

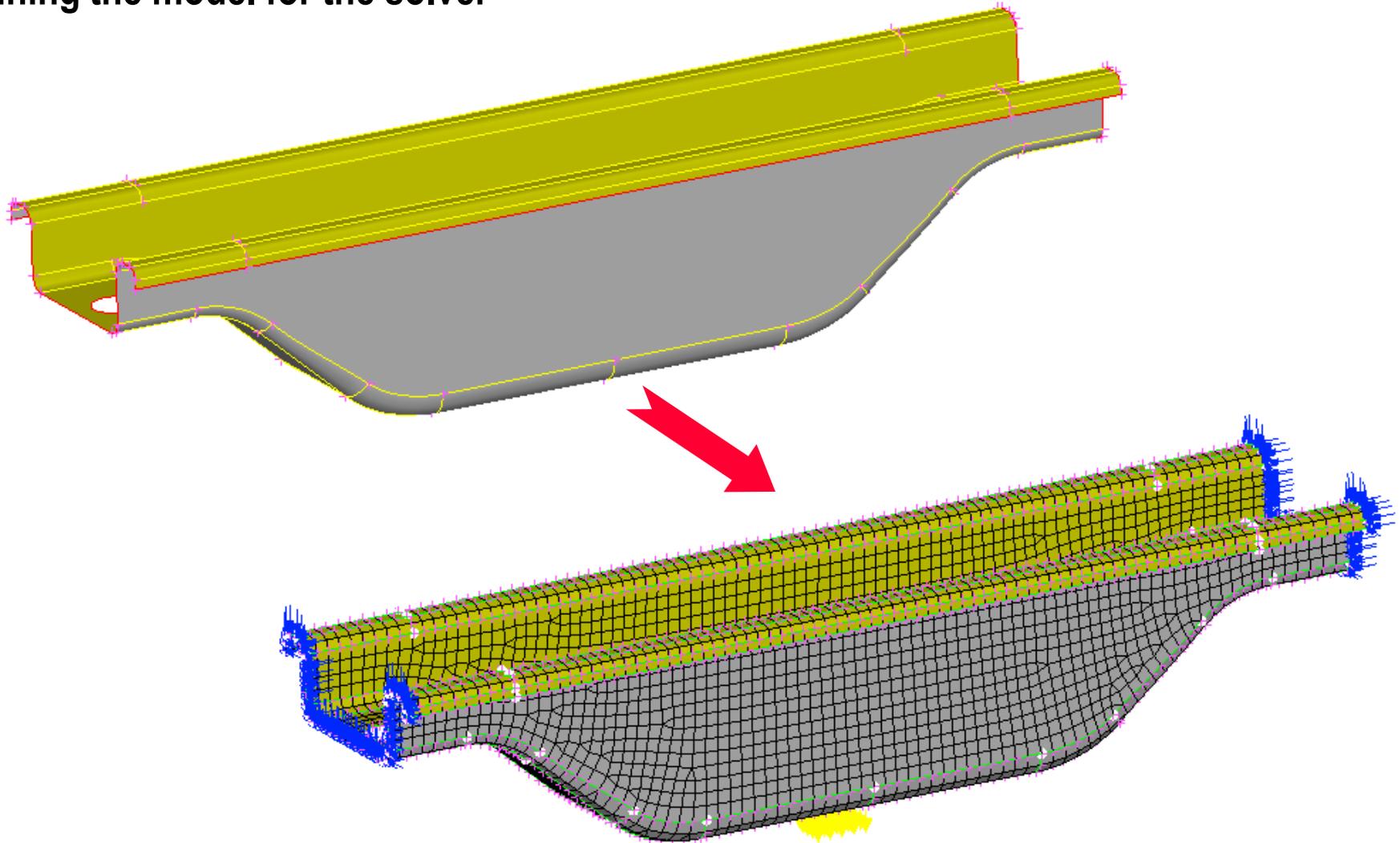


ANSA AS A PRE-PROCESSOR FOR LS-OPT OPTIMIZATION APPLICATIONS

Georgios Korbetis

- ◆ **Problem Definition**
- ◆ **Optimization Run**
- ◆ **Morphing Capabilities**
- ◆ **Conclusions**

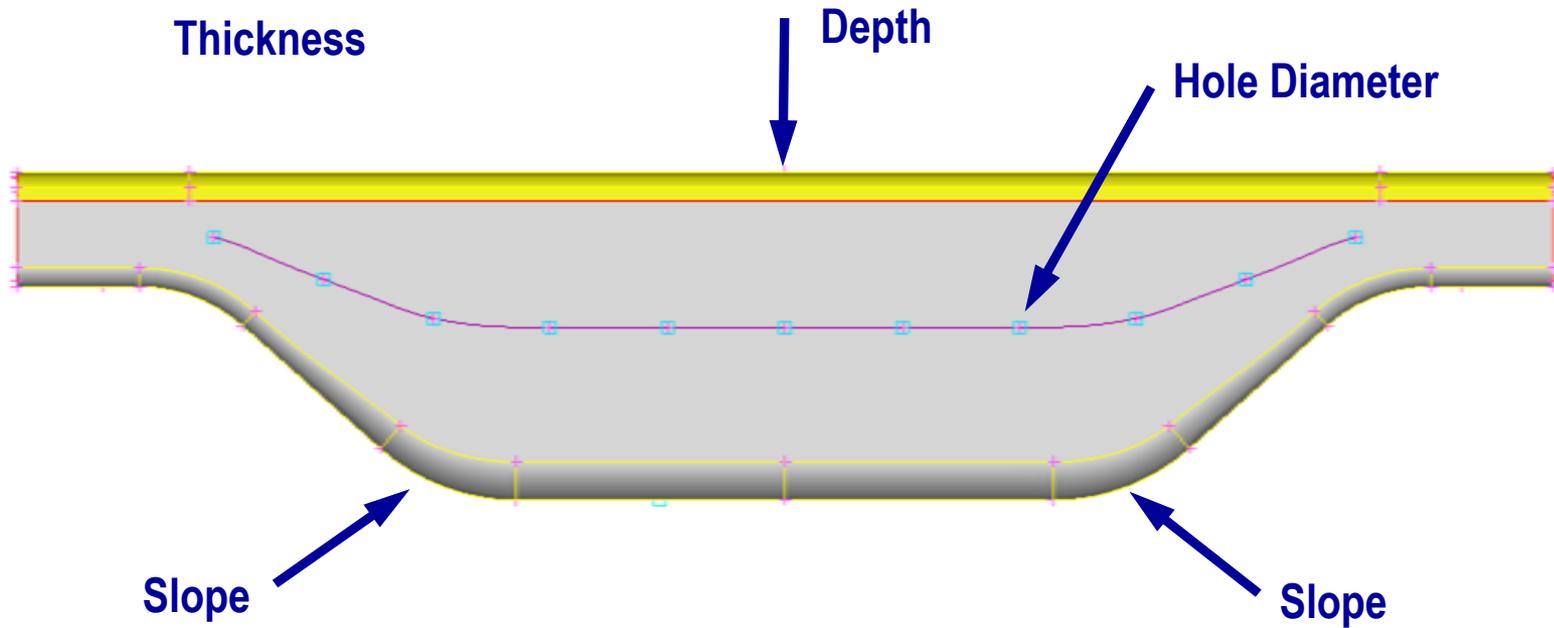
Defining the model for the solver



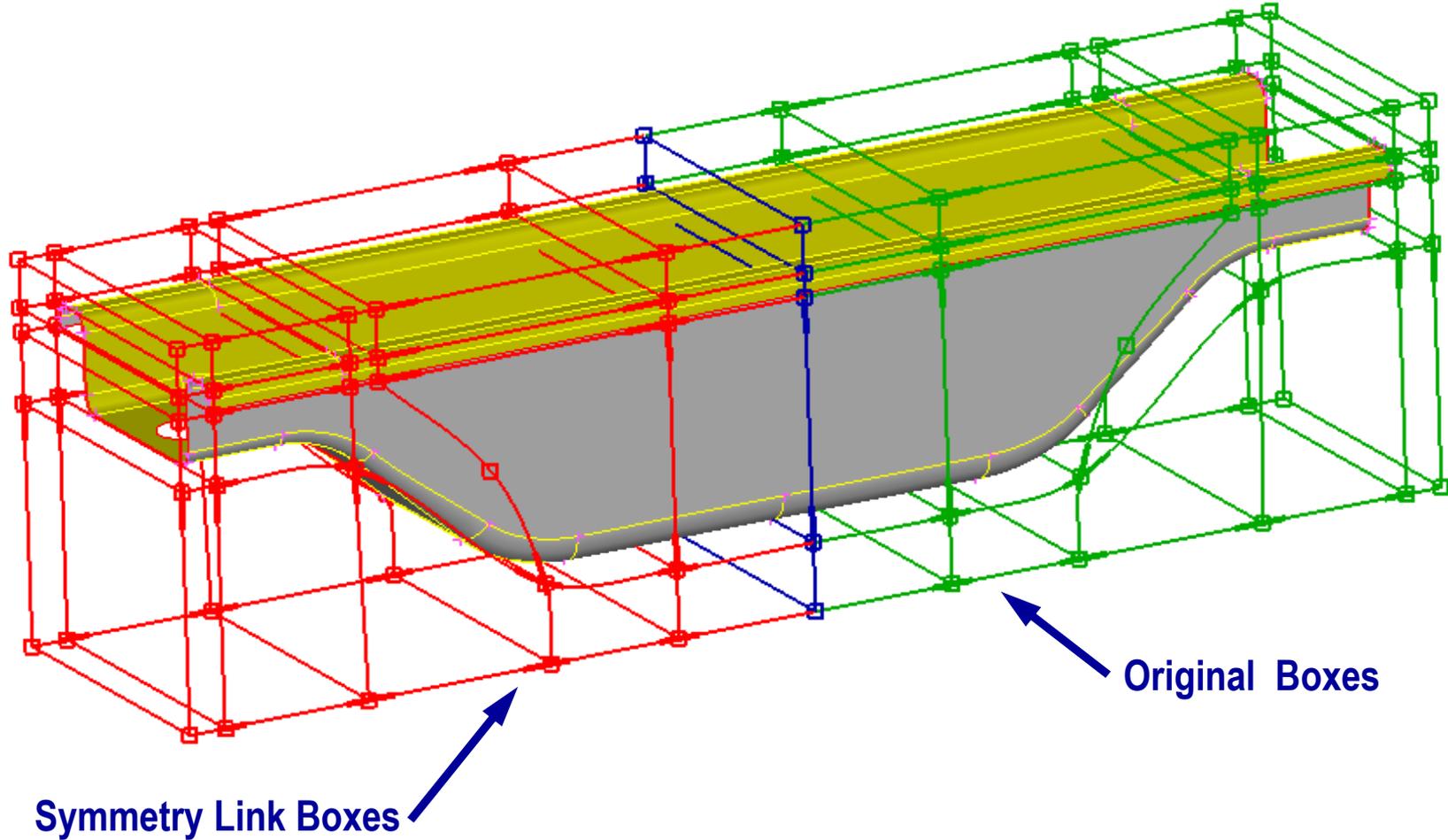
Objective function

Constraints

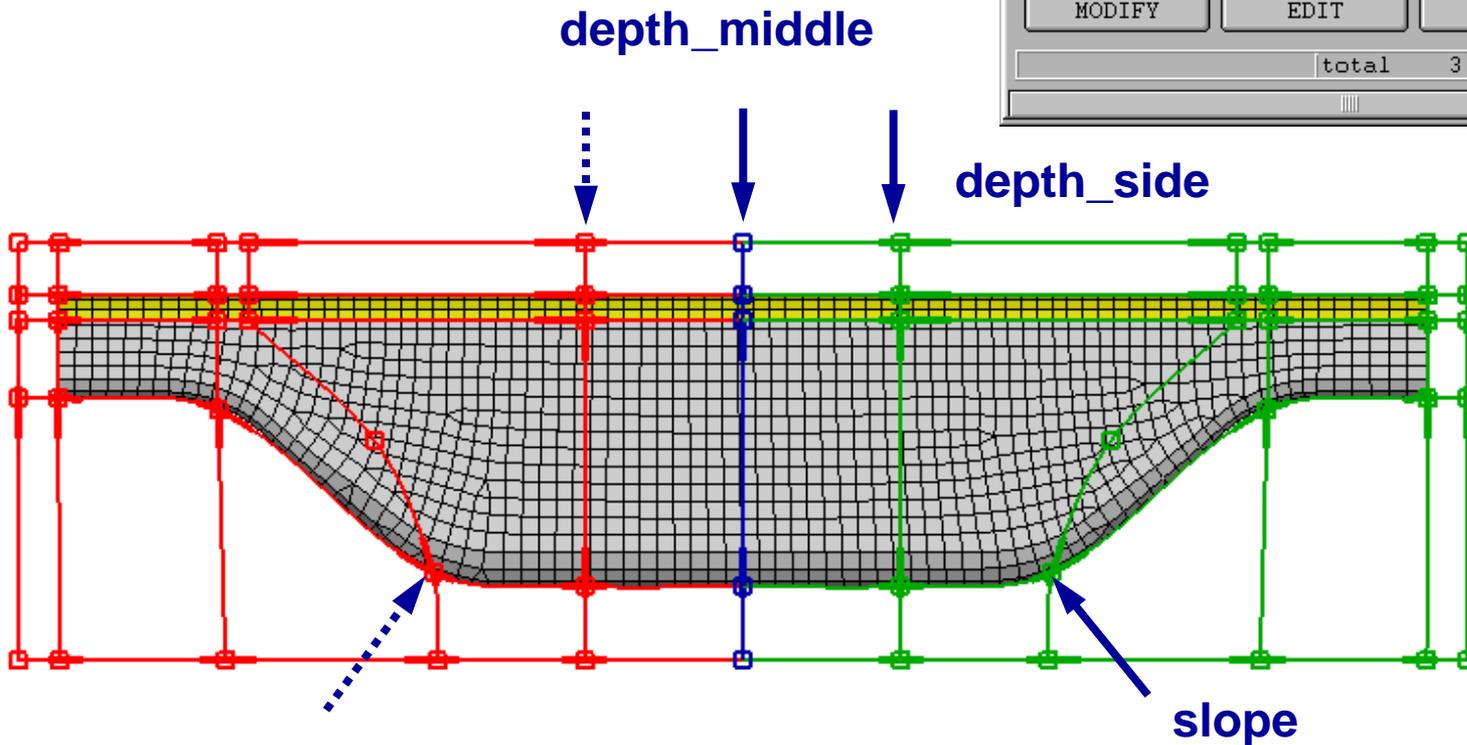
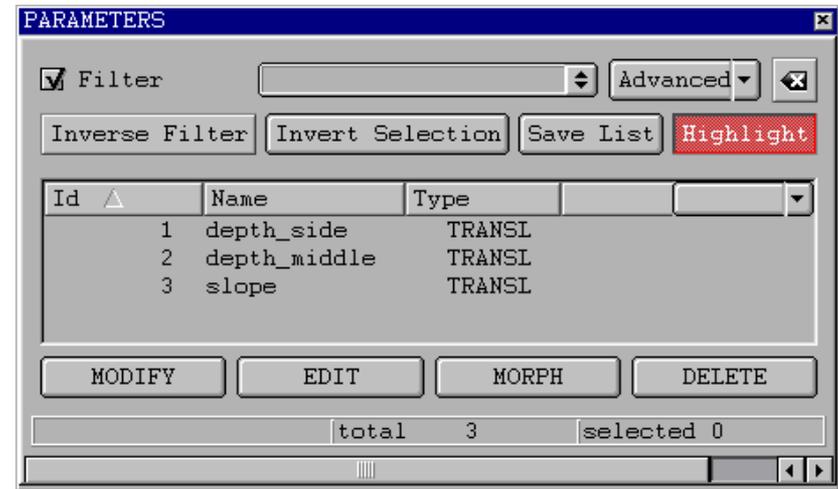
Design Variables



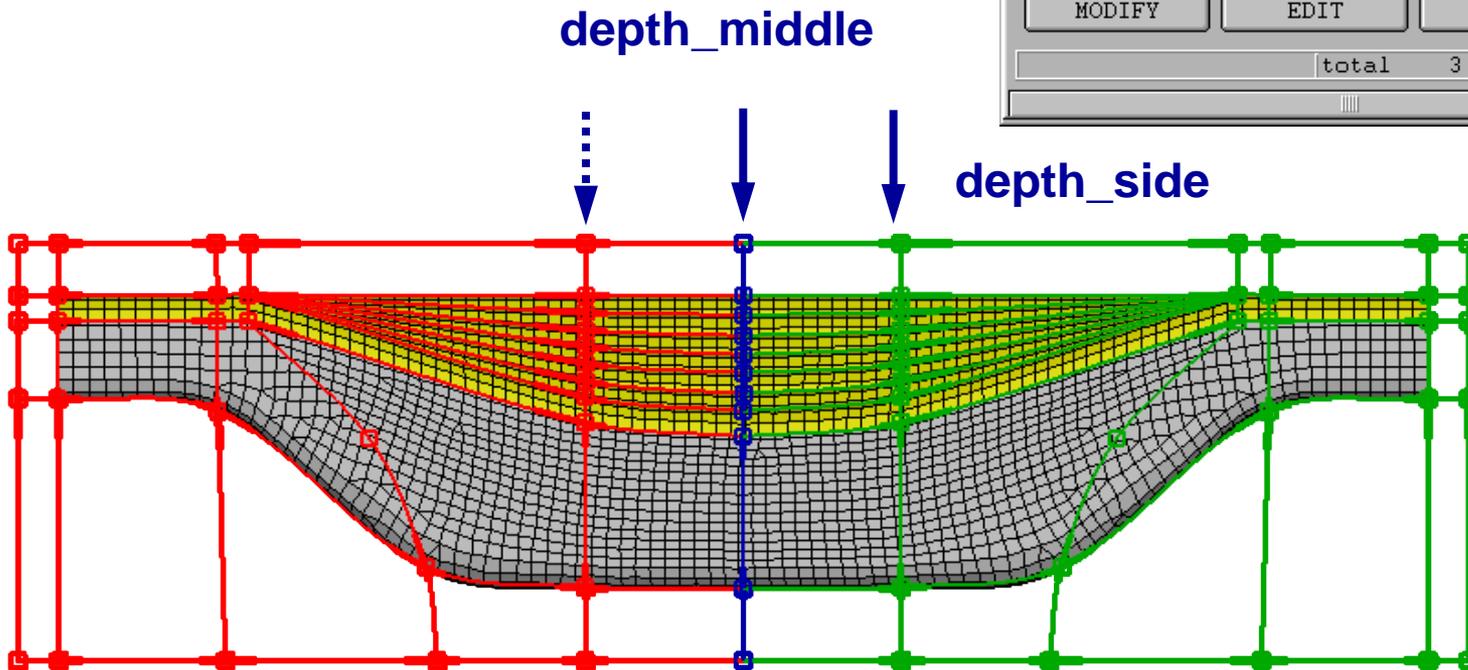
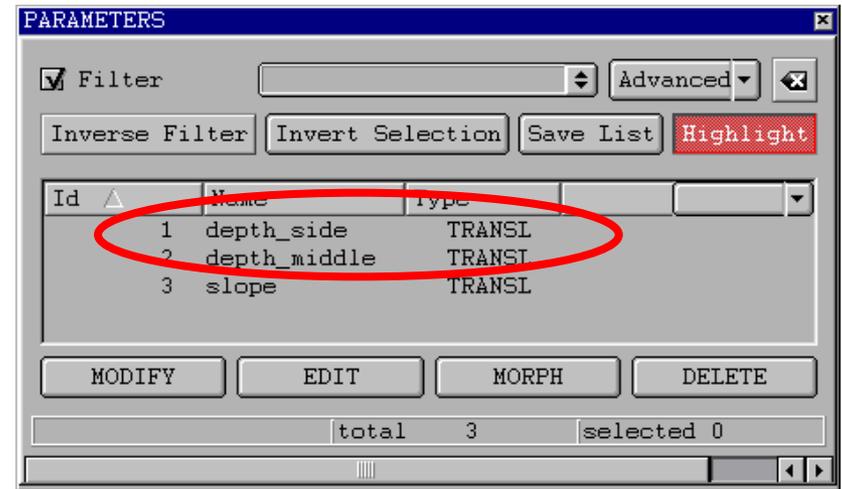
Creating Morphing Boxes



Defining Morphing Parameters

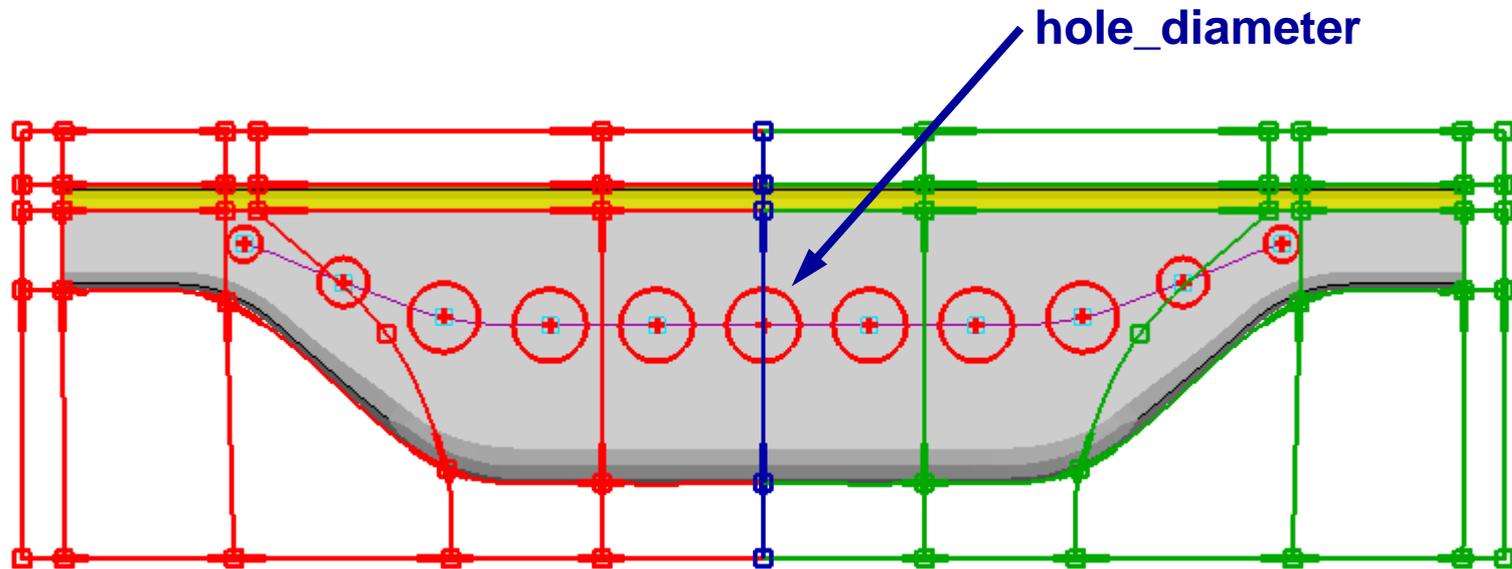


Defining Morphing Parameters



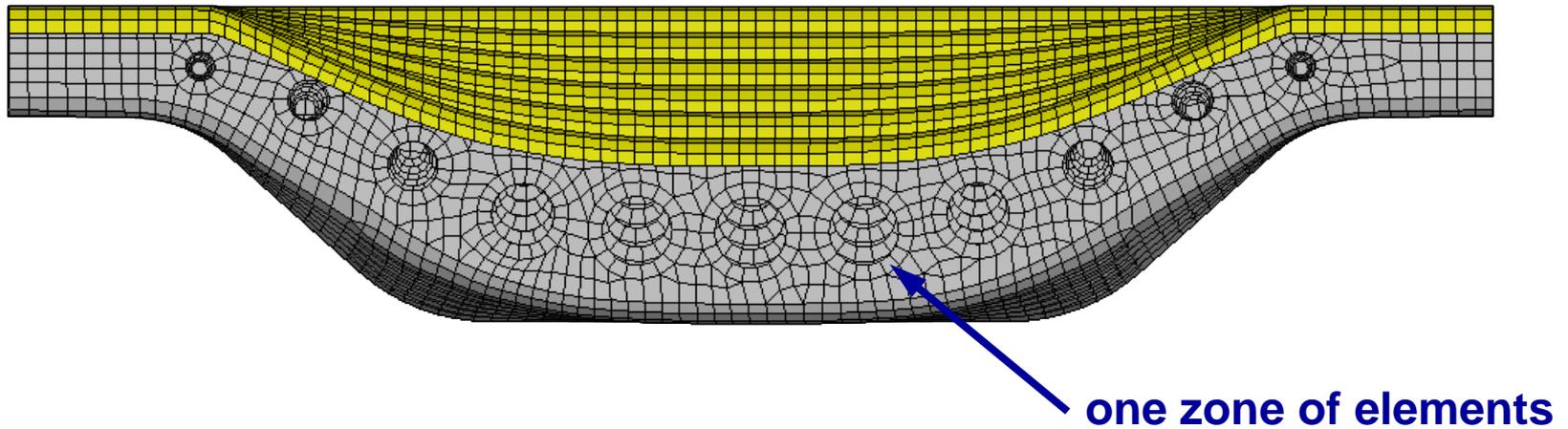
Connecting Design Variables with user scripts

- ◆ Open holes in FE-Model
- ◆ Specify meshing parameters for the holes

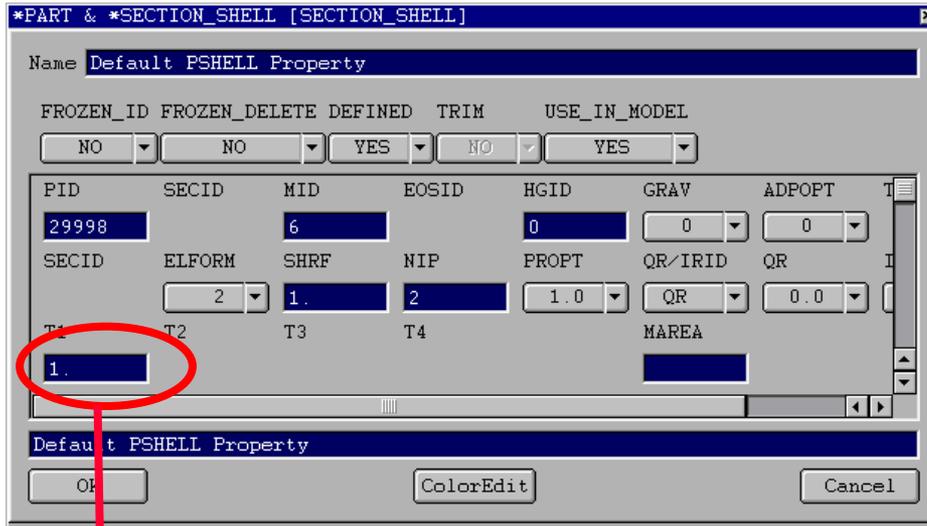


Connecting Design Variables with user scripts

- ◆ Open holes in FE-Model
- ◆ Specify meshing parameters for the holes

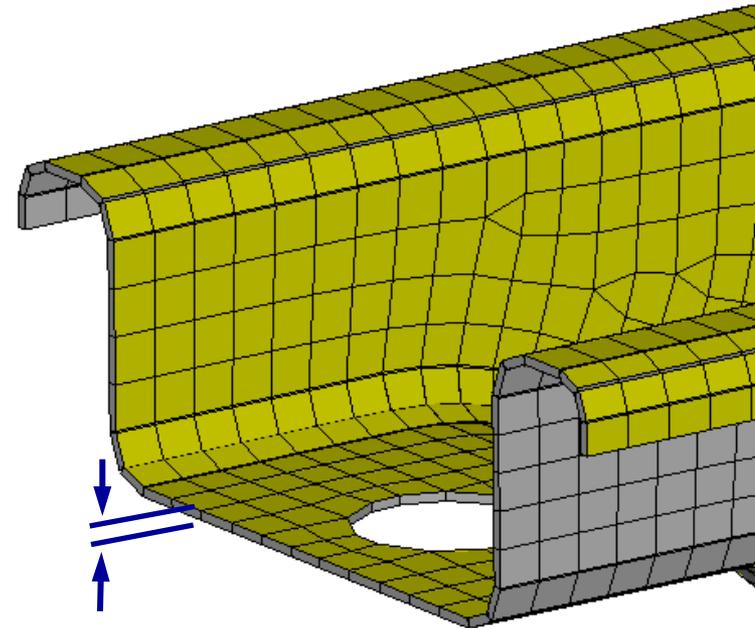


Defining thickness as ANSA Parameter



ANSA Parameter

Design Variable



shell_thickness

Defining Task Manager sequence

The screenshot displays the ANSYS Workbench interface for a task manager sequence. The central window shows a 3D mesh model of a subframe, with nodes colored in red, green, and blue. The left sidebar, titled 'Tasks View', shows a tree structure under 'Root' with the following tasks: Optimization Task, DV file, DEPTH (with sub-tasks depth_side and depth_middle), SLOPE (with sub-task slope), HOLES DIAMETER, User Script, THICKNESS (with sub-task Thickness), Reconstruct, and FE_output. A large red arrow points downwards from the 'User Script' task to the 'User Script:' field below the tree. The right sidebar contains various tool palettes for 'HOT POINTS', 'WELD SPOTS', 'CONS', 'FACES 5', 'SURFS 2', 'CURVES 3', and 'POINTS'. The bottom toolbar includes options for 'GEOMETR', 'MATs', 'PROP's', 'D.UTIL', 'FOCUS', 'OR', 'AND', 'INOT', 'ENT', 'RITERIA', 'WARP', 'VISIB', 'GEOM', 'ENT', 'FACES', 'HIDDEN', 'CURVES', 'CROSSH', and many others.

Connecting Design Variables with Morphing Parameters

The screenshot displays the BETA CAE-Systems S.A. interface. On the left, the 'Tasks View' tree shows a hierarchy under 'Optimization Task' including 'DEPTH', 'SLOPE', 'HOLES DIAMETER', 'THICKNESS', 'Reconstruct', and 'FE_output'. The 'DEPTH' folder is expanded, showing sub-items 'depth_side' and 'depth_middle'. A 3D model of a mechanical part is shown in the center, with red arrows pointing from the 'depth_side' and 'depth_middle' folders to the 'Morph Parameters' dialog box.

The 'DESIGN VARIABLE [OPTIMIZATION_TASK]' dialog box is open, showing the configuration for the 'DEPTH' variable:

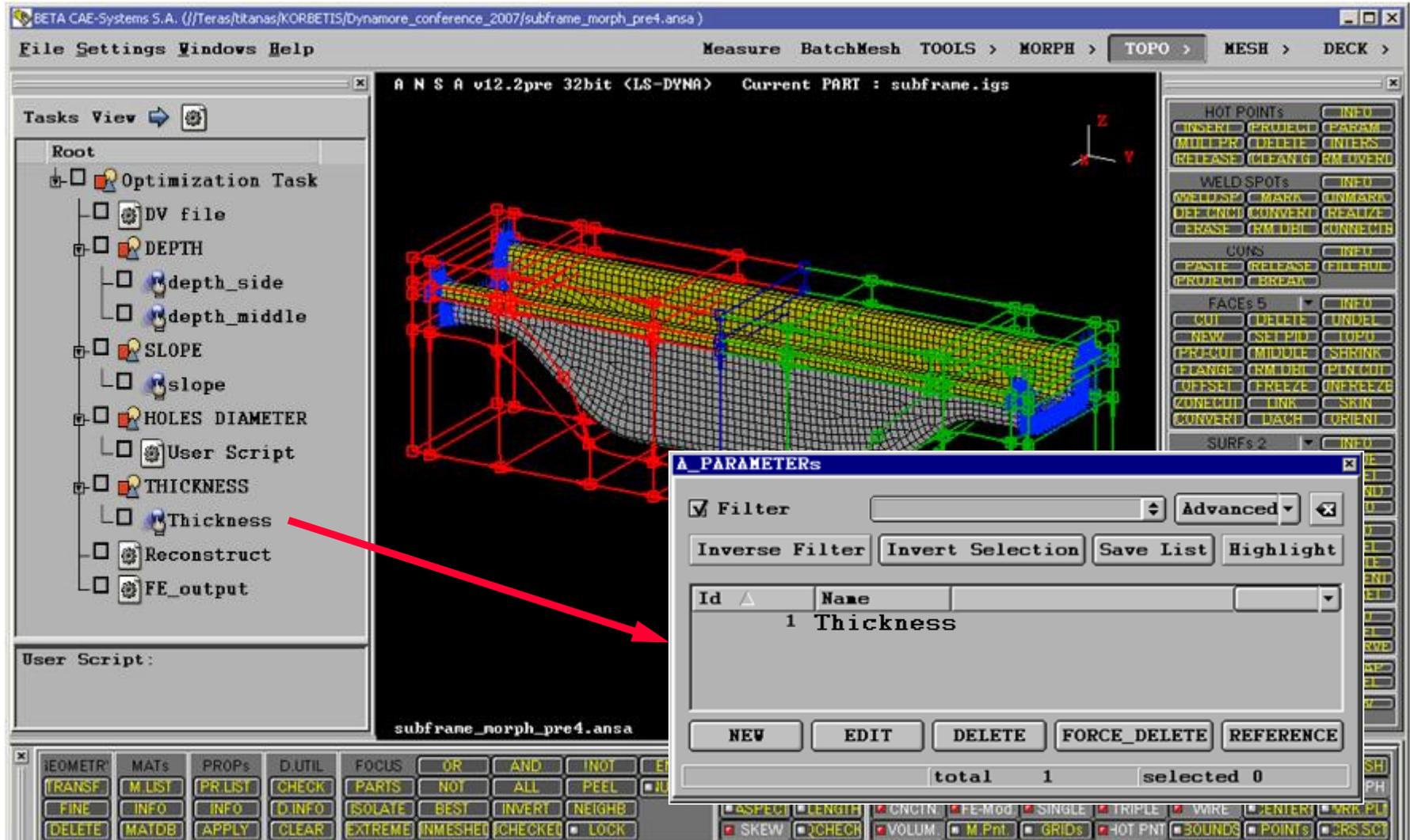
ID	TYPE	RANGE
1	REAL	BOUNDS
Min Value	Current Value	Max Value
0.	5.	50

The 'Morph Parameters' dialog box is also open, showing a table of morphing parameters:

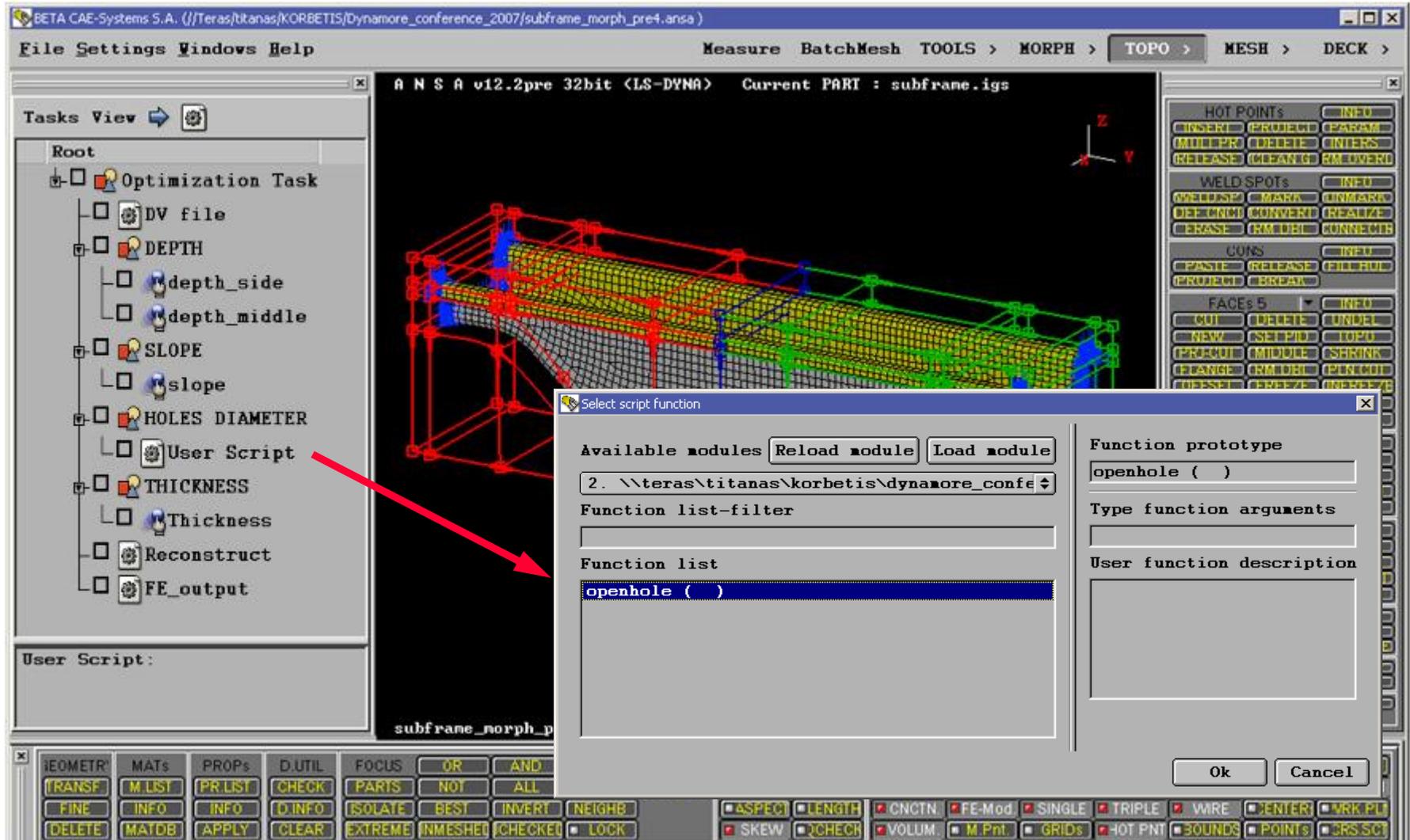
ID	Name	Type	Current value
1	depth_side	TRANSL	DEPTH
2	depth_middle	TRANSL	DEPTH *1.1
3	slope	TRANSL	DEPTH

At the bottom of the interface, there is a toolbar with various tool icons such as 'TRANSF', 'M LIST', 'PR LIST', 'CHECK', 'PARTS', 'OR', 'AND', 'INOT', 'ENT', 'RITERIA', 'WARP', 'VISIB', 'GEOM', 'ENT', 'FACES', 'HIDDEN', 'CURVES', 'CROSH', etc.

Connecting Design Variables with ANSA parameters



Connecting user scripts to Design Variables

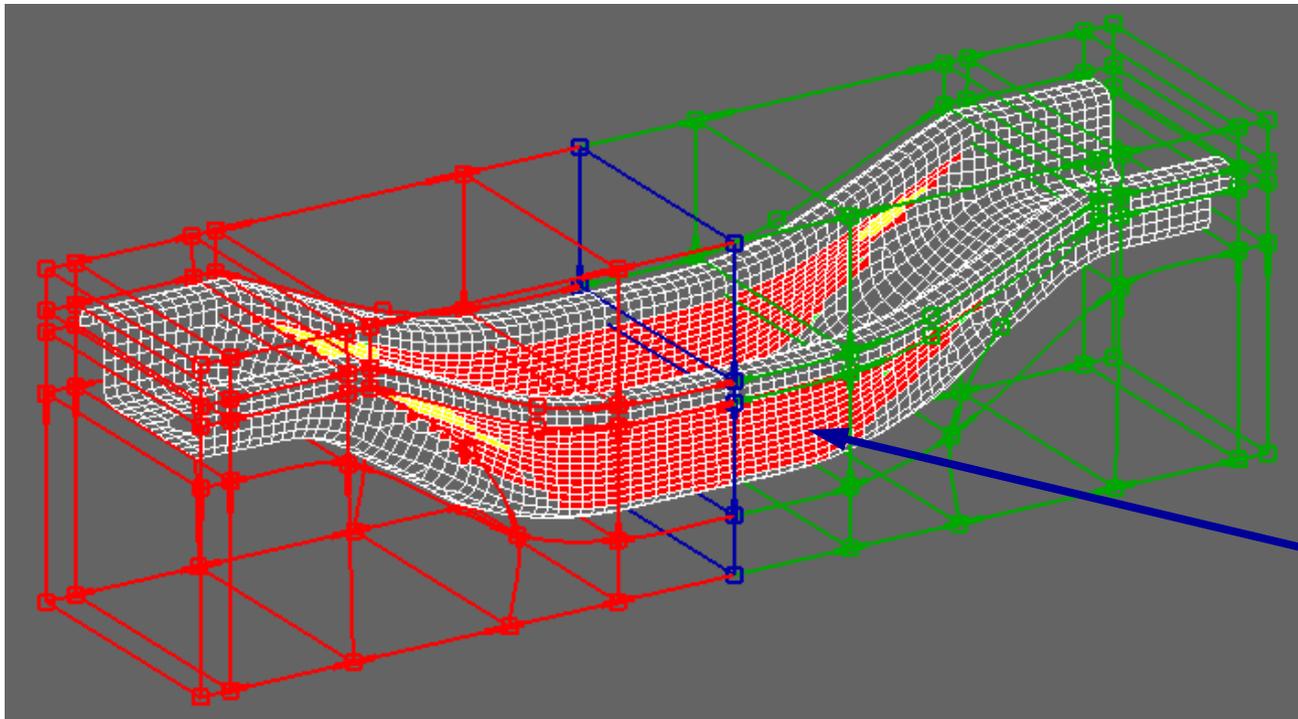


Checking Model Validity

Simulate window

	ID	Name	Type	Range	Simulate	Minimum	Maximum	Current
1	1	DEPTH	Real	Bounds	<input checked="" type="checkbox"/>	0	50	5
2	2	SLOPE	Real	Bounds	<input checked="" type="checkbox"/>	0	10	0
3	4	HOLES DIAMETER	Real	Bounds	<input checked="" type="checkbox"/>	0	20	0
4	3	THICKNESS	Real	List	<input checked="" type="checkbox"/>	1	1.4	1.0

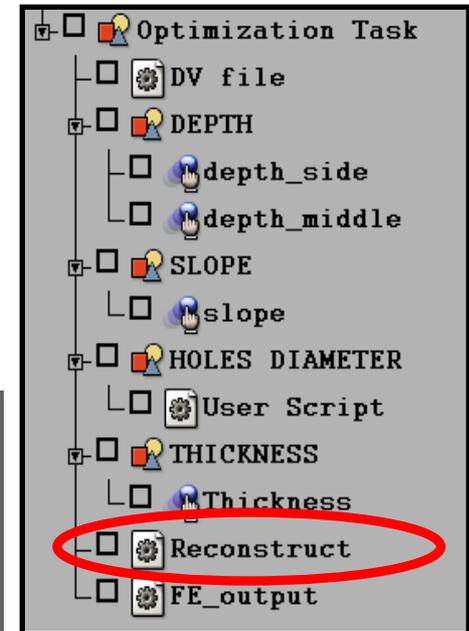
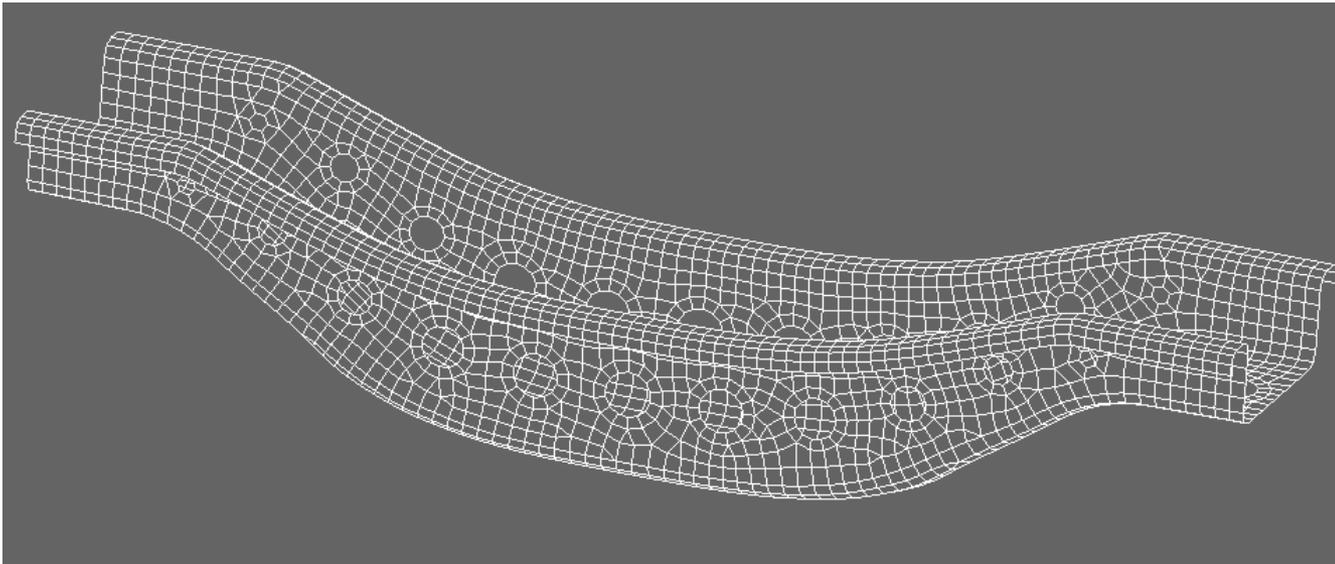
OK Apply Restore Cancel



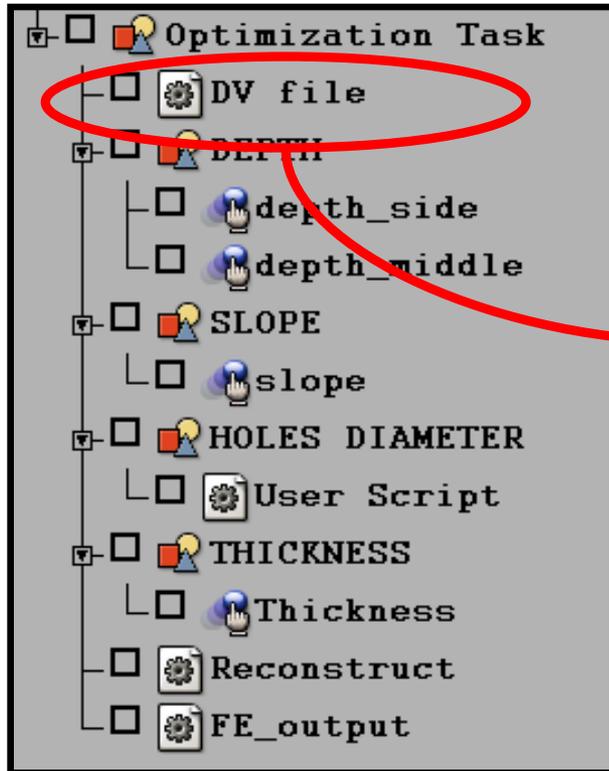
30

6.0

Improve model quality using scripts and session commands

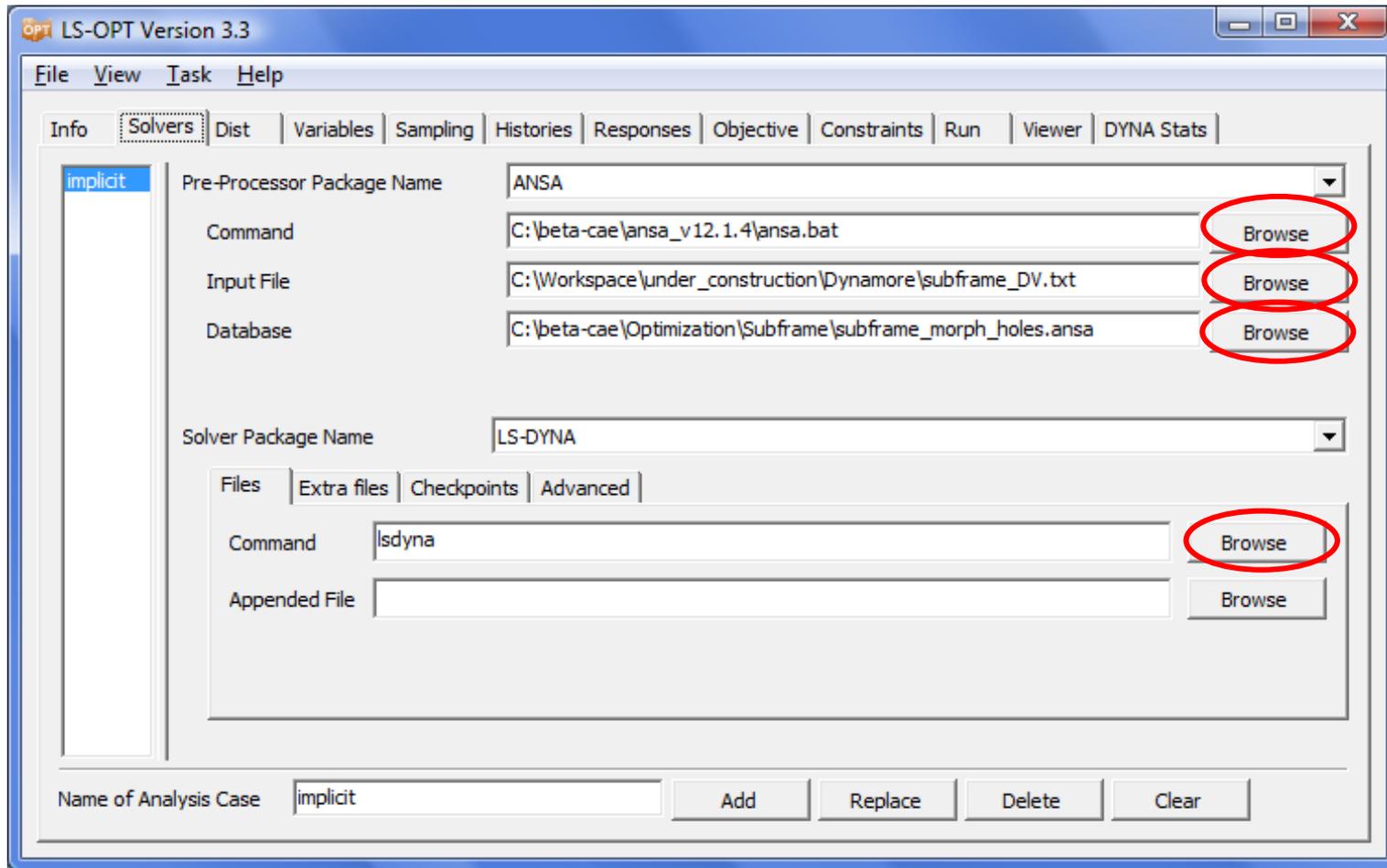


Output Design Variables



```
$ DESIGN VARIABLES
$-----
$ ID | DESIGN VARIABLE NAME | TYPE | RANGE | CURRENT
VALUE | MIN VALUE --> MAX VALUE | STEP
$-----
1 DEPTH REAL BOUNDS 10. 0. 50.
2 SLOPE REAL BOUNDS 10. 0. 10.
3 HOLES DIAMETER REAL BOUNDS 0. 0. 20.
4 THICKNESS REAL LIST 1. 1. 1.2 1.4
$-----
```

Connect ANSA to LS-OPT



Connect ANSA to LS-OPT

The screenshot shows the LS-OPT Version 3.3 interface with the 'Variables' tab selected. The 'Design Variables' table is populated with the following data:

Type	Name	Starting	Init. Range	Minimum	Maximum
Variable	DEPTH	10		0	50
Variable	SLOPE	10		0	10
Variable	HOLES_DIAMETER	0		0	20
Discrete Var	THICKNESS	1	Values	1 1.2 1.4	

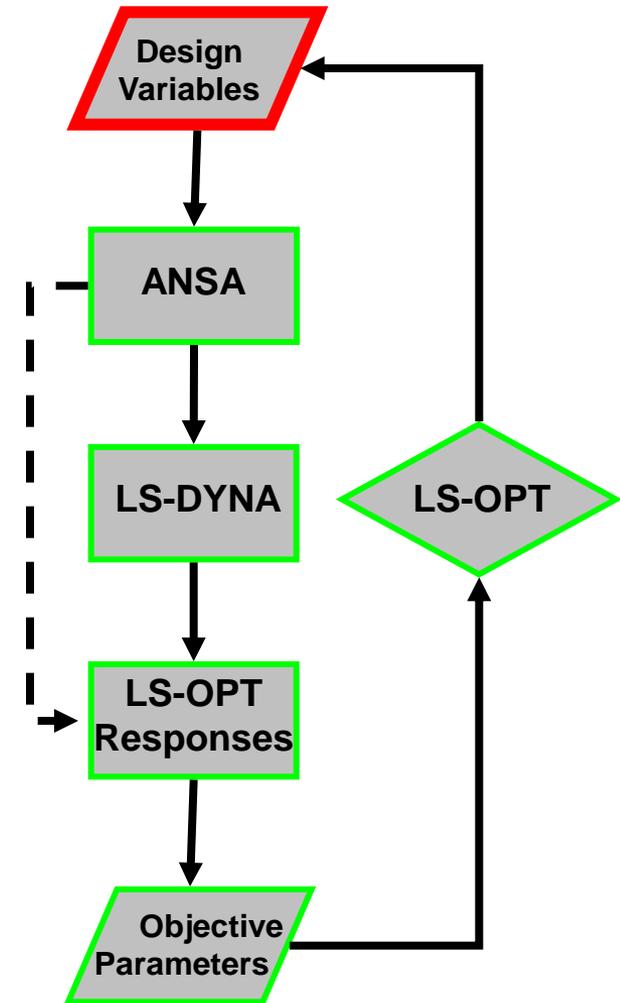
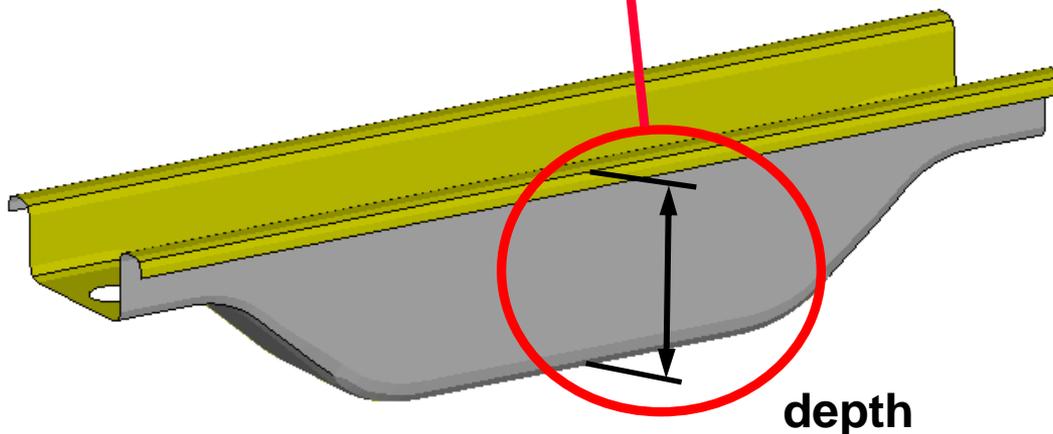
Additional interface elements include a 'Saddle Direction' dropdown set to 'Minimize' and 'Cases' radio buttons for 'All' and 'List'. An 'Add a Variable' button is located at the bottom left of the window.

```

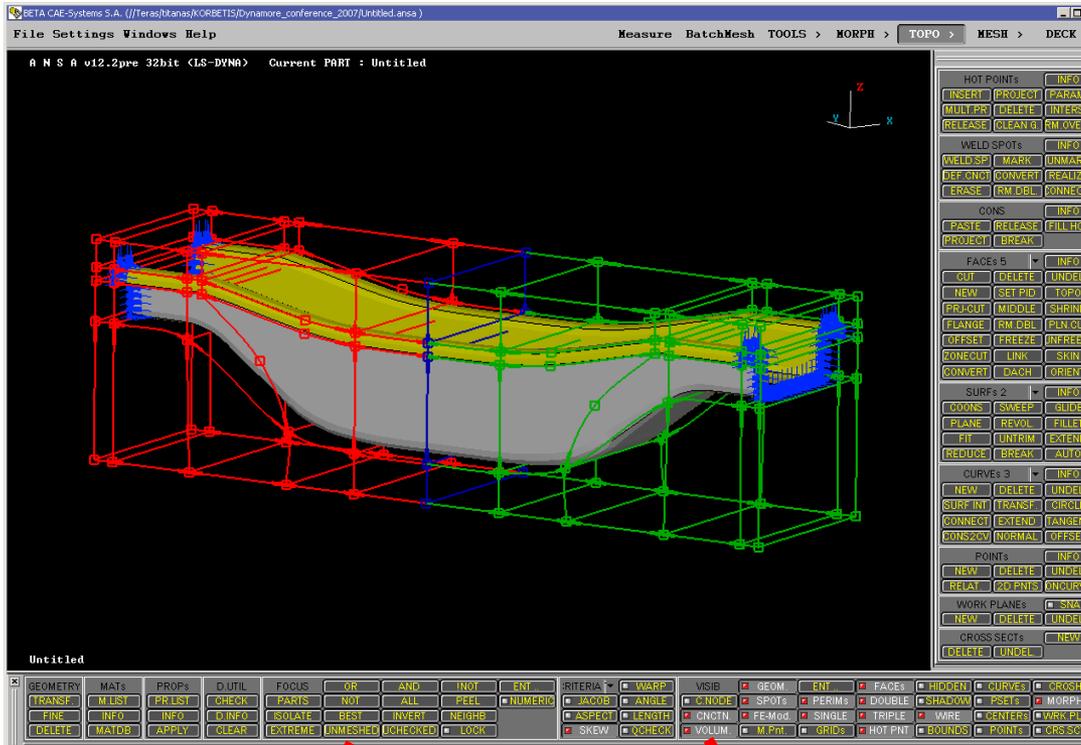
$ DESIGN VARIABLES
$-----
$ ID | DESIGN VARIABLE NAME | TYPE | RANGE | CURRENT
VALUE | MIN VALUE --> MAX VALUE | STEP
$-----
1 DEPTH REAL BOUNDS 10.0.50.
2 SLOPE REAL BOUNDS 10.0.10.
3 HOLES DIAMETER REAL BOUNDS 0.0.20.
4 THICKNESS REAL LIST 1.1.1.2 1.4
$-----
    
```

Modifying Design Variables

```
$ DESIGN VARIABLES
$-----
$ ID | DESIGN VARIABLE NAME | TYPE | RANGE | CURRENT VALUE | MIN
VALUE --> MAX VALUE | STEP
$-----
1 DEPTH REAL BOUNDS <<DEPTH>> 0. 50.
2 SLOPE REAL BOUNDS <<SLOPE>> 0. 10.
3 HOLES DIAMETER REAL BOUNDS <<HOLES_DIAMETER>> 0. 20.
4 THICKNESS REAL LIST <<THICKNESS>> 1. 1.2 1.4
$-----
```

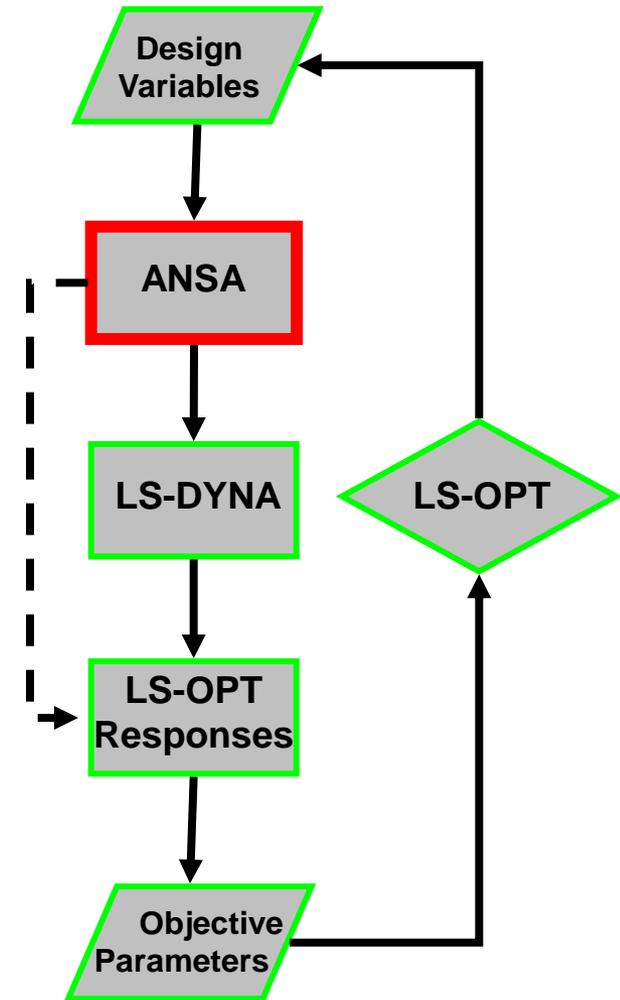


Runs the task manager sequence
Output LSDYNA file and model report

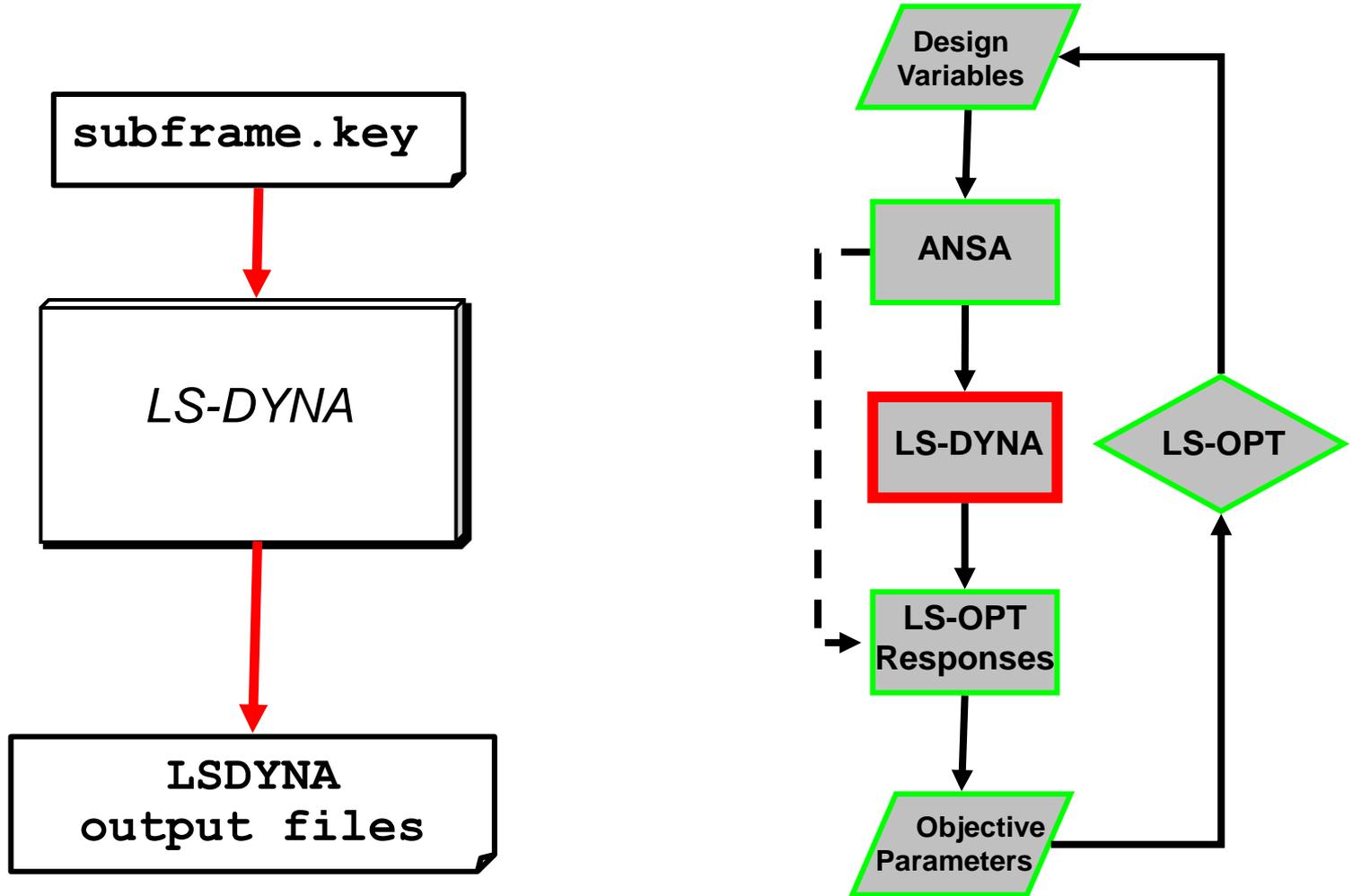


model_report.txt

subframe.key

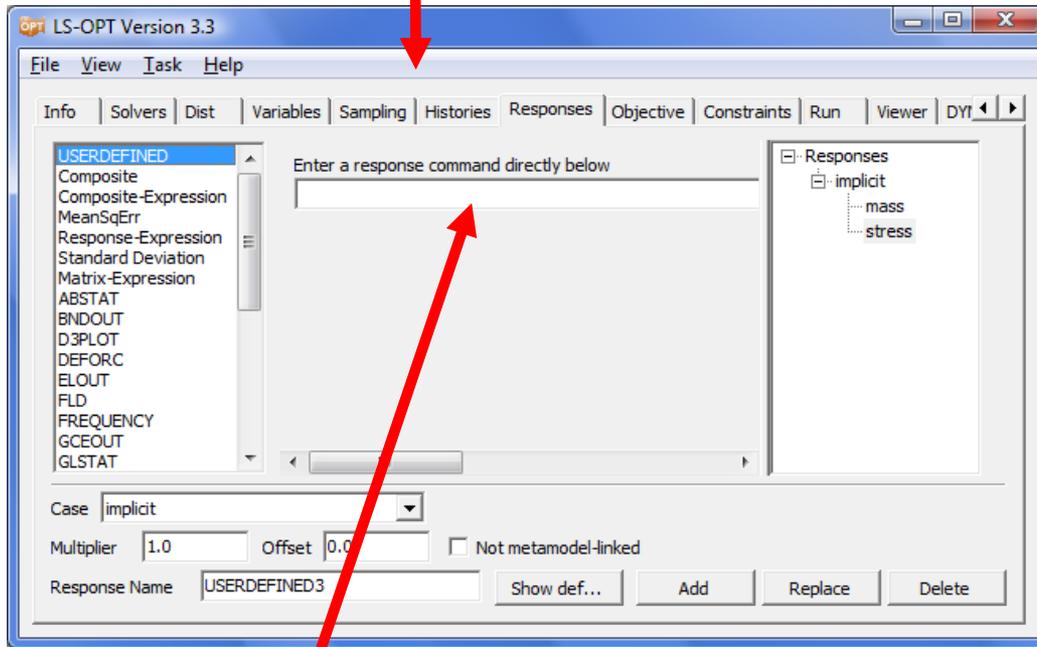


Invoke solver

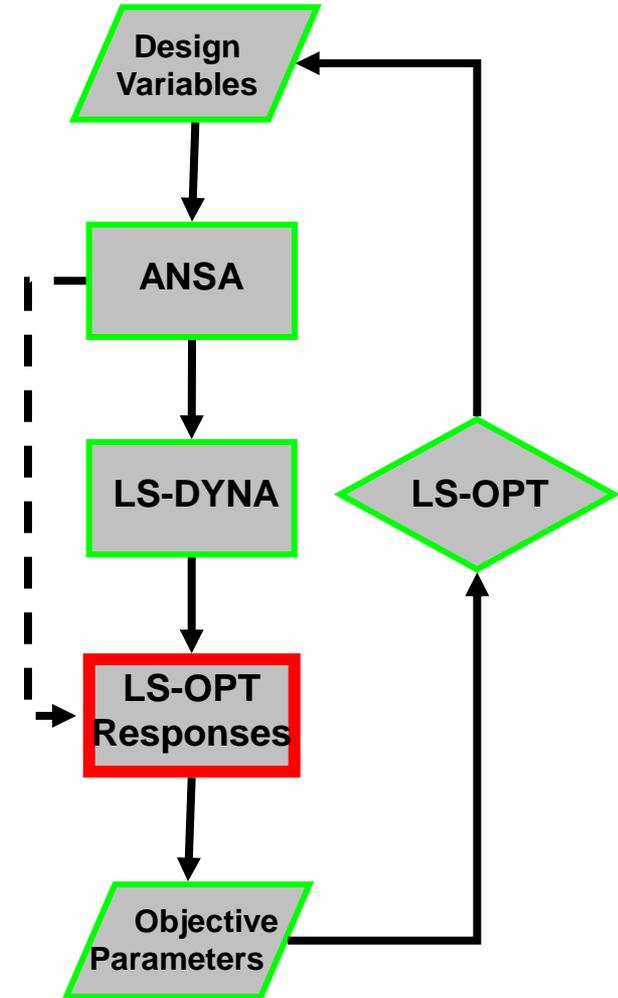


Extract responses using LS-OPT functionality

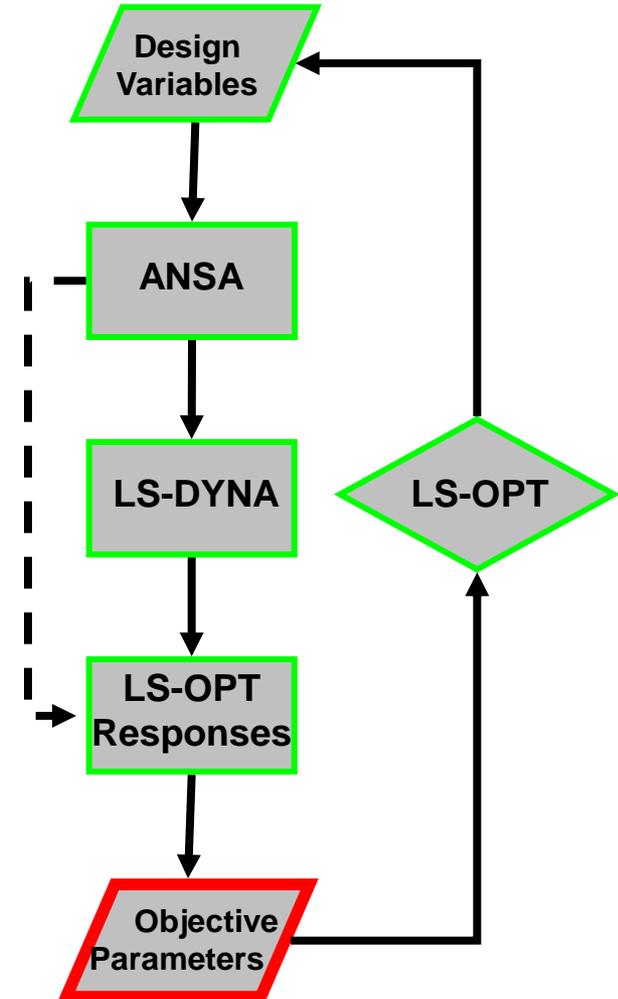
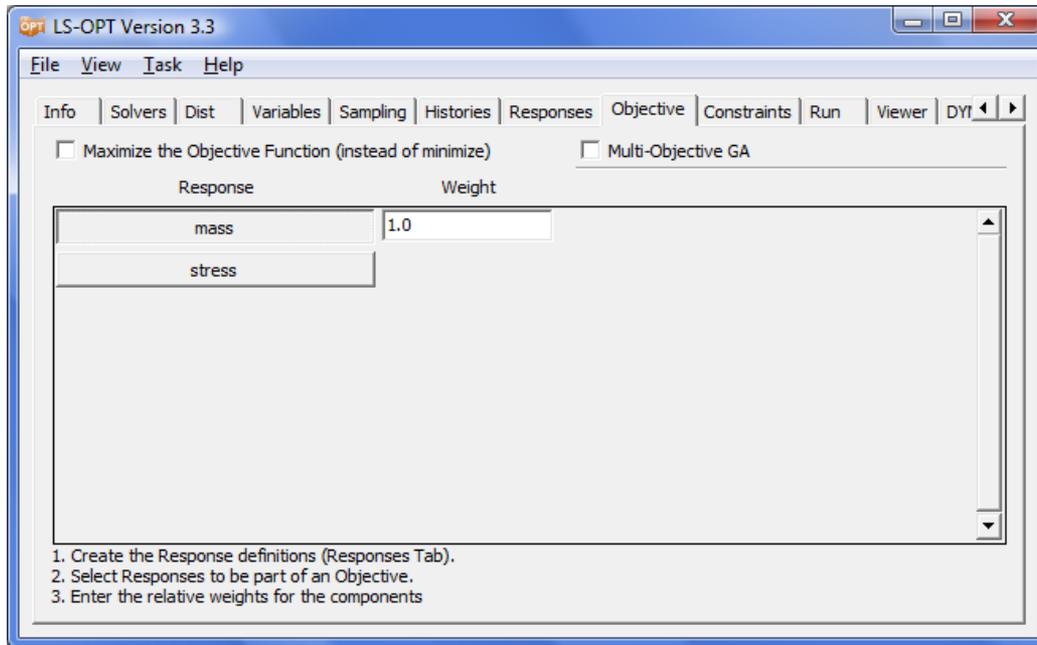
LS-DYNA
output files



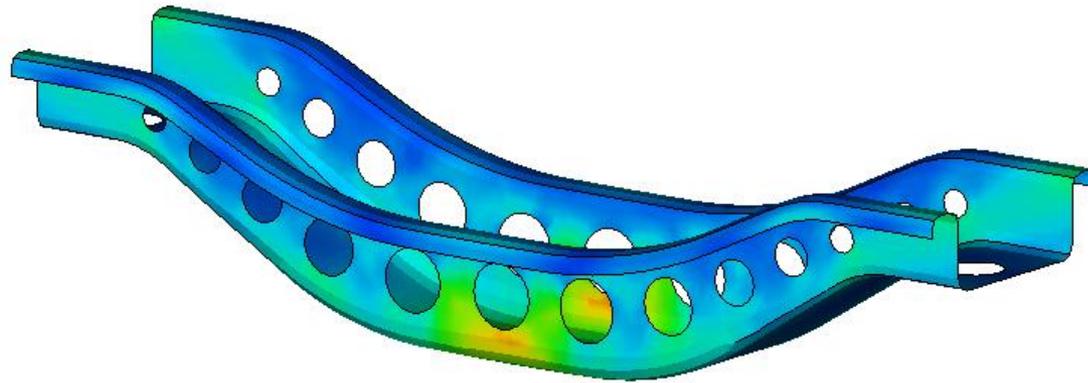
Max_stress.txt



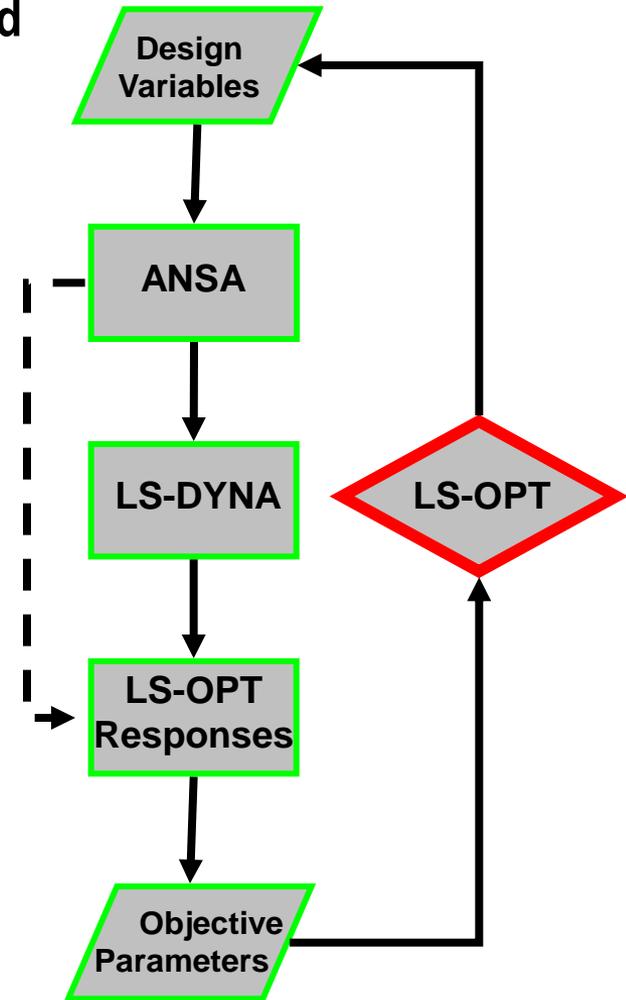
Calculate objective function and constraints



The optimization algorithm calculates new values for the design variables
The process is repeated until the optimal solution is found

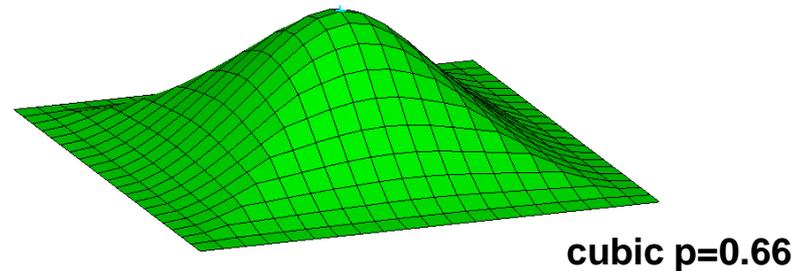
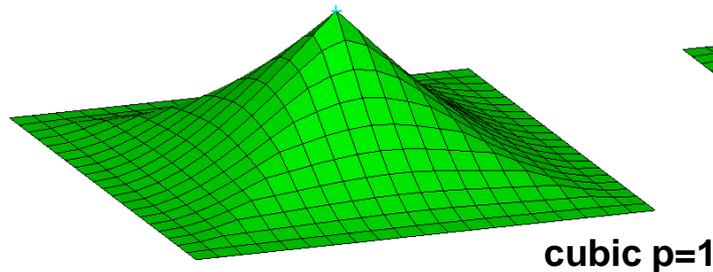
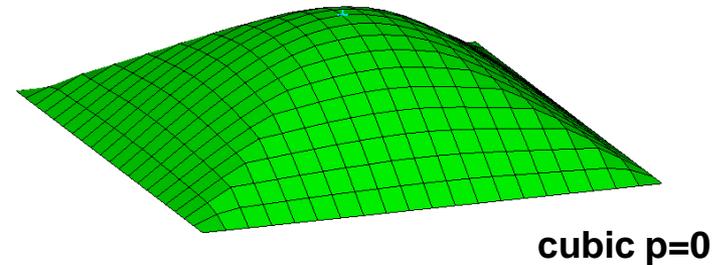
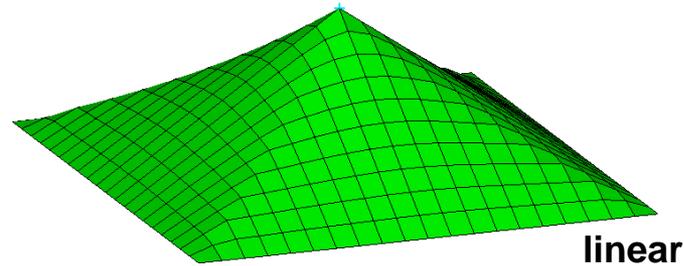
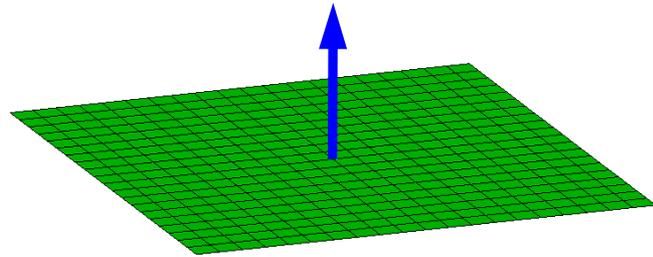


Optimal solution



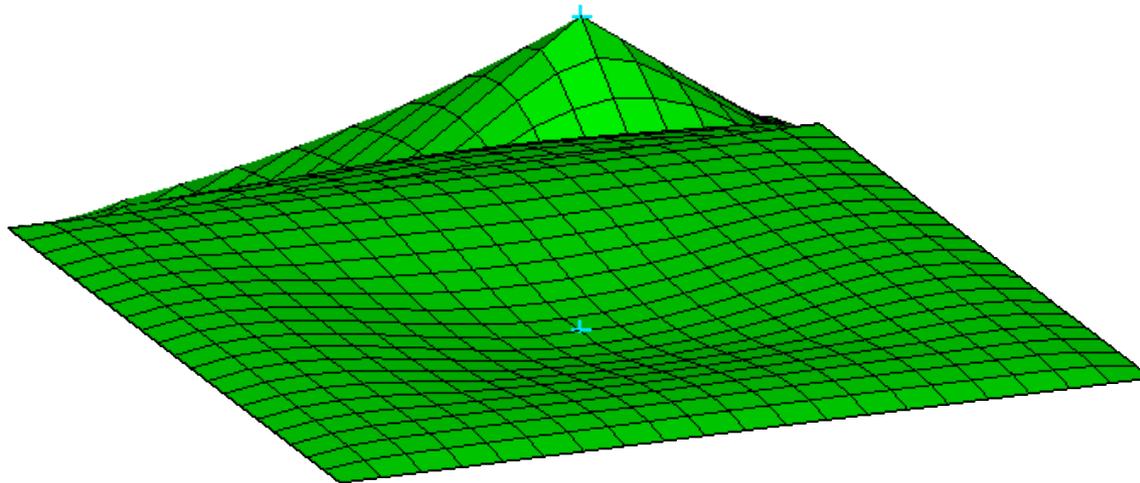
Direct Morphing

- ◆ Apply different algorithms of morphing
- ◆ Define complicated shapes from basic geometry



Direct Morphing

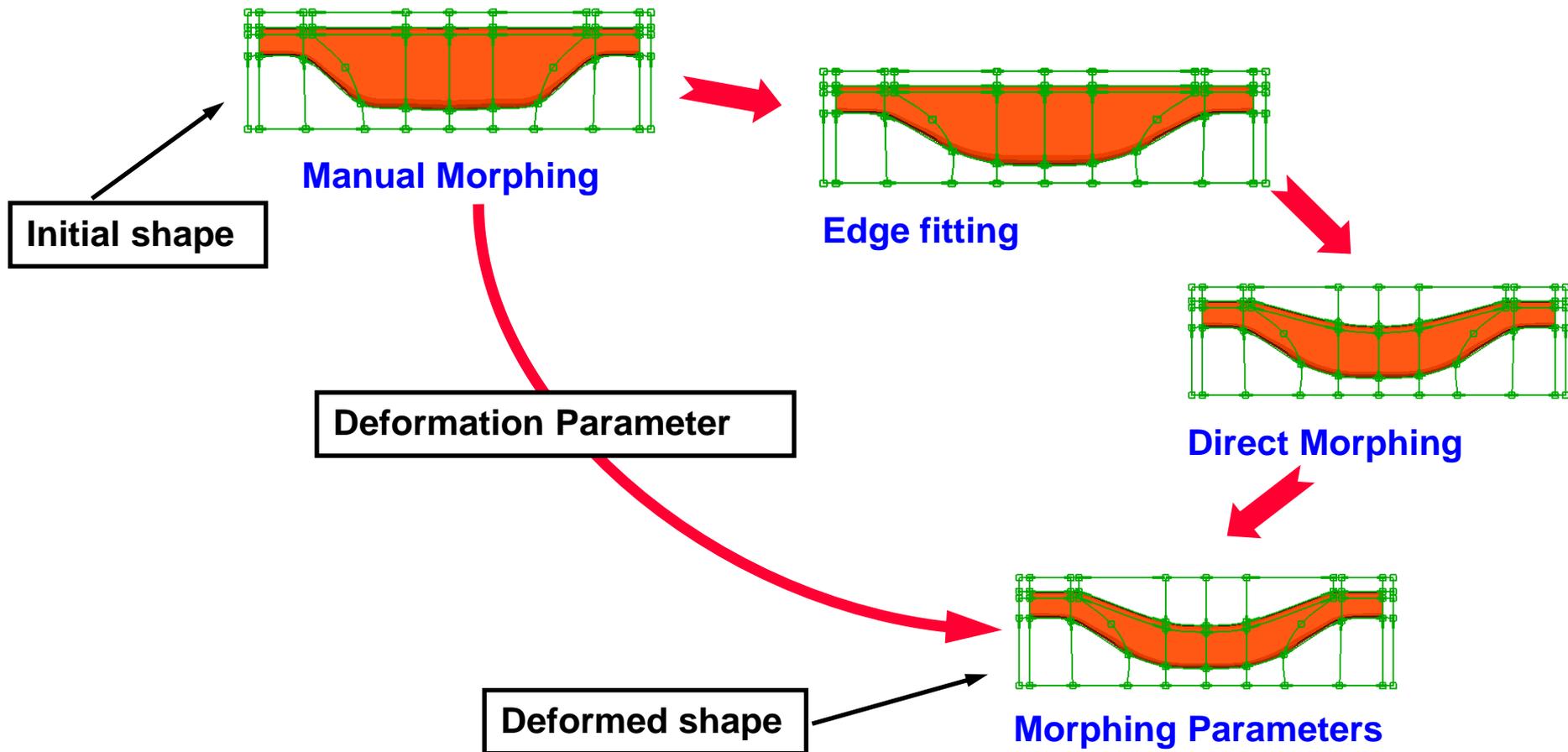
- ◆ Apply different algorithms of morphing
- ◆ Define complicated shapes from basic geometry



linear + cubic (p=1) + cubic (p=0)

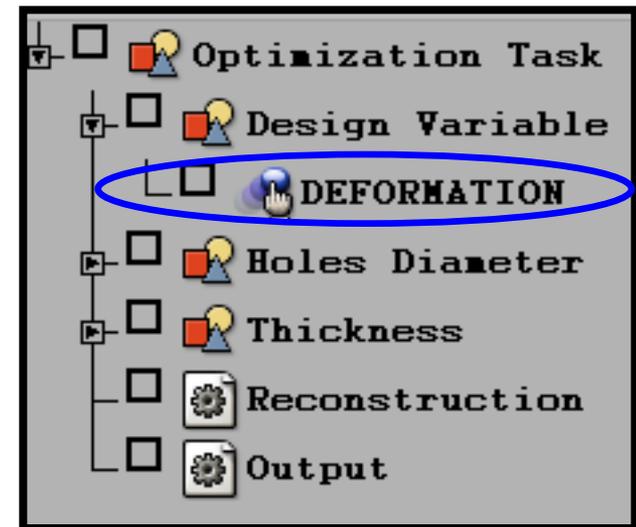
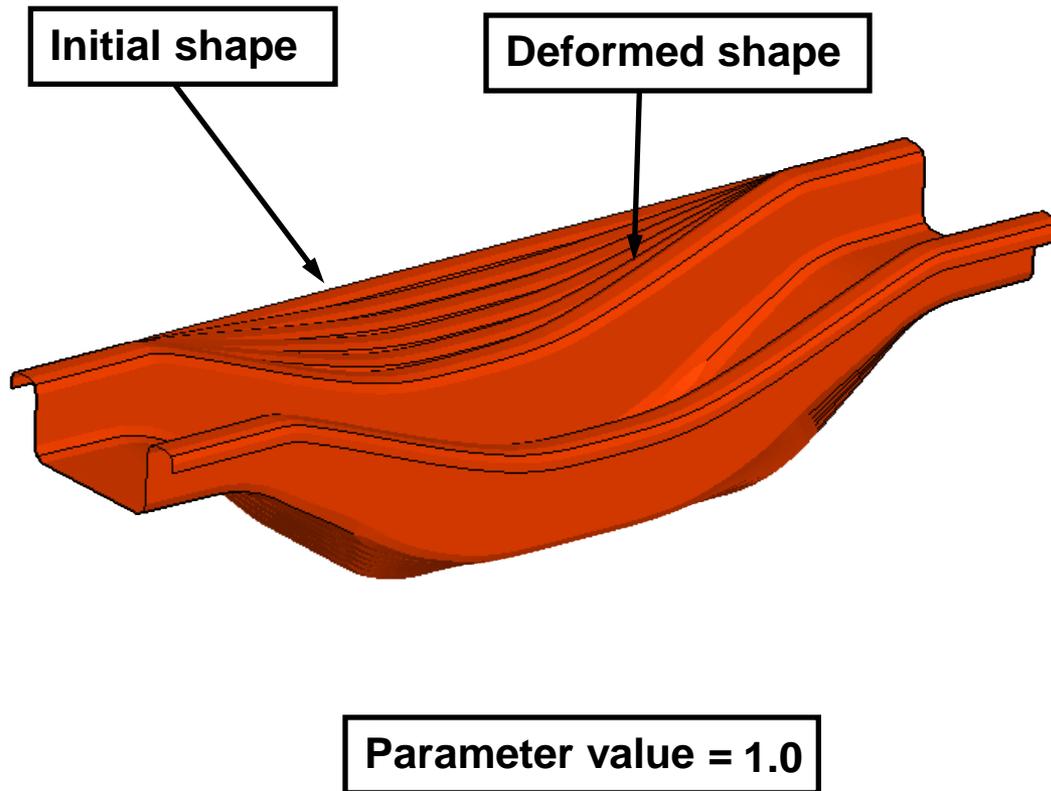
Deformation Morphing Parameter

- ◆ Combining many morphing processes in one Parameter
- ◆ Connect any morphing application to Task Manager

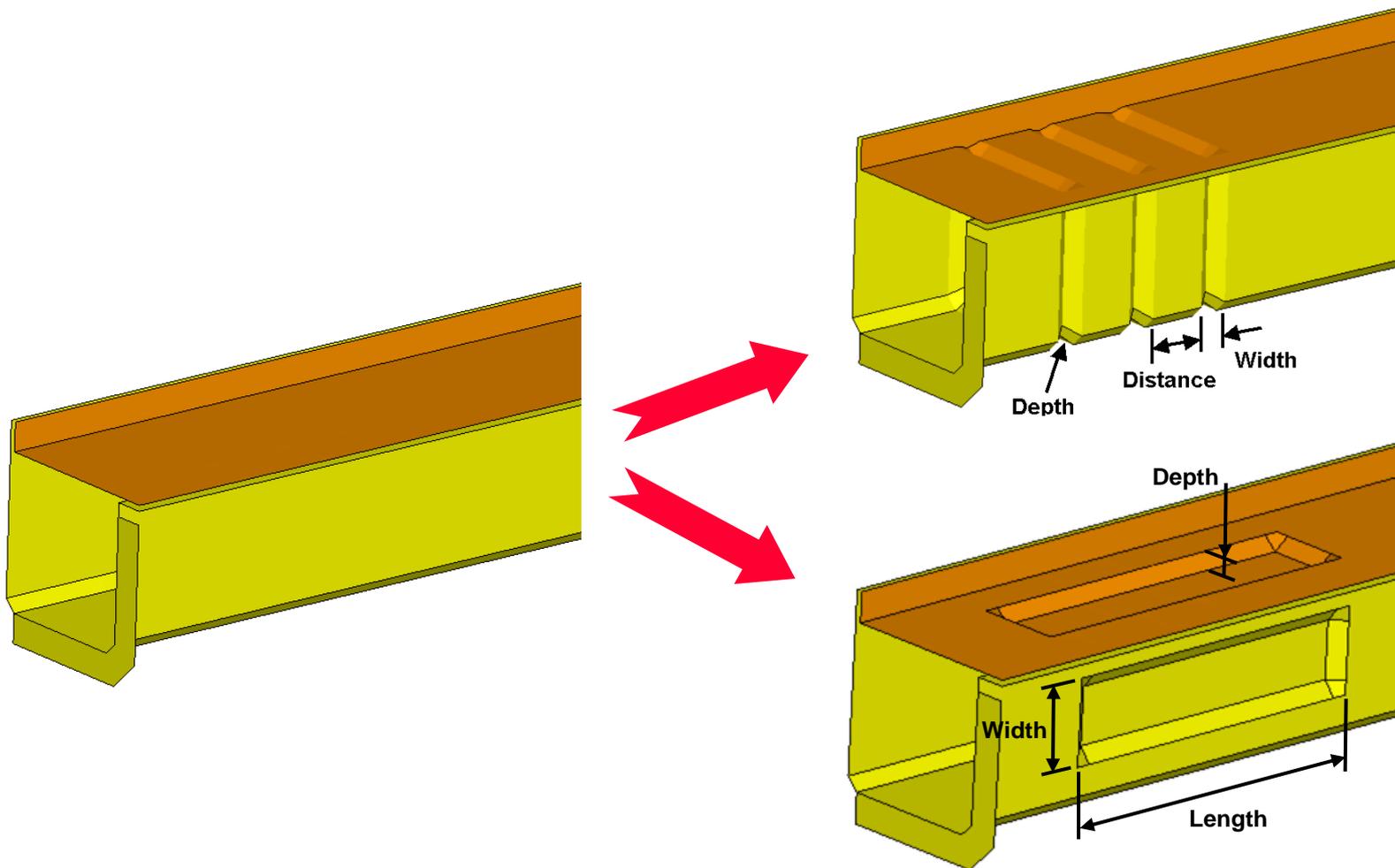


Deformation Morphing Parameter

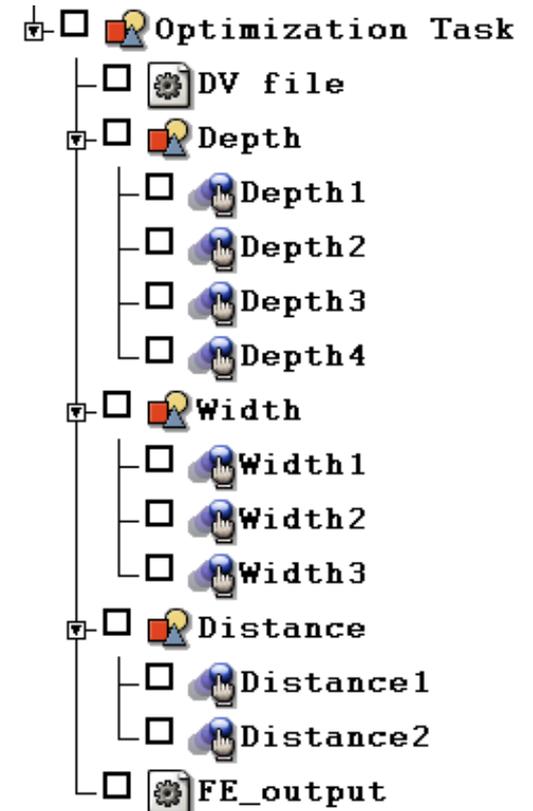
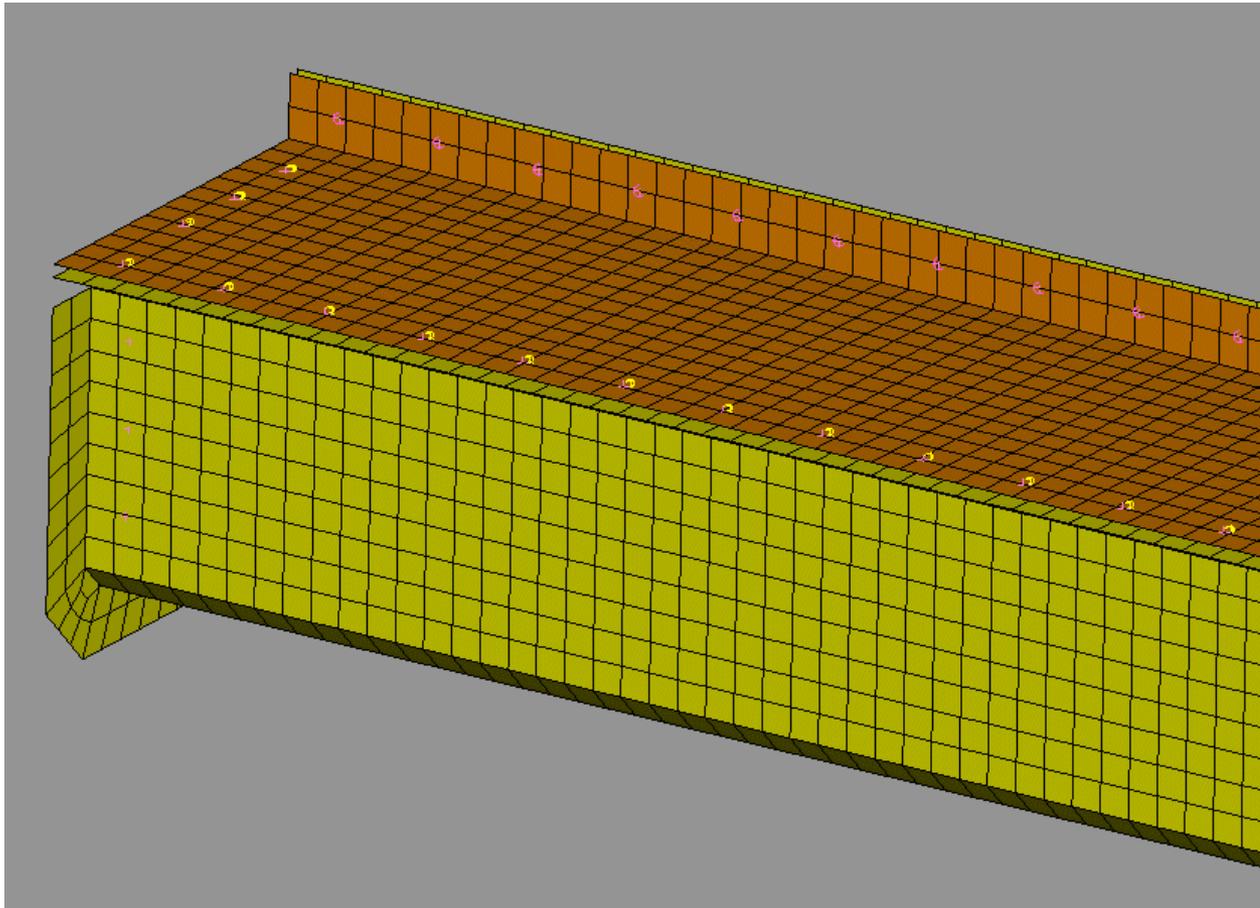
- ◆ Combining many morphing processes in one Parameter
- ◆ Connect any morphing application to Task Manager



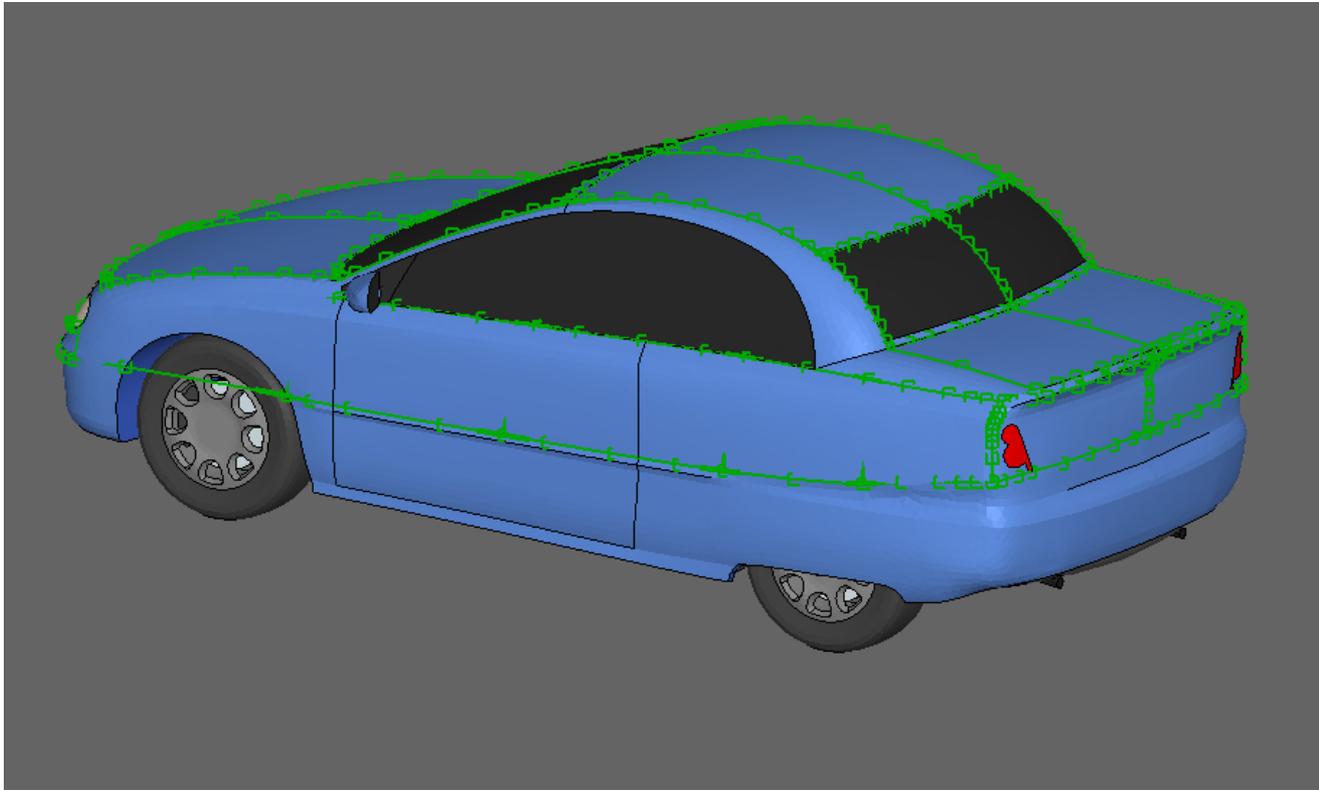
- ◆ **Creating simple features like ribs and beads using Direct Morphing**
- ◆ **Modifying feature dimensions with Morphing Parameters**



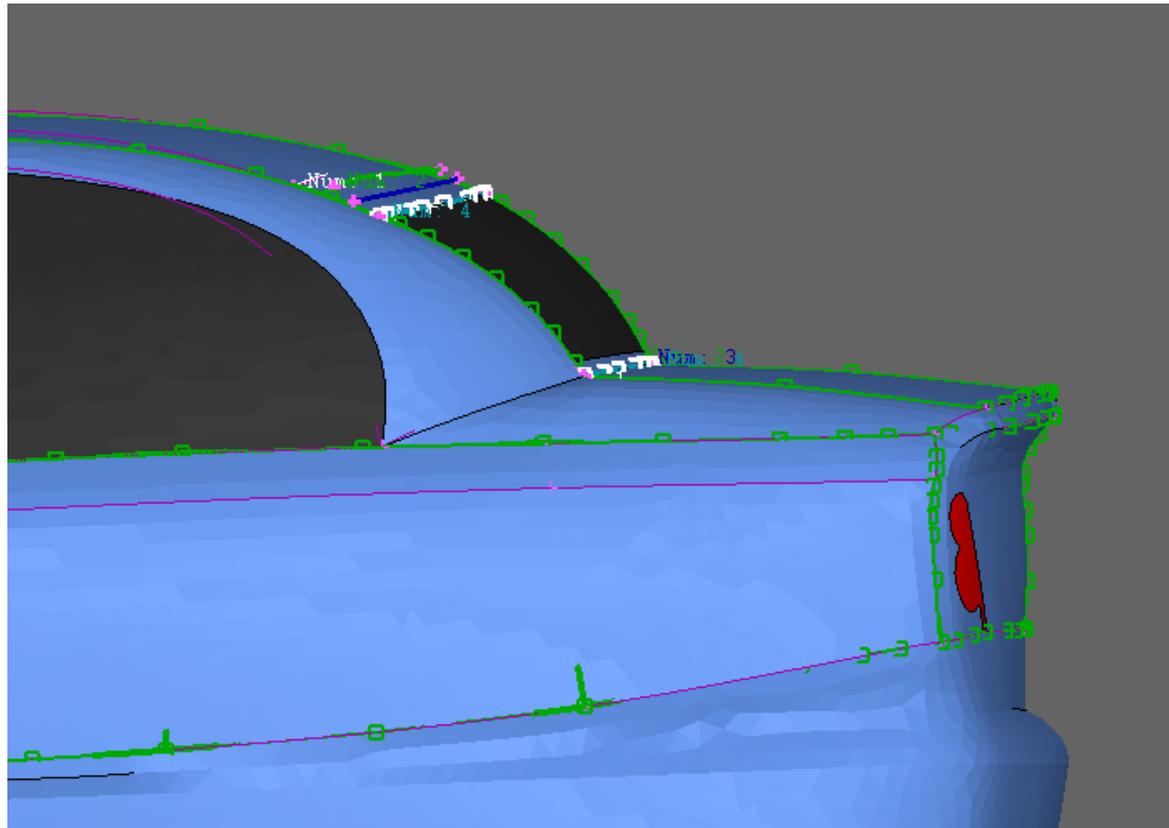
- ◆ Creating simple features like ribs and beads using Direct Morphing
- ◆ **Modifying feature dimensions with Morphing Parameters**



- ◆ **Fitting FE-Model on different shapes using target curves**
- ◆ Handling the shaping with Morphing Parameters



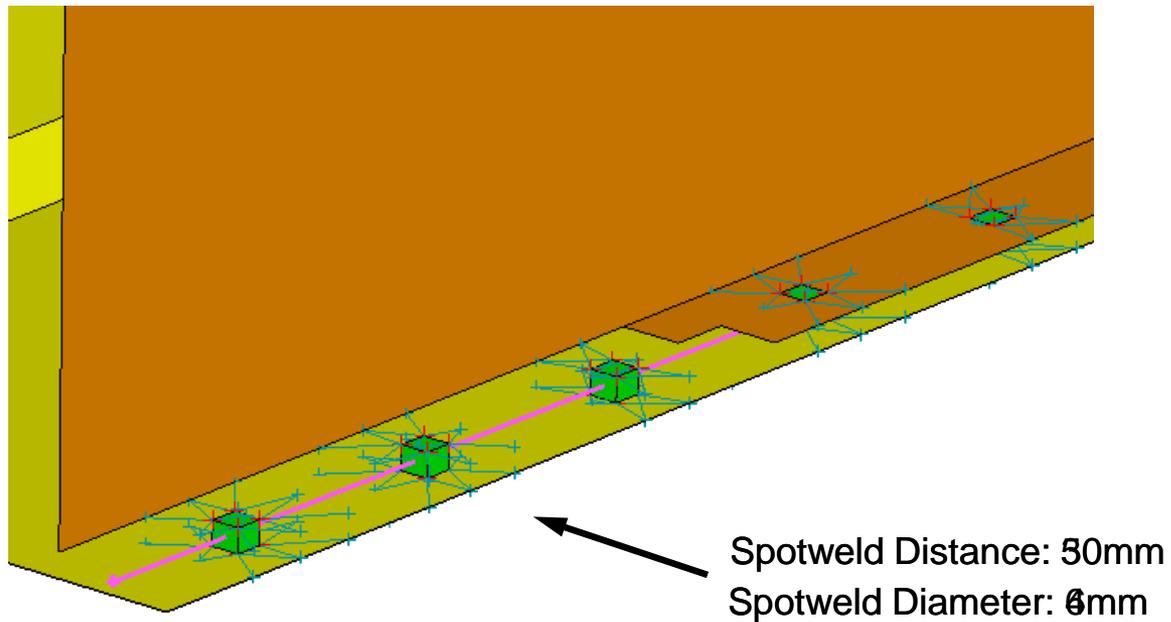
- ◆ Fitting FE-Model on different shapes using target curves
- ◆ **Handling the shaping with Morphing Parameters**



Spotweld optimization is possible through ANSA functionality

As Design Variables can be set Connection parameters:

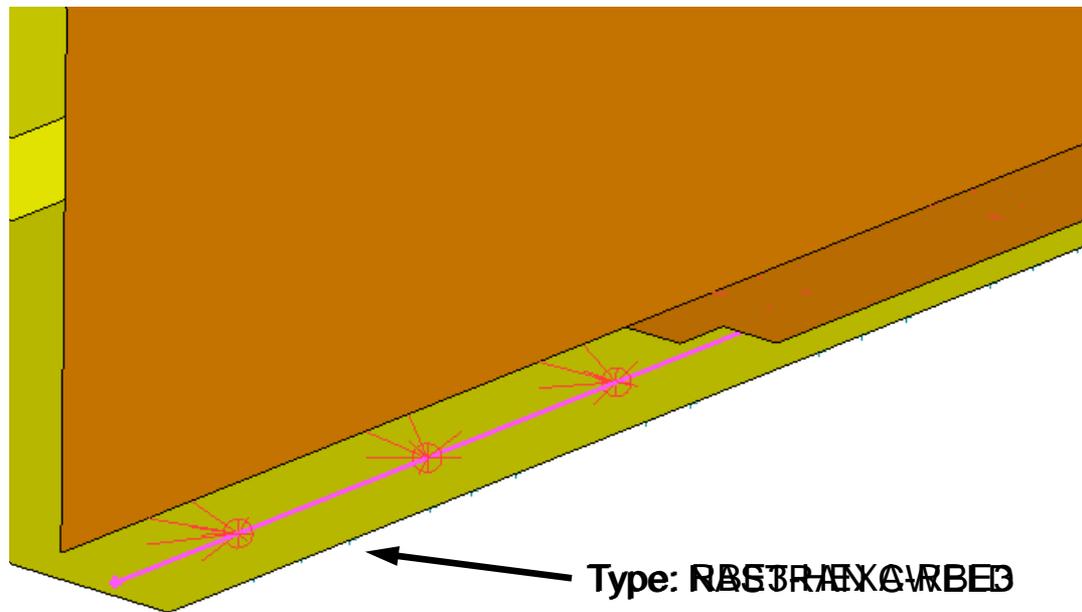
- ◆ Spotweld distance
- ◆ Number of spotwelds
- ◆ Spotweld diameter



Spotweld optimization is possible through ANSA functionality

As Design Variables can be set :

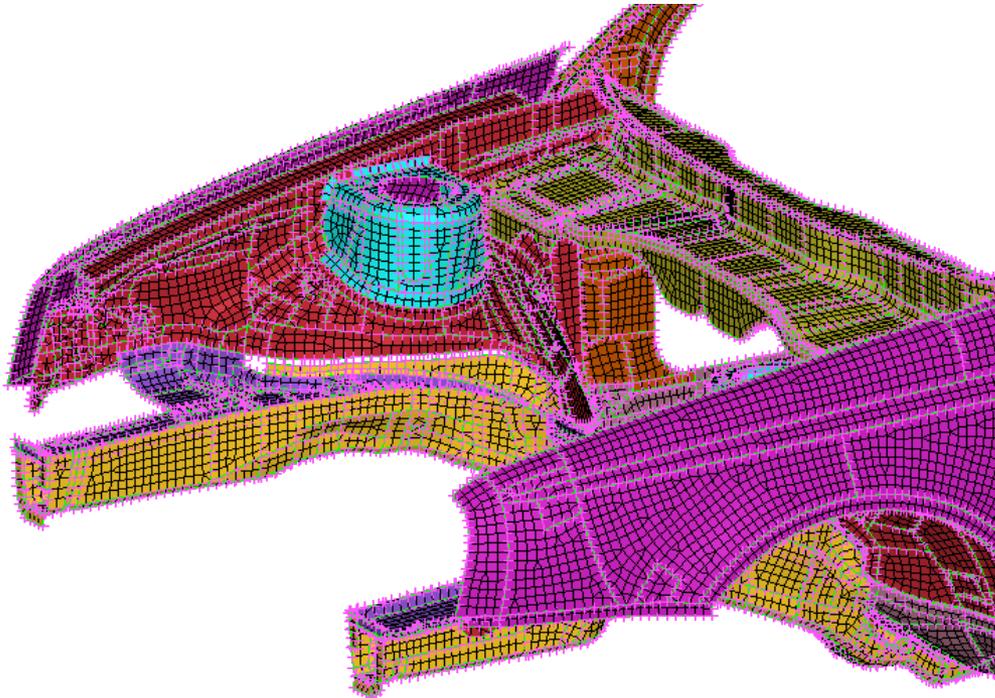
- ◆ Connection properties and materials
- ◆ Application of different types of spotwelds to the Connections



The batch mesh parameters and quality criteria can be used as Design Variables in the optimization loop

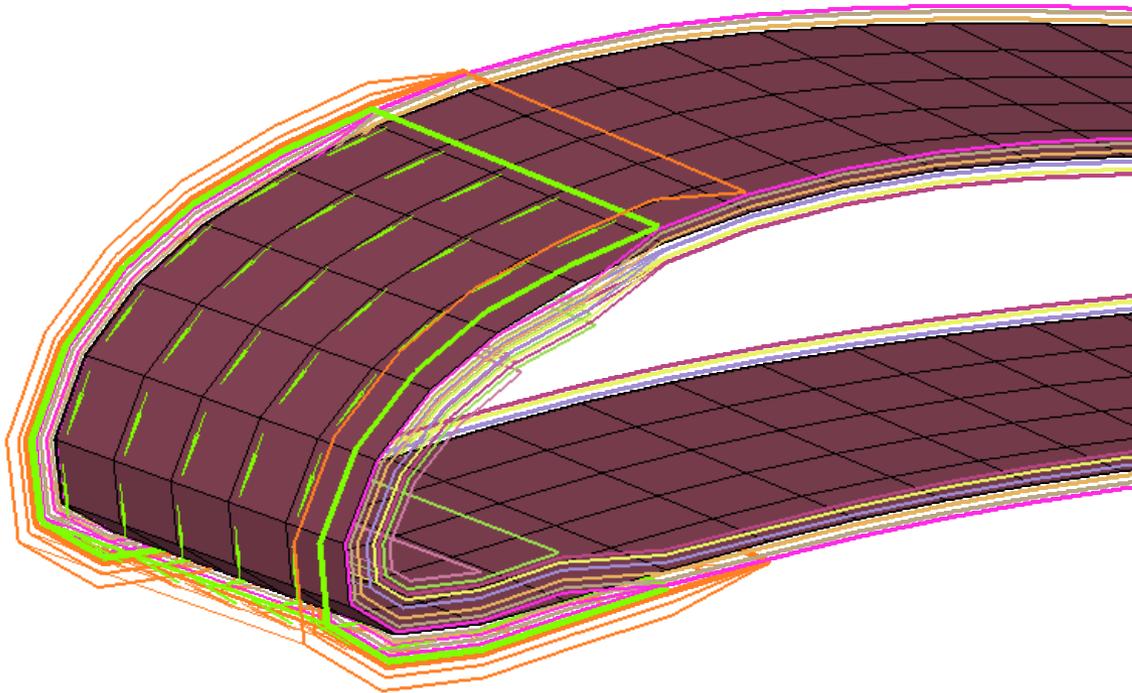
Such Variables can be:

- ◆ Element length
- ◆ Treatment of holes and fillets



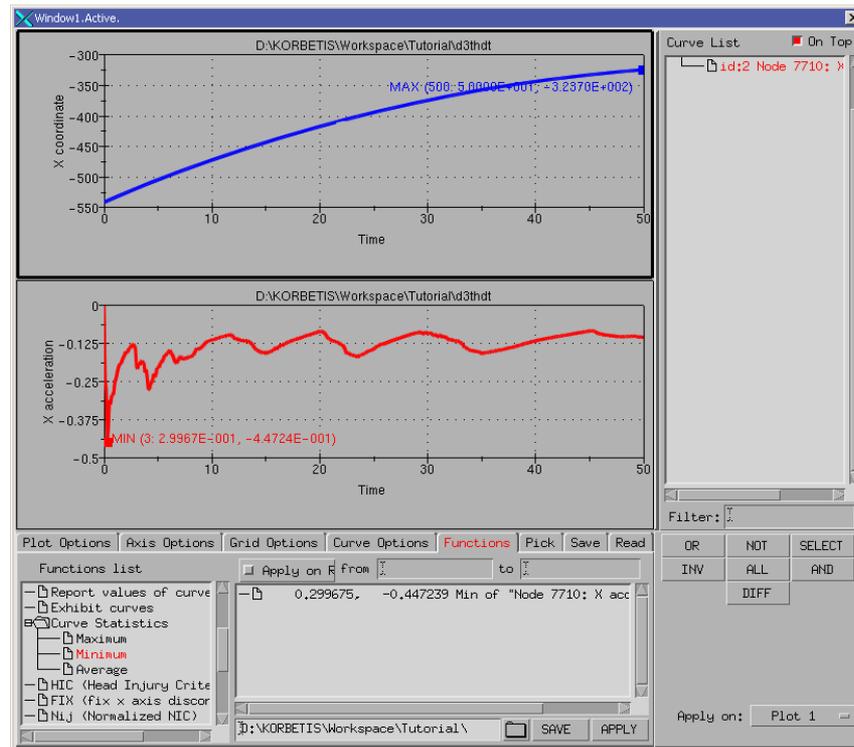
Using the ANSA Laminate Tool for composite optimization

- ◆ Changing fabric orientation
- ◆ Changing layer thickness



METAPost can provide a fast and easy way to extract constraints and objective parameters from solvers result files

- ◆ Support of binary or ascii result files
- ◆ Calculations to extract the desired results



- ◆ **The set up of shape and property optimization for LSOPT is possible in the ANSA pre-processor**
- ◆ **The Morphing Tool provides a powerful functionality for shaping FE model which is the key for the shape optimization**
- ◆ **The pre-processing of the optimization problem can be automated by the Task Manager**

THANK YOU