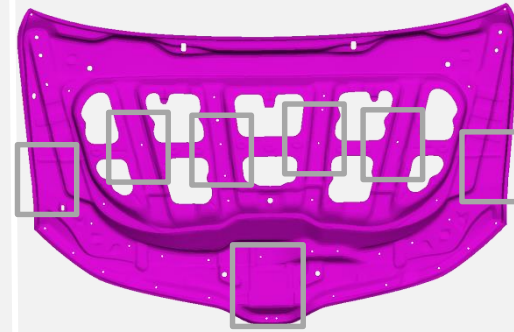
› Creation libraries of features



Processes & User Cases



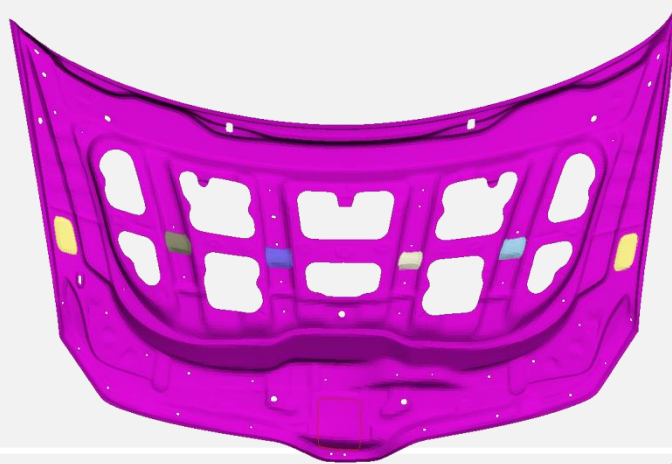
- › Prior to DoE
 - › Detaching features
 - › Global morphing



Processes & User Cases



- › **During DoE**
 - › Merging features
 - › Feature-based morphing
 - › Width/Height of features
 - › Attaching features
 - › Local morphing
 - › Width of Members



Processes & User Cases



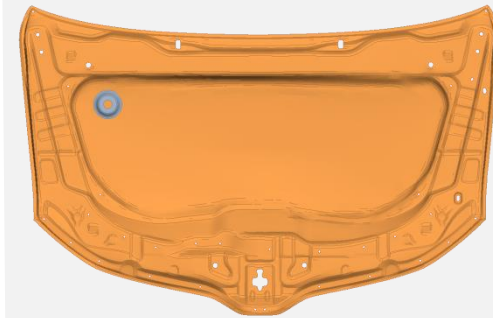
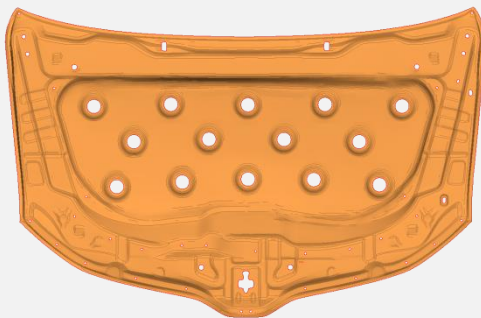
› New Designs



Processes & User Cases



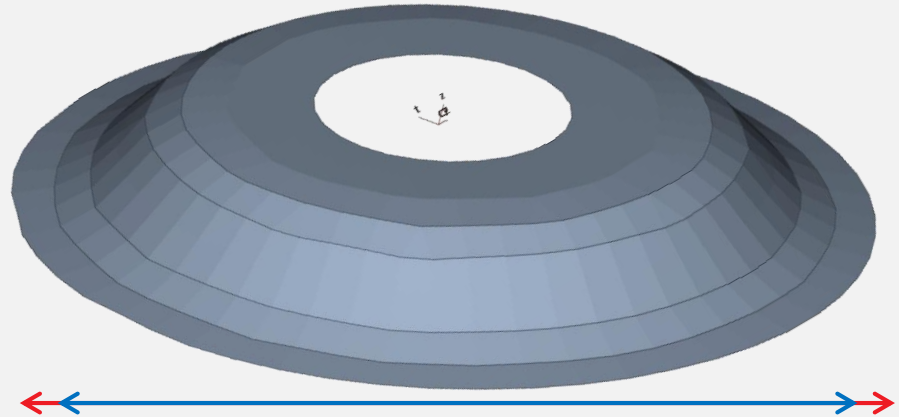
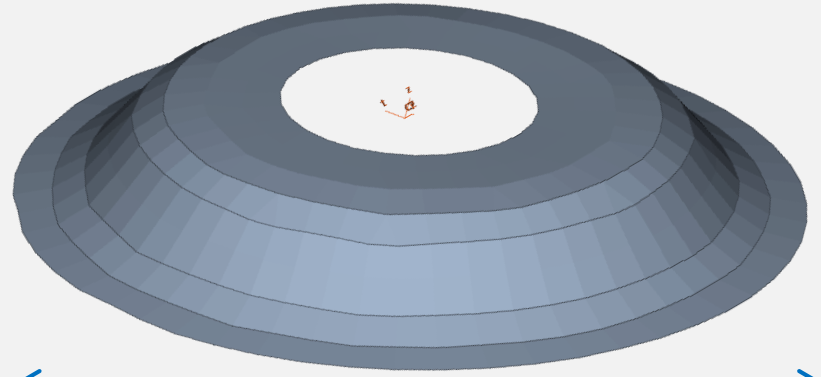
- › Hood reinforcement
Pattern Optimization
 - › Design area selection
 - › Merging feature
 - › Pattern creation



Processes & User Cases



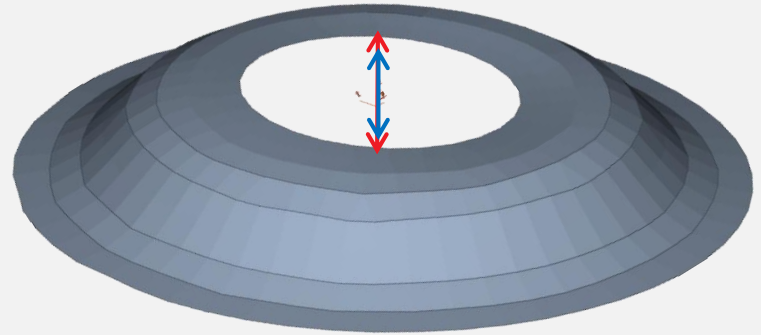
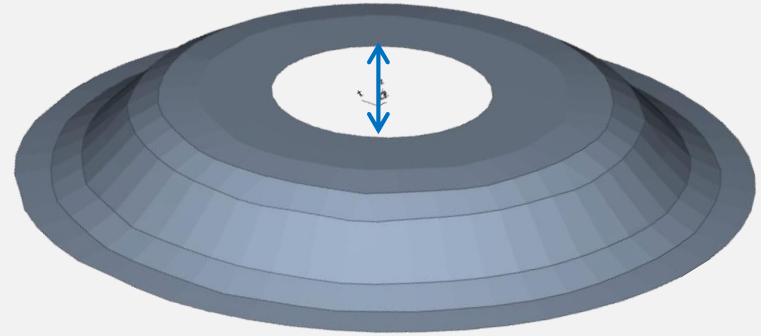
- › Feature Design Variables
 - › Outer Diameter



Processes & User Cases



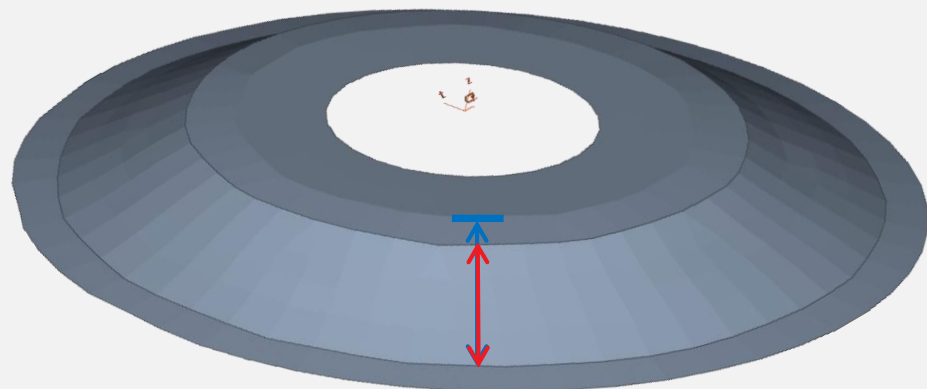
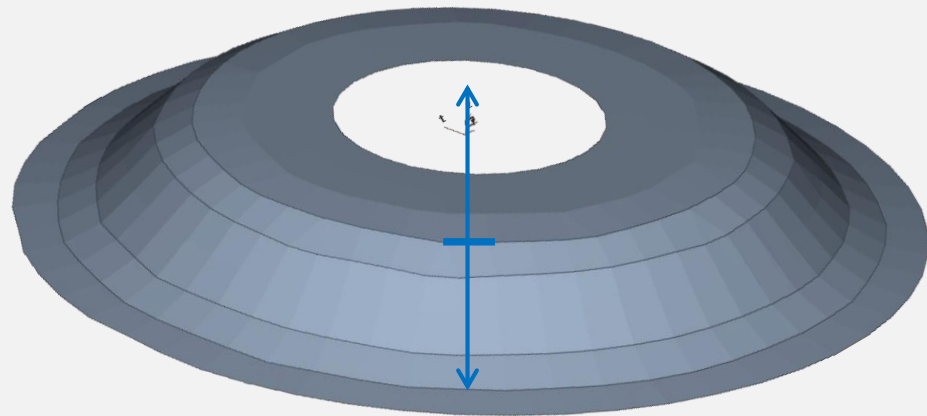
- › Feature Design Variables
 - › Outer Diameter
 - › Inner Diameter



Processes & User Cases



- › Feature Design Variables
 - › Outer Diameter
 - › Inner Diameter
 - › Height

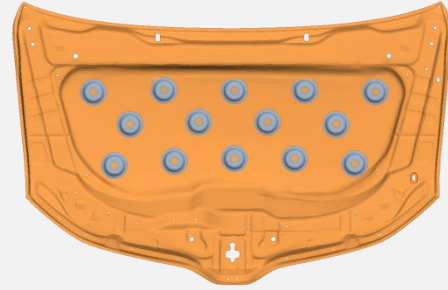
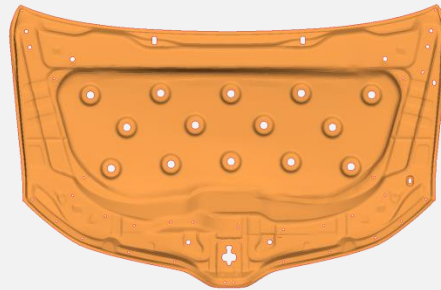


Processes & User Cases



Optimization Process

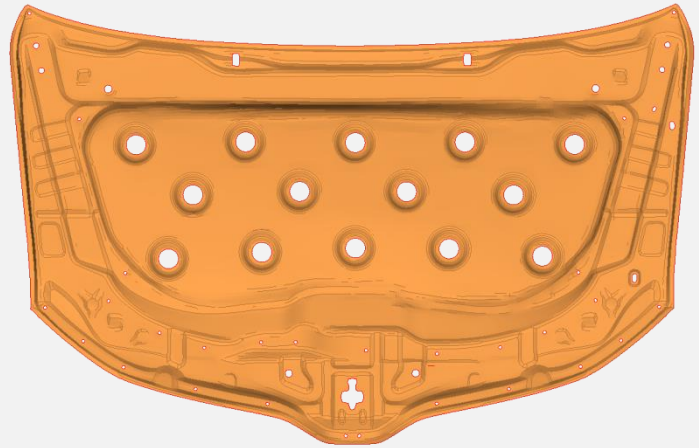
- › **Pattern**
 - › Product of Mathematical Expression
 - › Rows of features
 - › Features per row
- › **Pattern Design Variables**
 - › Number of Rows(DV)
 - › Features per Row(DV)
 - › Diam./Height of Features(DV)
 - › Copying Feature
 - › Projection/Attachment



Processes & User Cases



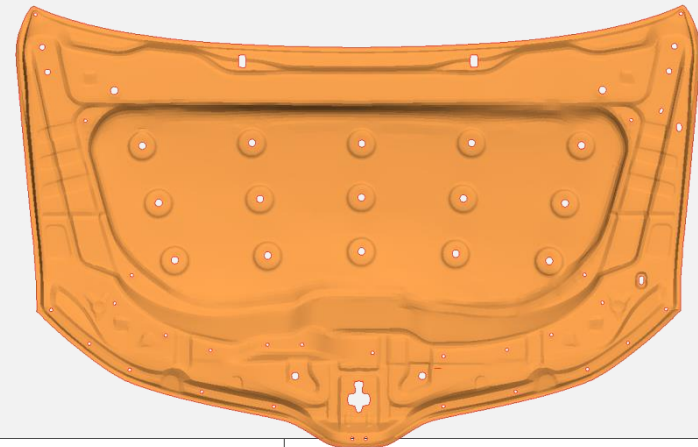
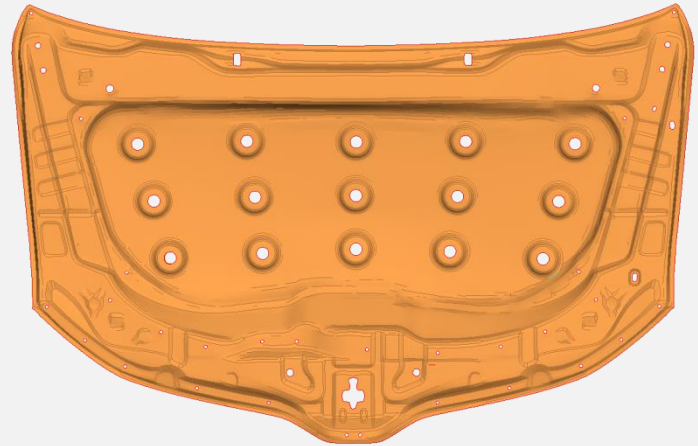
› Pattern A Designs



Processes & User Cases



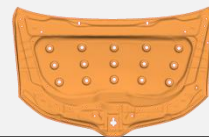
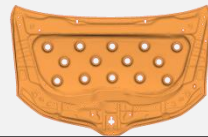
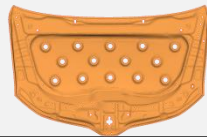
- › Pattern A Designs
- › Pattern B Designs



Processes & User Cases



› New Designs



Overview



- Concept design
- Fine tuning
- Optimization



- Create
- Feature Manager
- Reinforcement
- Bulkhead



- Collaboration



Stay connected