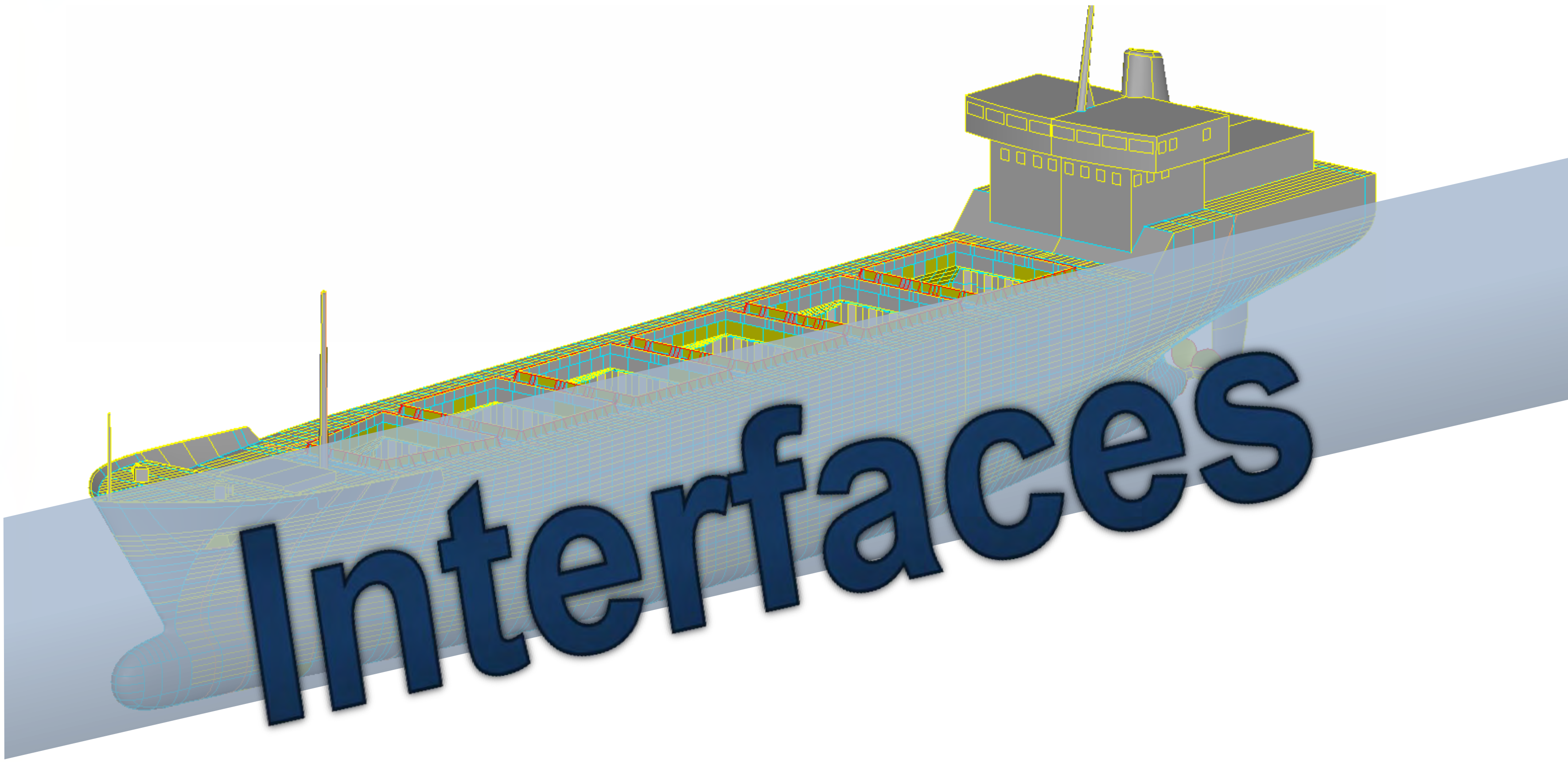
ANSA and μETA for the Maritime and Offshore structures analysis



Interfaces

Interfaces

CAD & PDM data

- CATIA
- Pro/ENGINEER
- NX-Unigraphics
- JT Open
- IGES
- STEP
- VDA-FS

Keyword files

- NASTRAN
- ABAQUS
- SESTRA
- LS-DYNA
- PAM-CRASH
- RADIOSS
- ADAMS/View
- ANSYS
- RADTHERM
- MOLDEX
- CFD++
- FLUENT
- OPENFOAM
- STAR-CD /CCM +
- CFX ...and more

Tessellated data

- STL
- VRML

Other (e.g. Medina)

IN

ANSA pre-processor

OUT

Ready-to-run solver input files

- NASTRAN
- ABAQUS
- SESTRA
- LS-DYNA
- PAM-CRASH
- RADIOSS
- ADAMS/View
- ANSYS
- RADTHERM
- PERMAS
- MOLDEX
- CFD++
- FLUENT
- OPENFOAM
- STAR-CD/CCM+
- CFX
- ...and more

CAD files

- IGES
- STEP
- VDA-FS

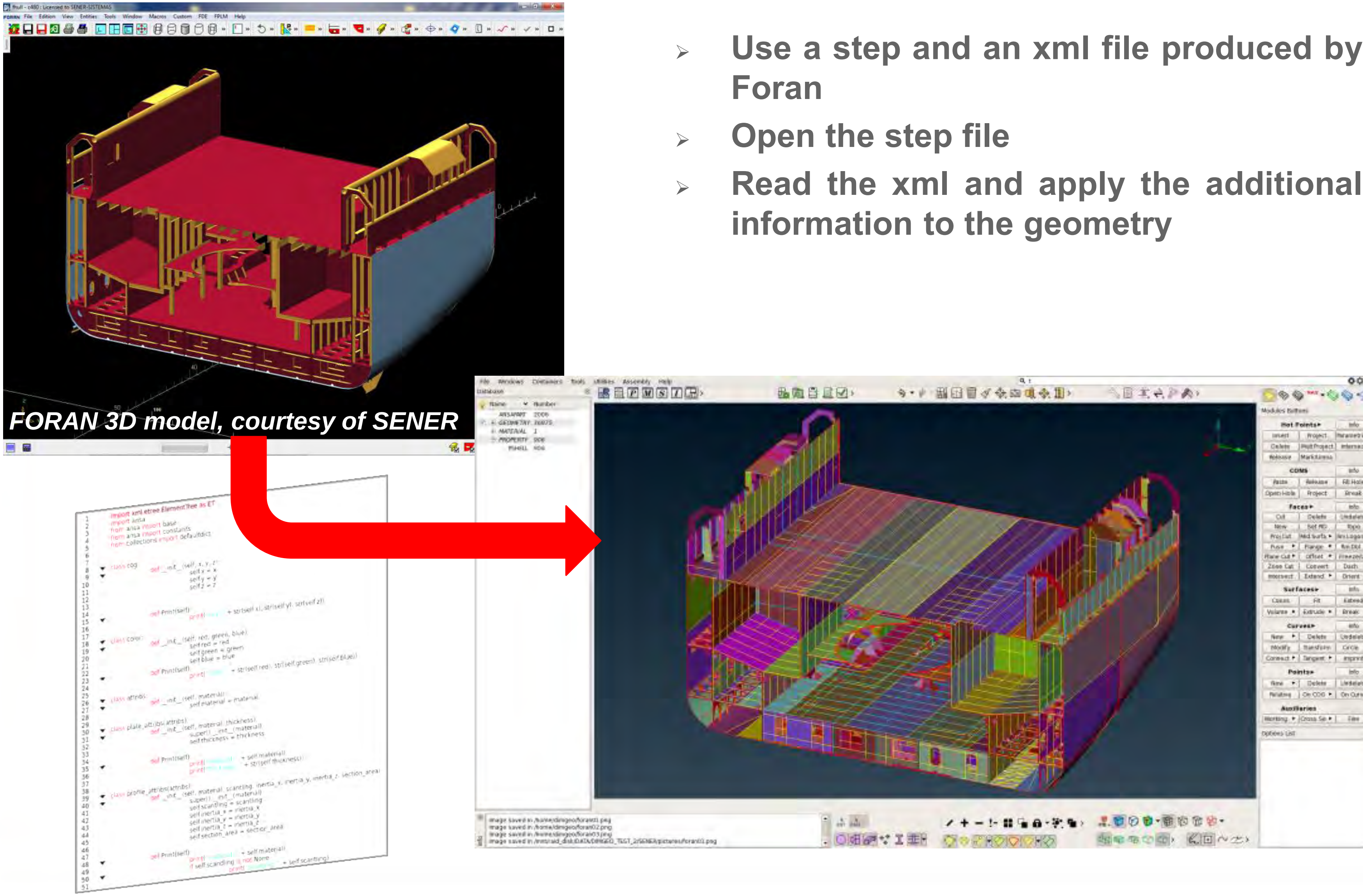
Tessellated data

- STL
- VRML

μETA Product Tree

From FORAN to ANSA

- Use a step and an xml file produced by Foran
- Open the step file
- Read the xml and apply the additional information to the geometry



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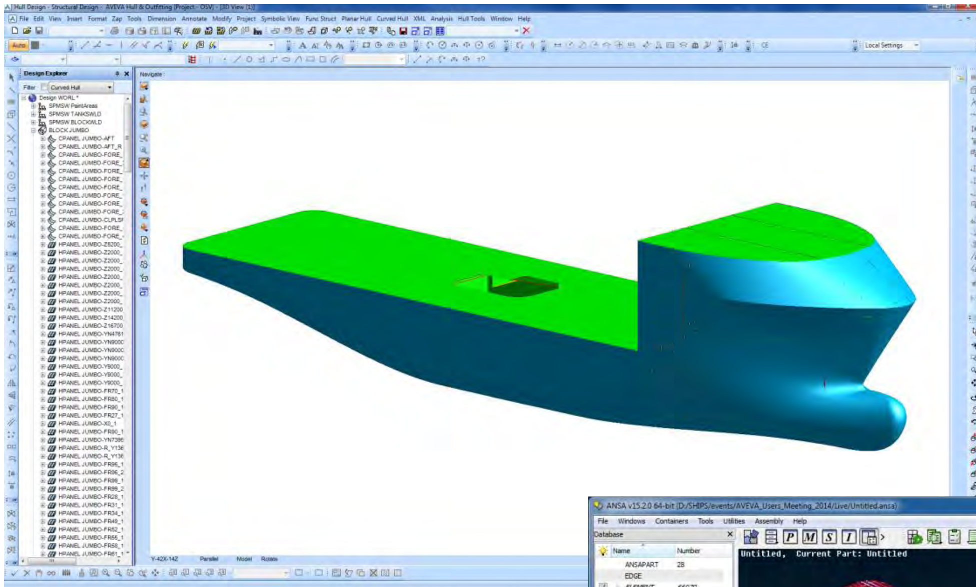
From AVEVA Marine to ANSA

Additional information is applied on the FE model by reading an XML file produced by AVEVA



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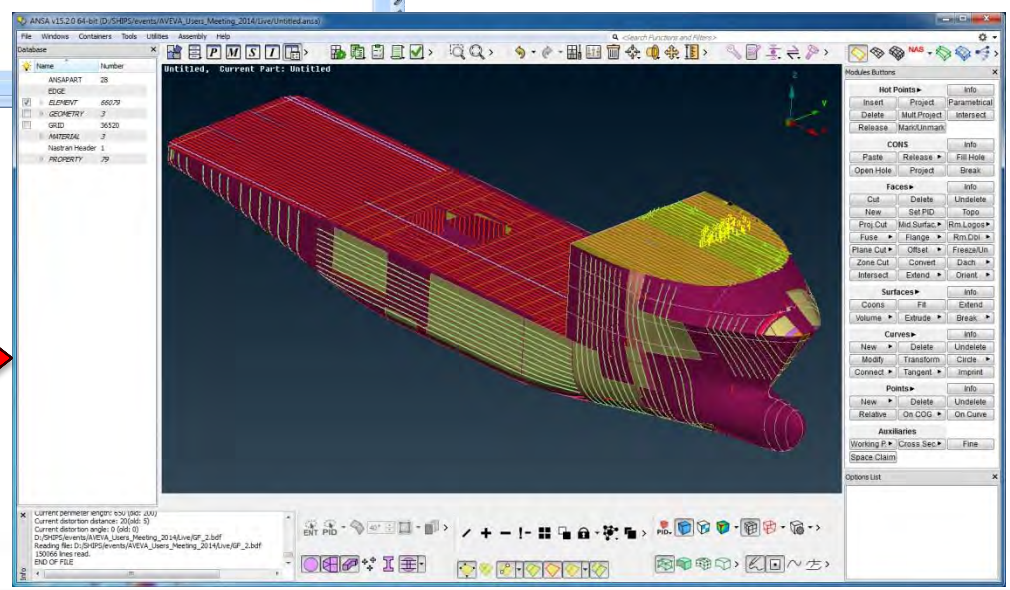
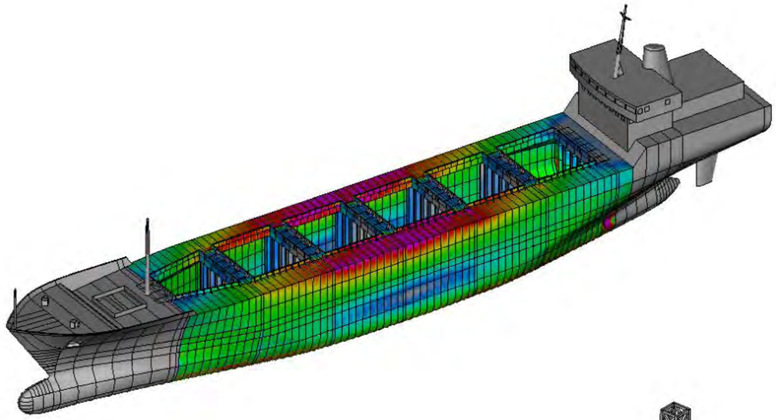
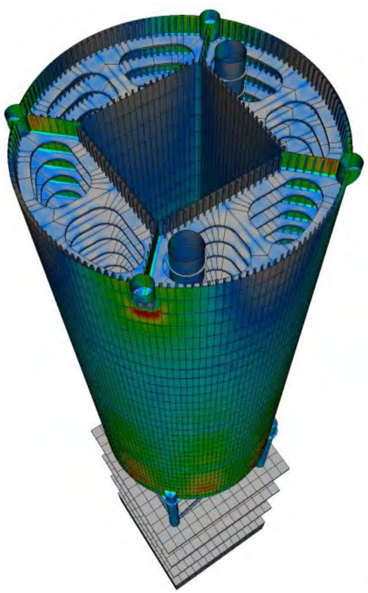
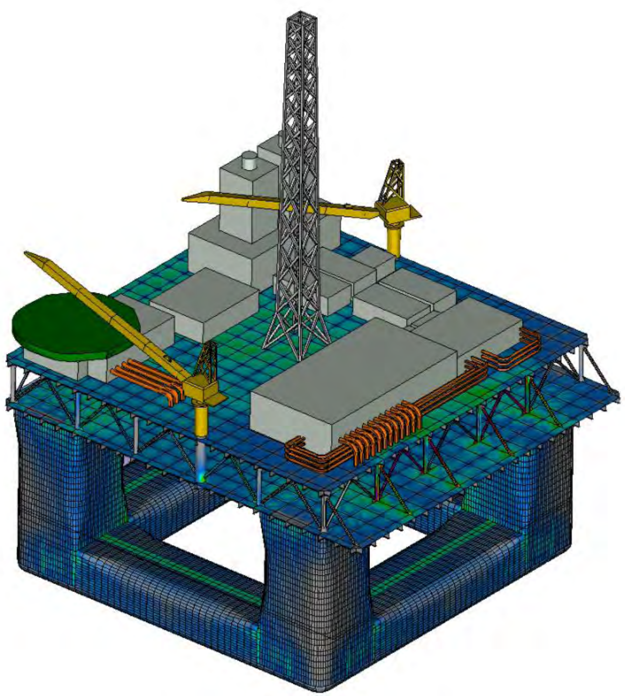


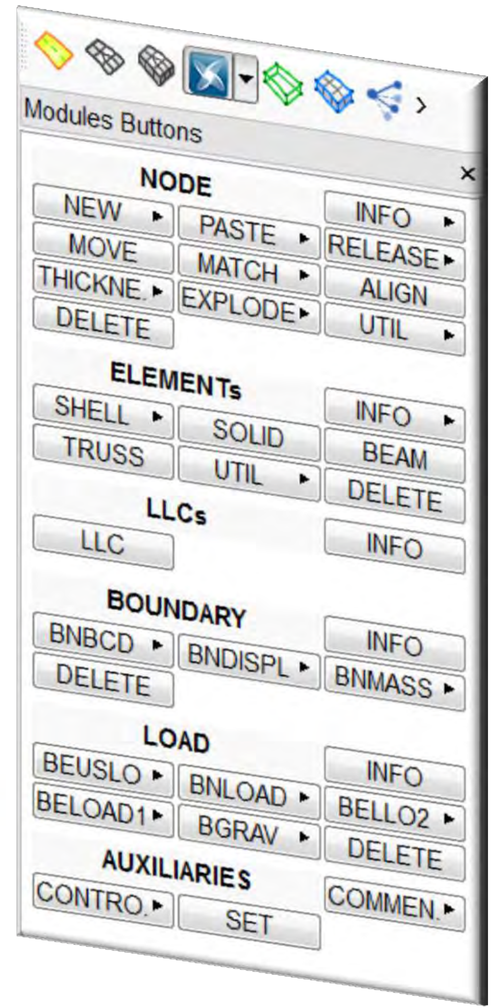
Interface for SESTRA

Input, output and new DECK for SESTRA

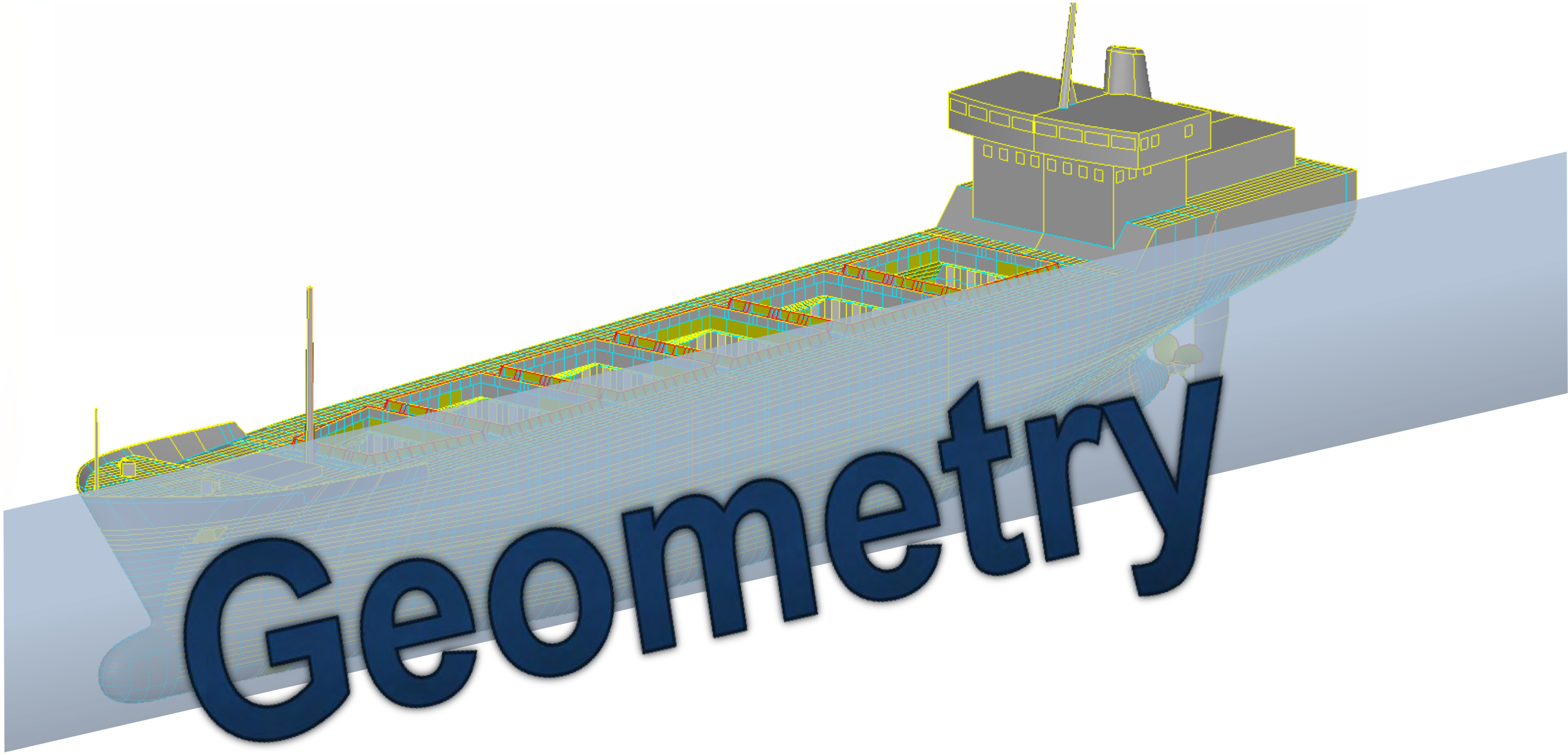






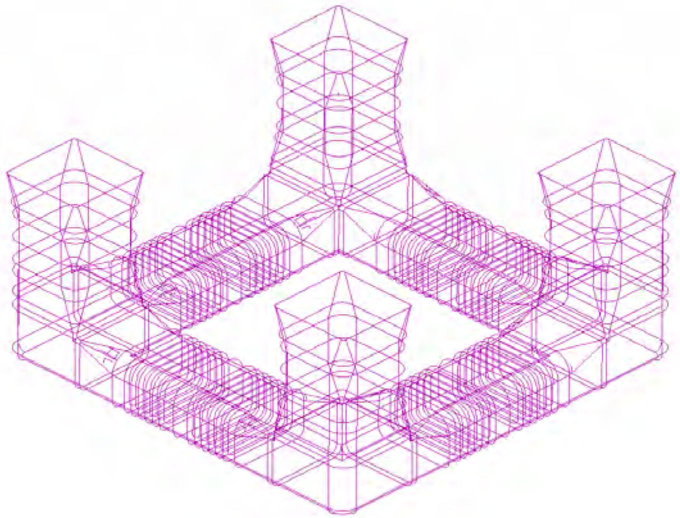


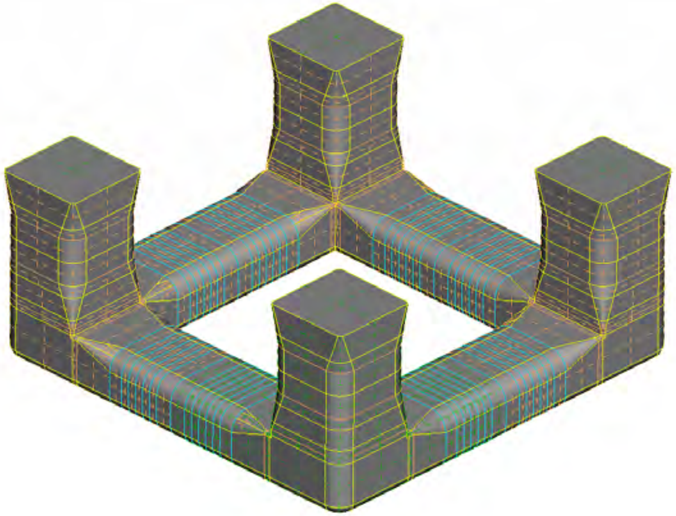
Geometry

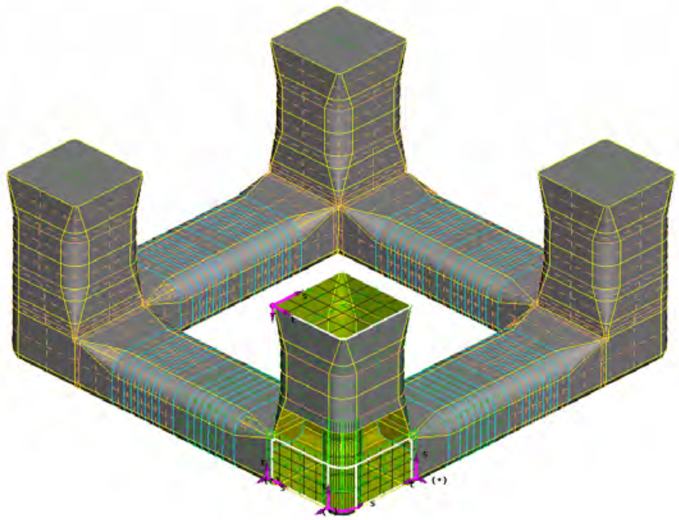


Geometry creation

Easy generation of 3d geometrical entities

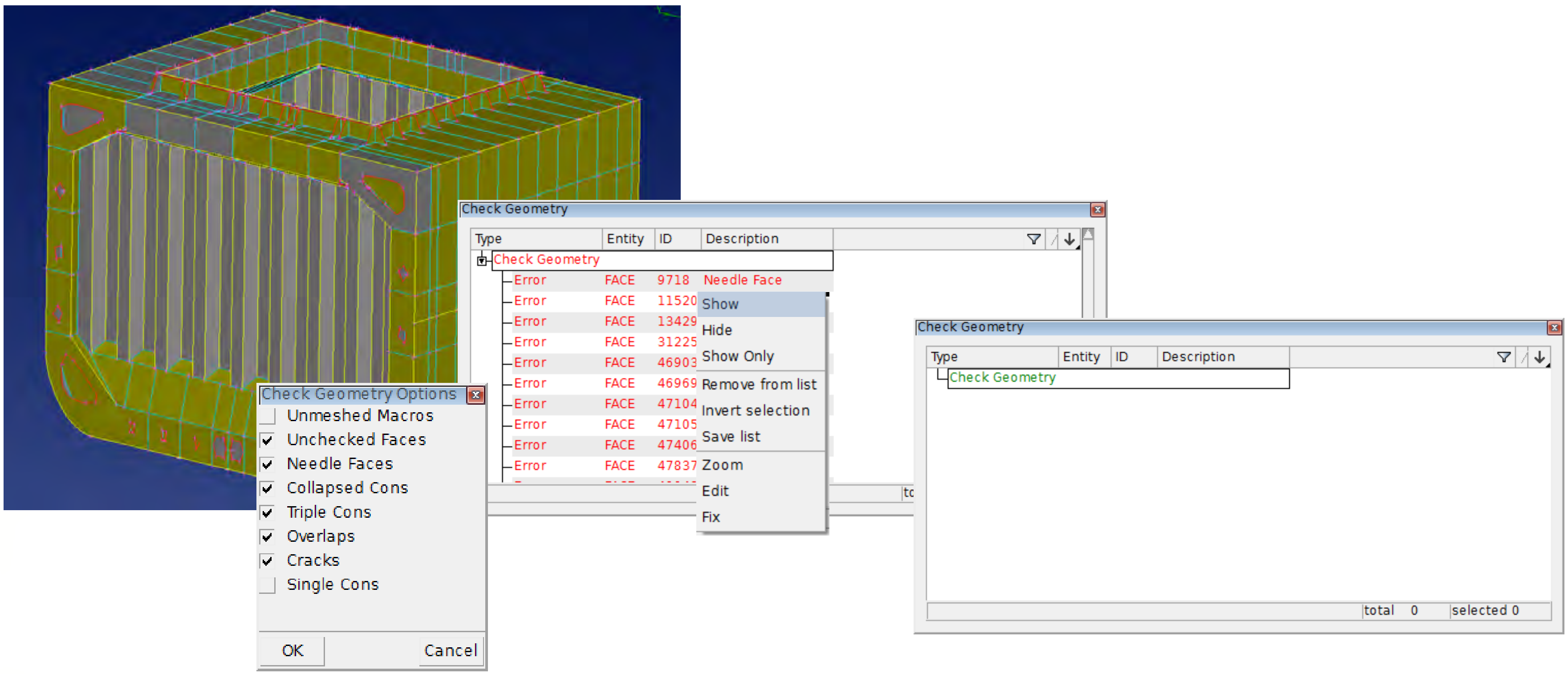






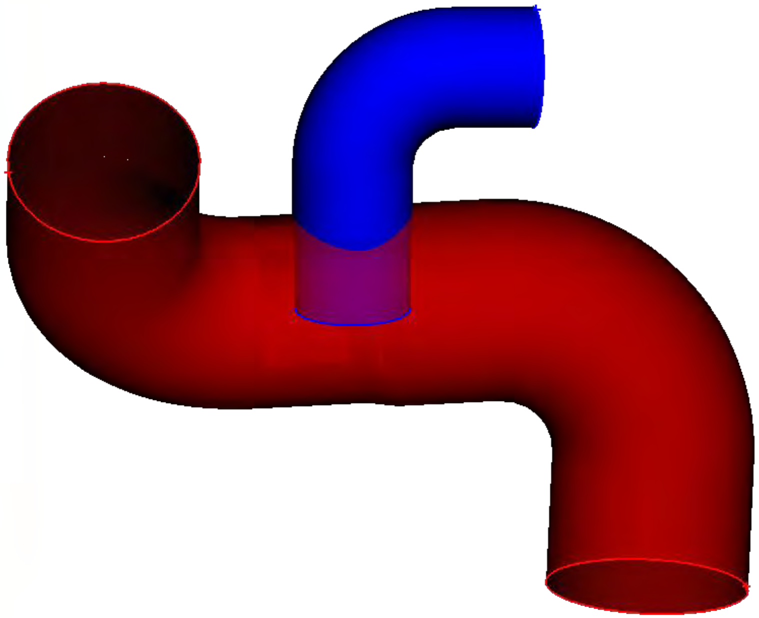
Geometry checks

Topological errors identification and fix

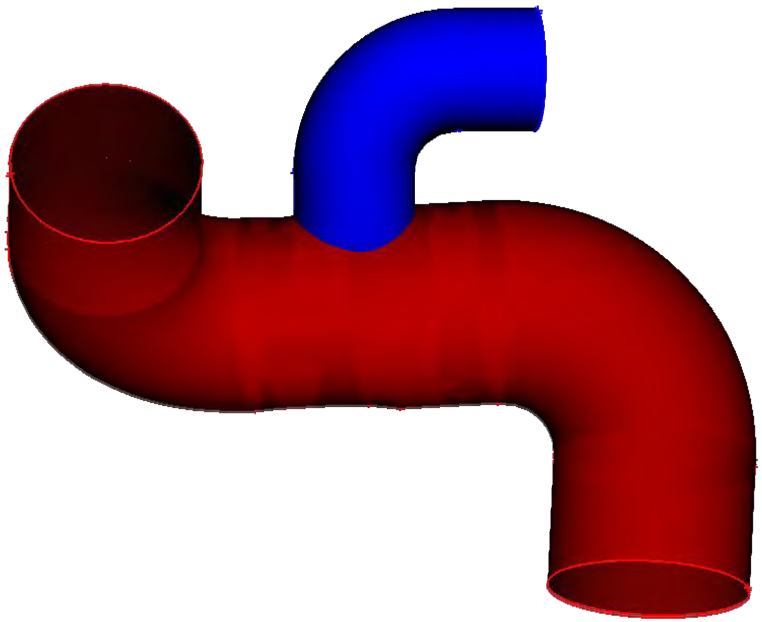


Intersections

Geometry trimming



Before

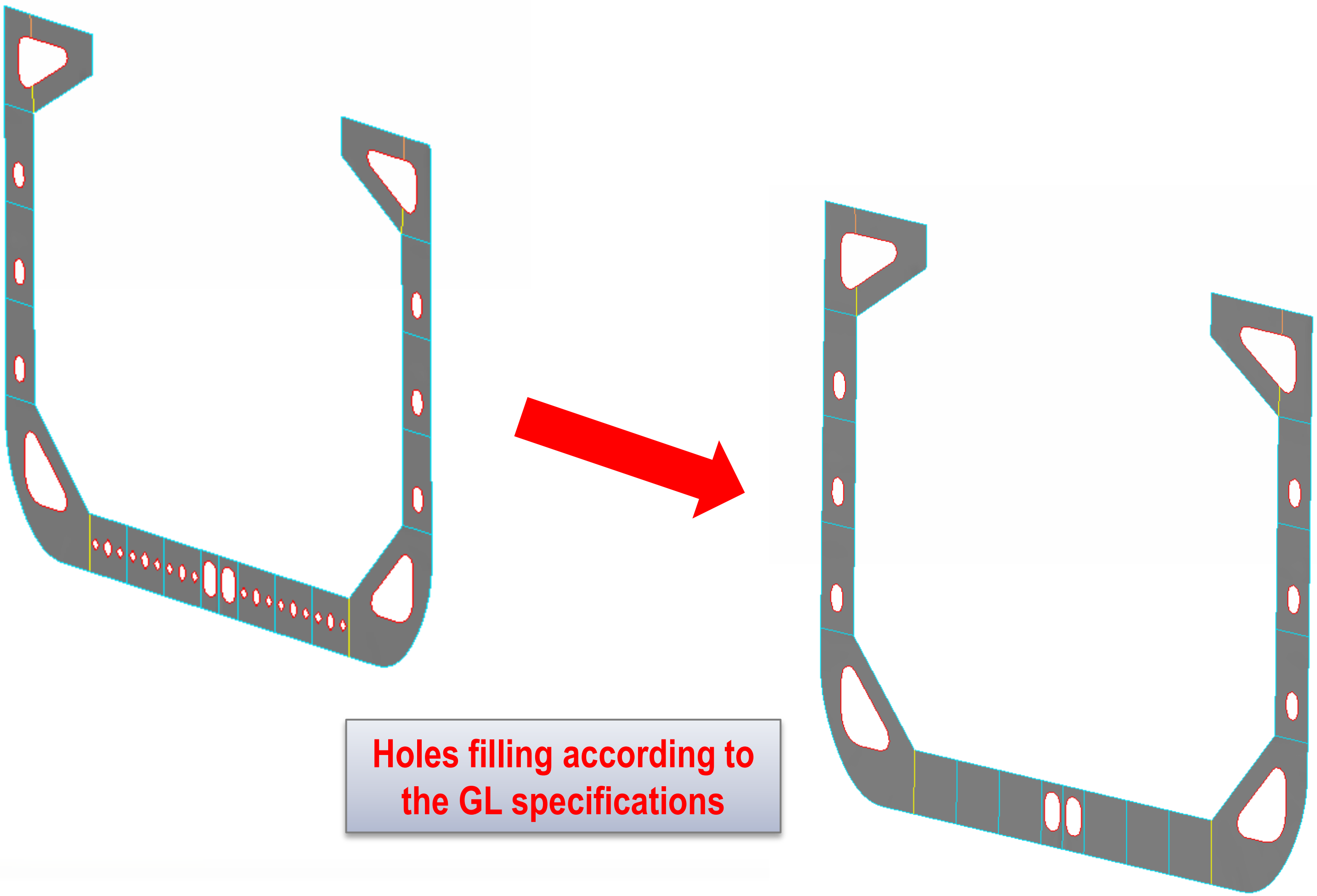


After

Geometry check & model simplification

Identifying unchecked faces, needle faces, collapsed CONS, triple bounds, overlaps, cracks

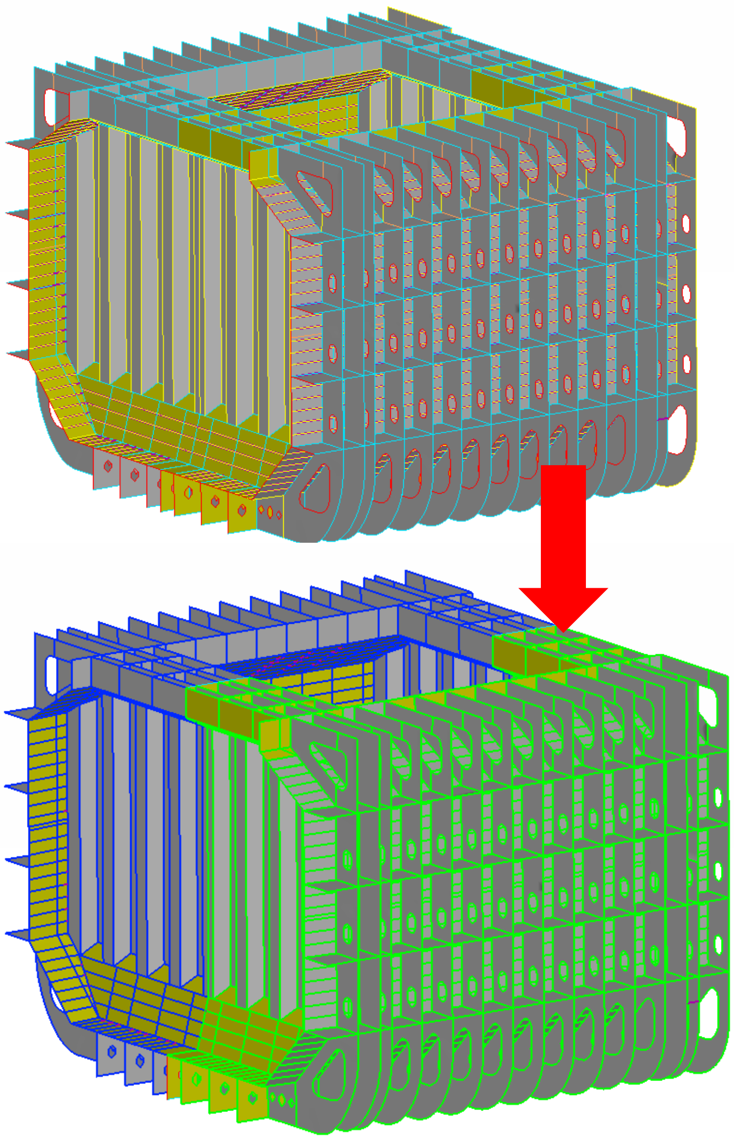
Treatment of holes, fillets, chamfers, features

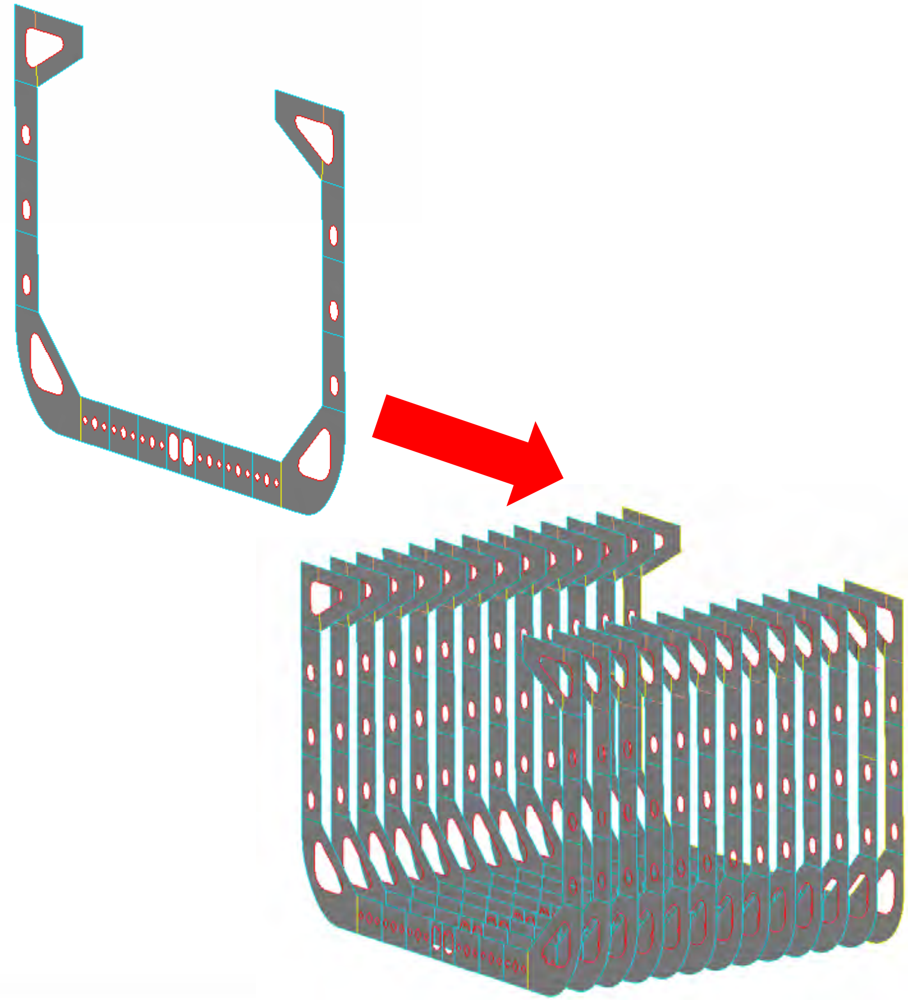


Handling pattern-wise faces & parts

Substitute geometry with Linked Faces

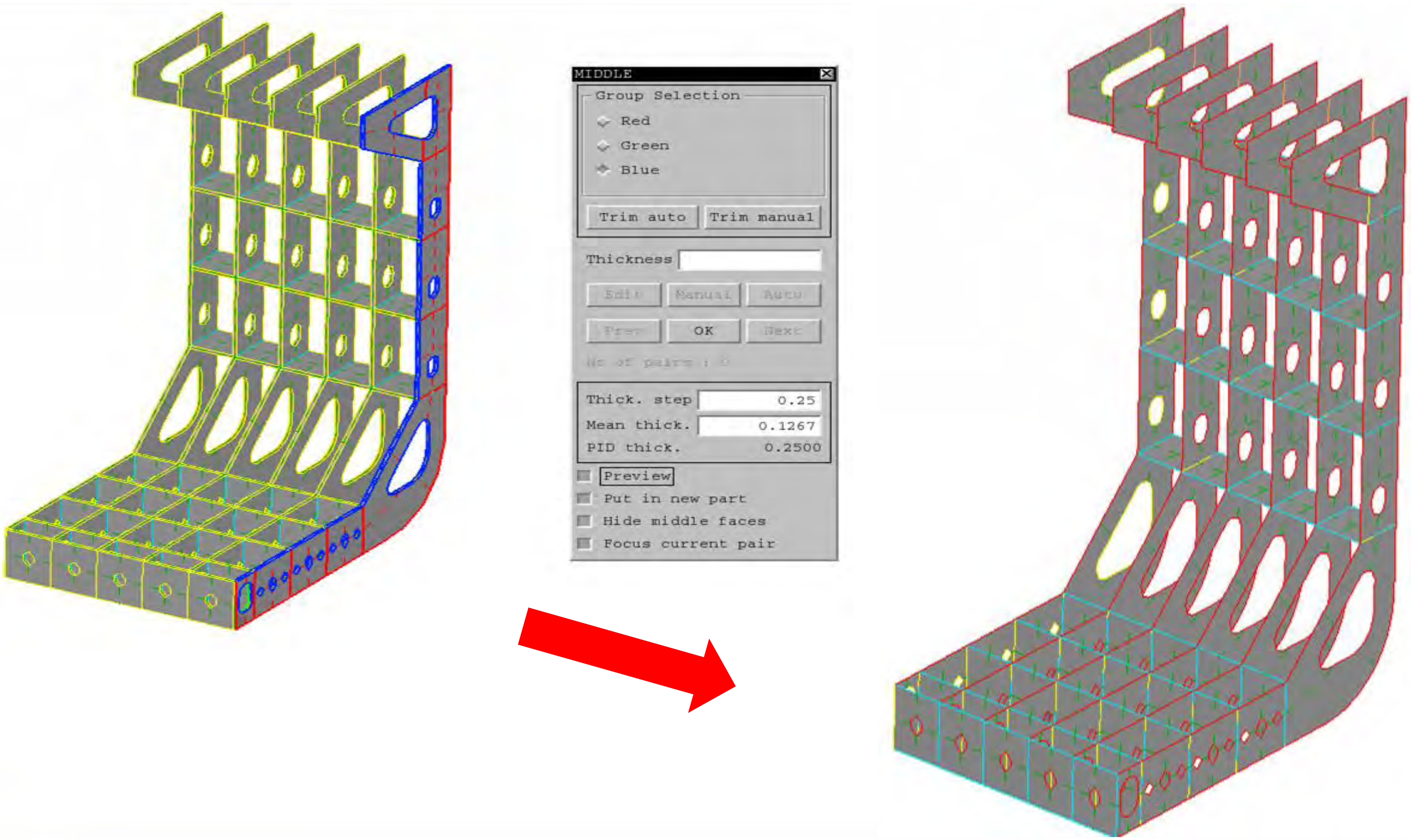
Create symmetry, mirror or translation Faces





Middle skin extraction

Special tool for middle skin extraction creates new geometry



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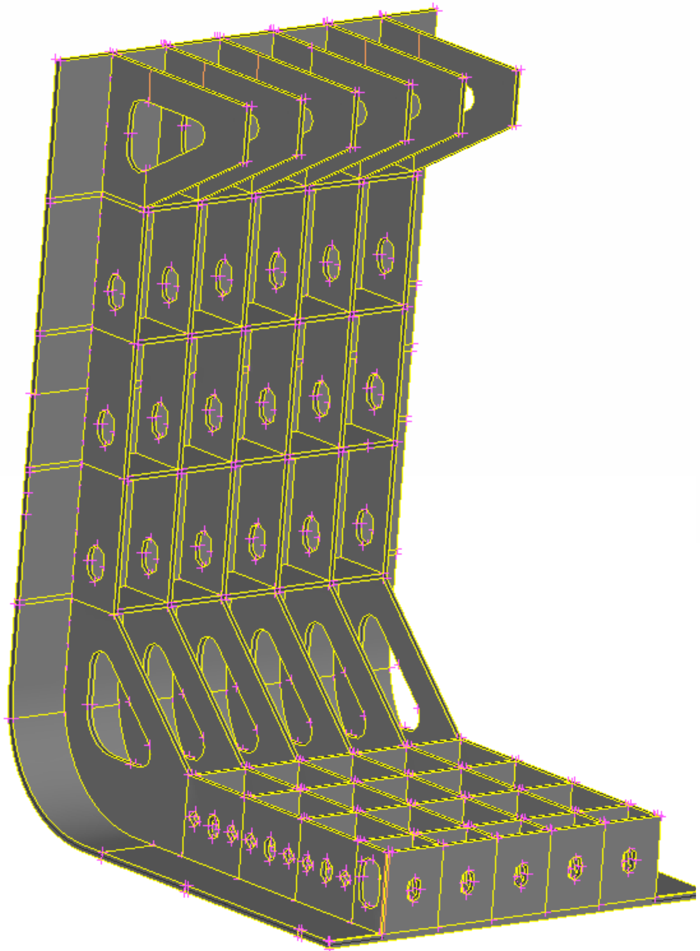
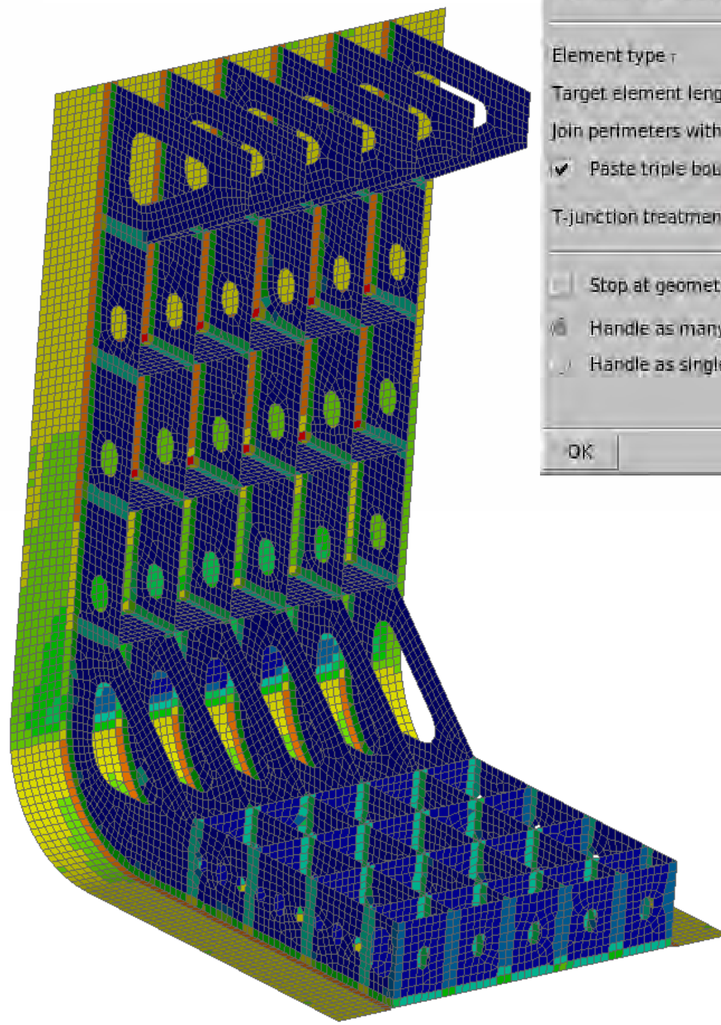
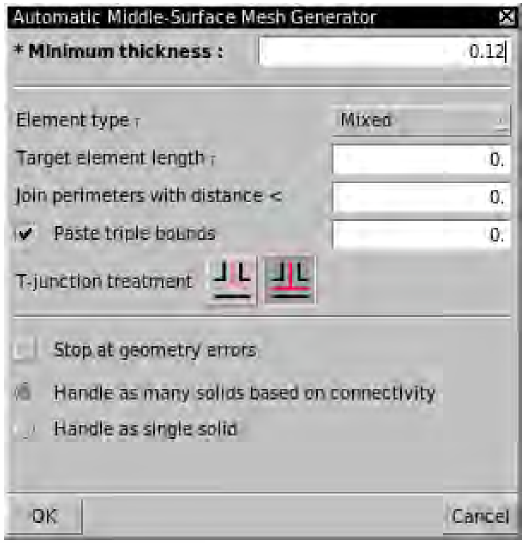
Middle skin extraction

Fully automatic middle surface extraction creates FE Model and assigns nodal thickness

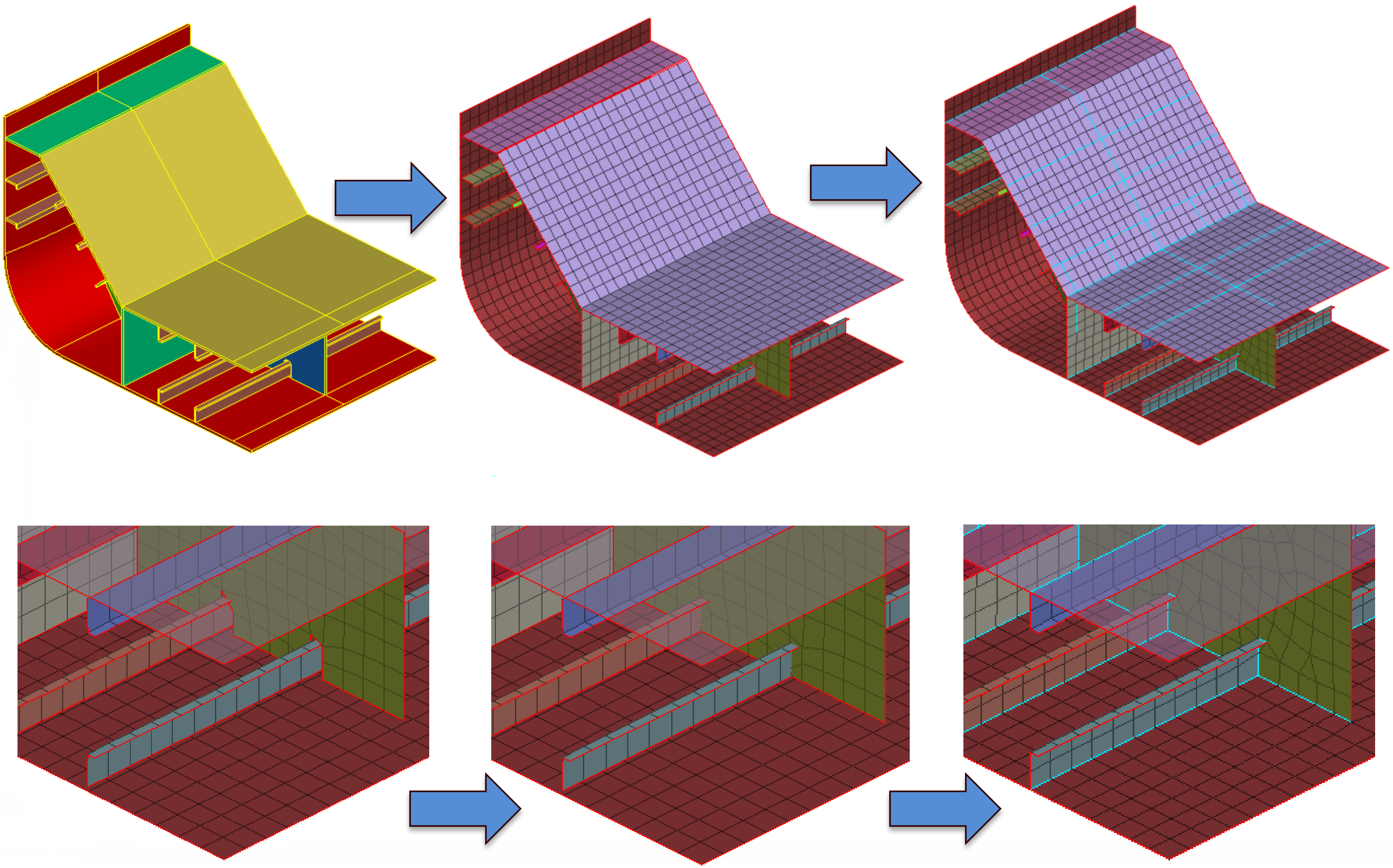




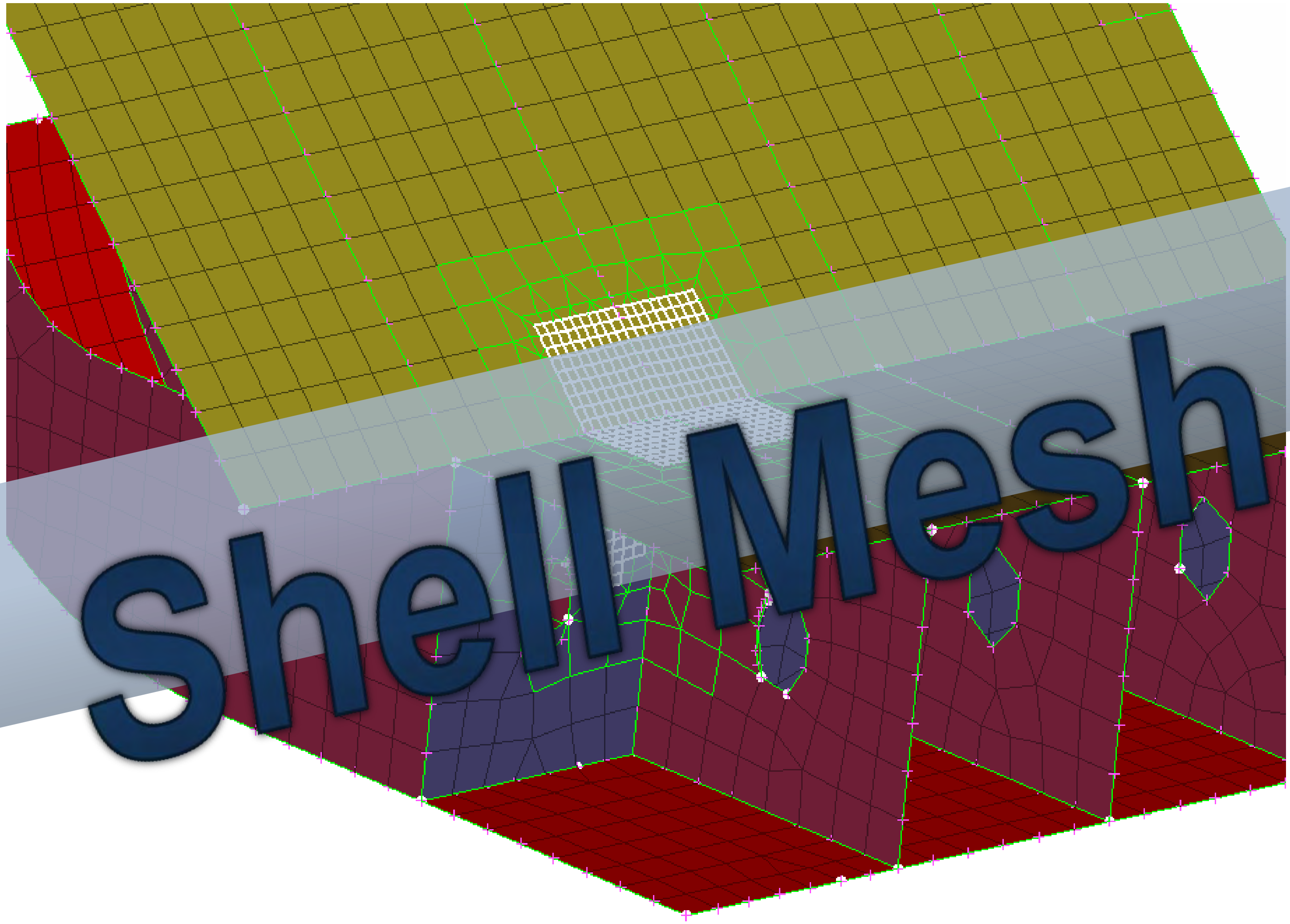


Automatic middle skin extraction and assembly

Creates the middle skin, connects the parts and fills unwanted openings



Shell Mesh



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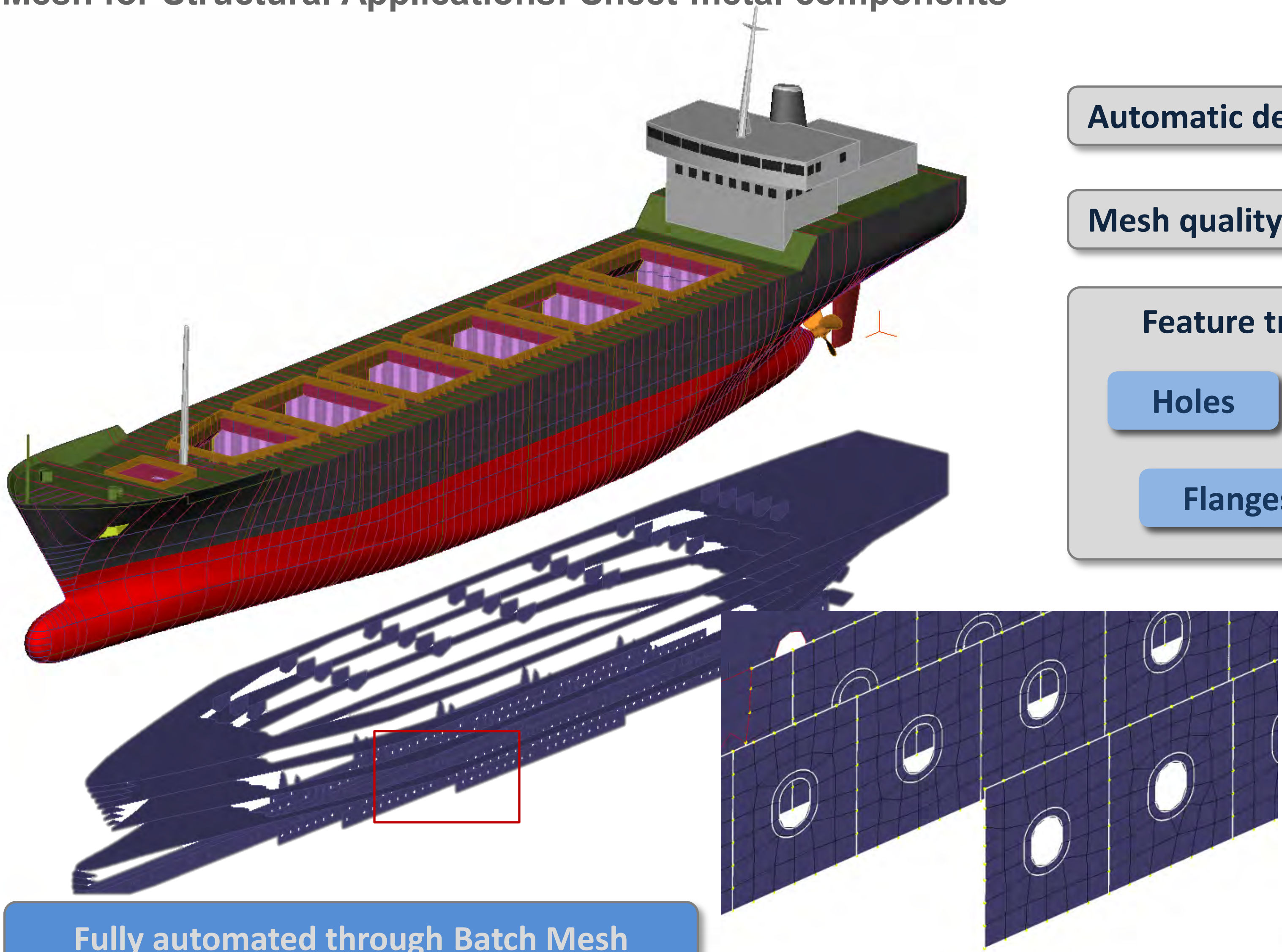
Shell Meshing

Mesh for Structural Applications: Sheet-metal components



Automatic defeaturing

Mesh quality control

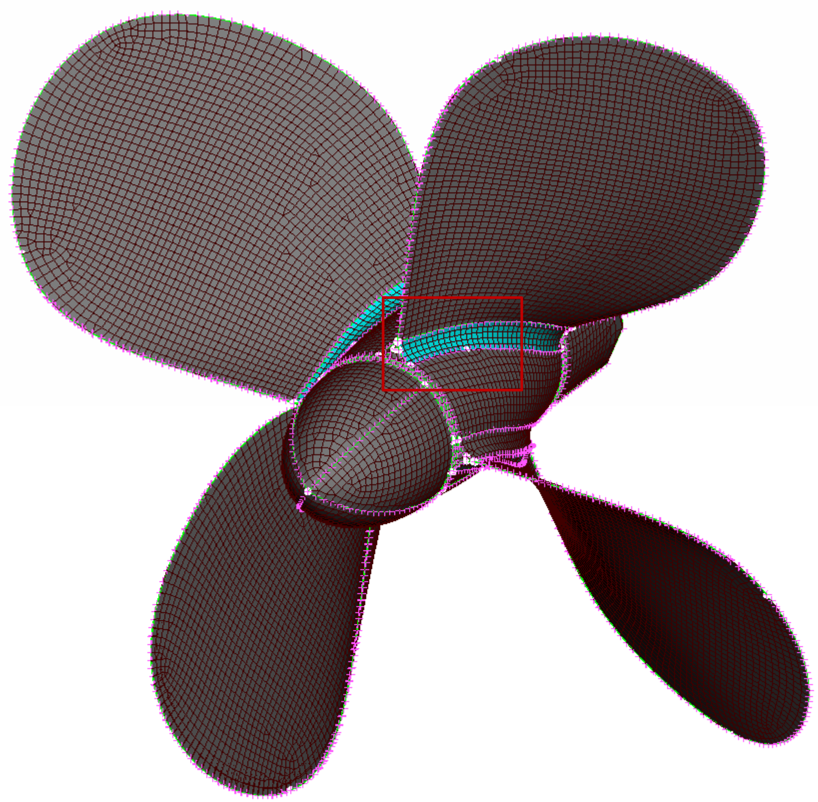
Feature treatment

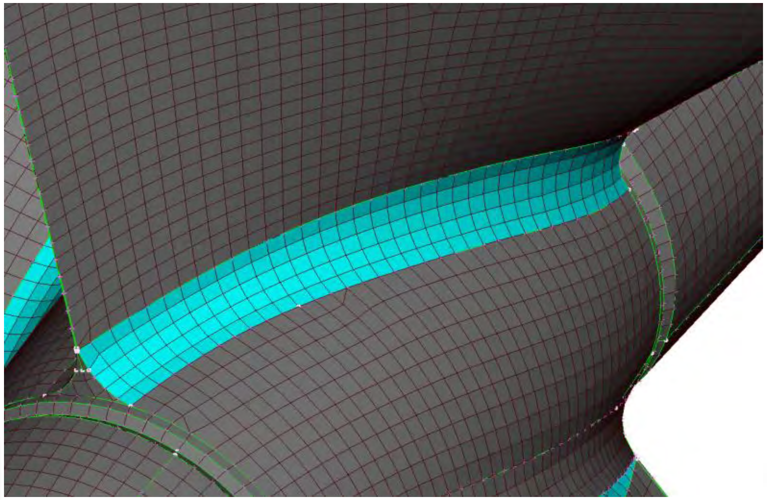
- Holes
- Fillets
- Flanges

Fully automated through Batch Mesh

Shell Meshing

Mesh for Structural Applications: Sheet-metal components





Automatic defeaturing

Mesh quality control

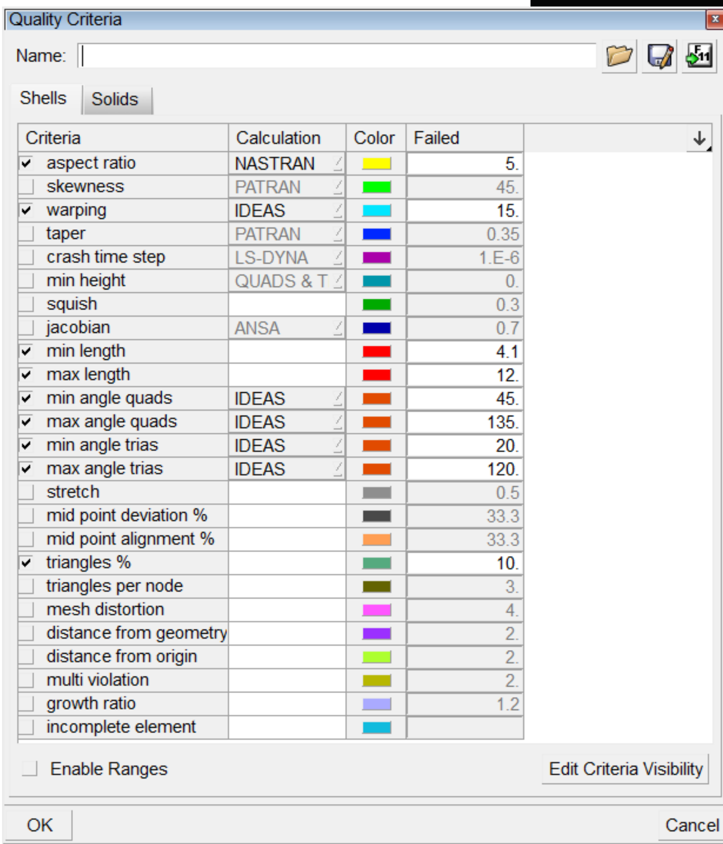
Feature treatment

- **Holes**
- **Fillets**
- **Flanges**

Fully automated through Batch Mesh

Shell Meshing

Numerous quality criteria



Quality Criteria

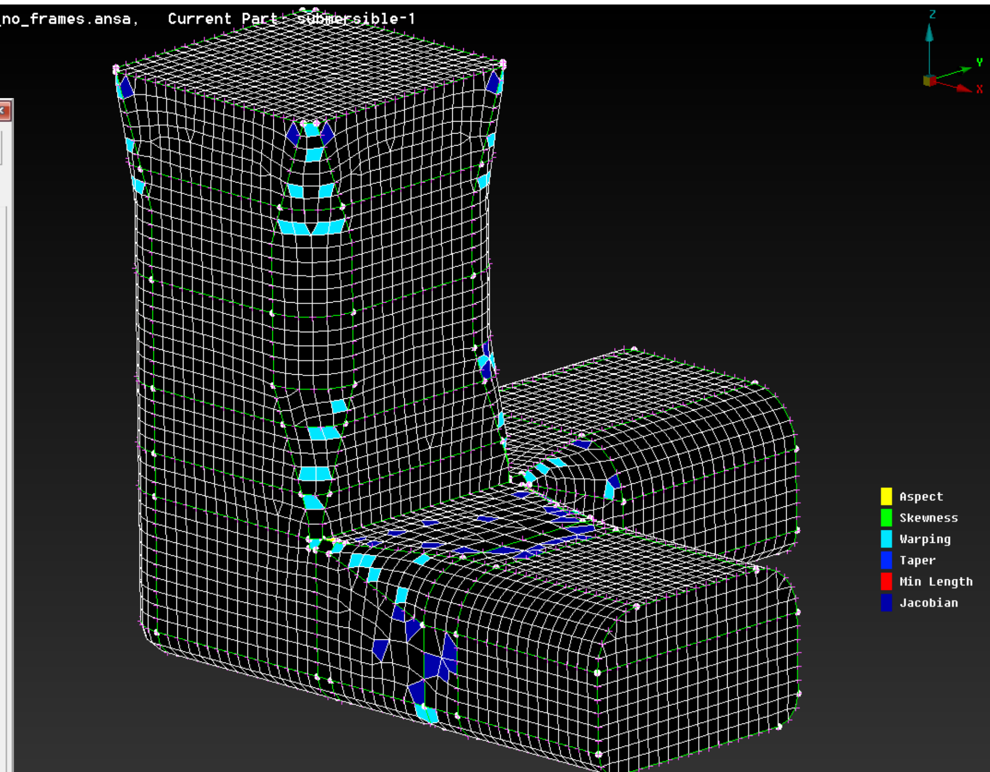
Name:

Shells | Solids

Criteria	Calculation	Color	Failed
☑ aspect ratio	NASTRAN	yellow	5.
☐ skewness	PATRAN	green	45.
☑ warping	IDEAS	cyan	15.
☐ taper	PATRAN	blue	0.35
☐ crash time step	LS-DYNA	purple	1.E-6
☐ min height	QUADS & T	teal	0.
☐ squish		green	0.3
☐ jacobian	ANSA	dark blue	0.7
☑ min length		red	4.1
☑ max length		red	12.
☑ min angle quads	IDEAS	orange	45.
☑ max angle quads	IDEAS	orange	135.
☑ min angle trias	IDEAS	orange	20.
☑ max angle trias	IDEAS	orange	120.
☐ stretch		grey	0.5
☐ mid point deviation %		dark grey	33.3
☐ mid point alignment %		light orange	33.3
☑ triangles %		sea green	10.
☐ triangles per node		olive	3.
☐ mesh distortion		pink	4.
☐ distance from geometry		violet	2.
☐ distance from origin		light green	2.
☐ multi violation		yellow-olive	2.
☐ growth ratio		lavender	1.2
☐ incomplete element		light blue	

☐ Enable Ranges — Edit Criteria Visibility

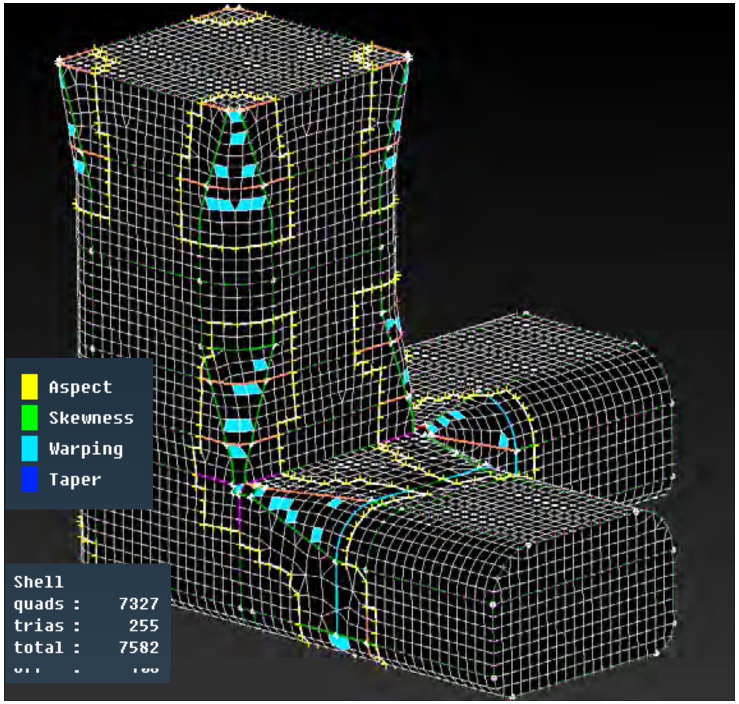
OK — Cancel

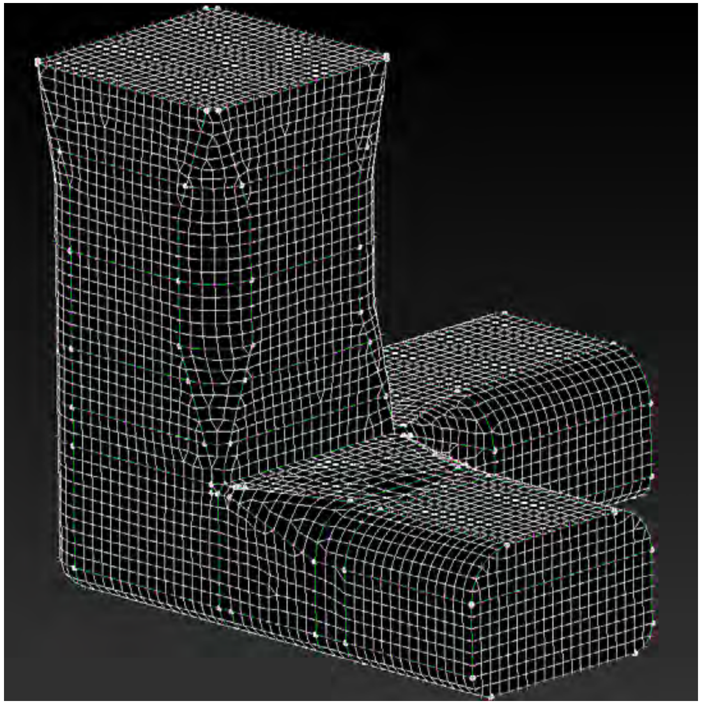


Color-coding of violations

Shell Meshing

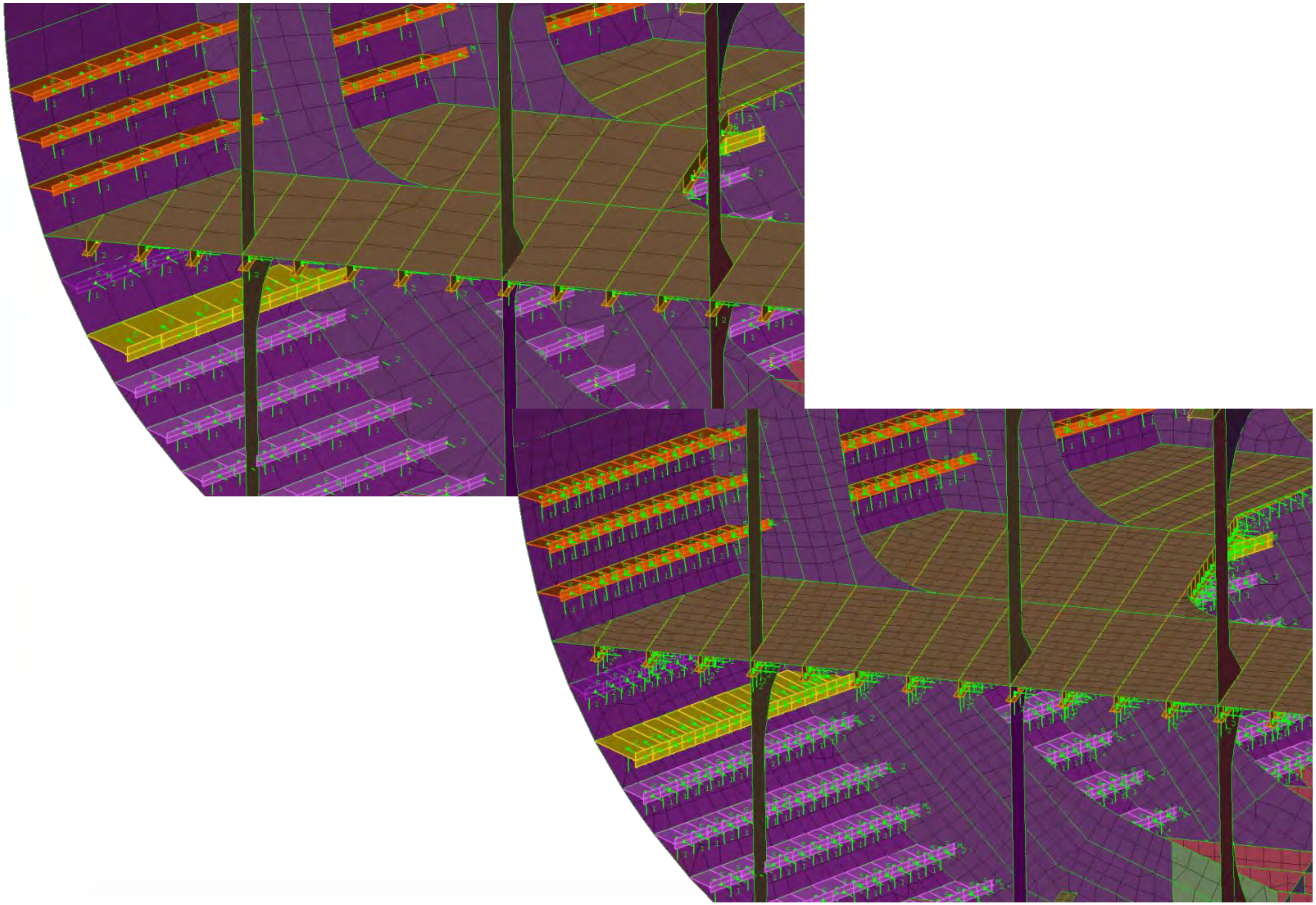
Automatic fix of quality violations





Reconstruct shells and beams

Reconstruct shells and the attached beams at the same time

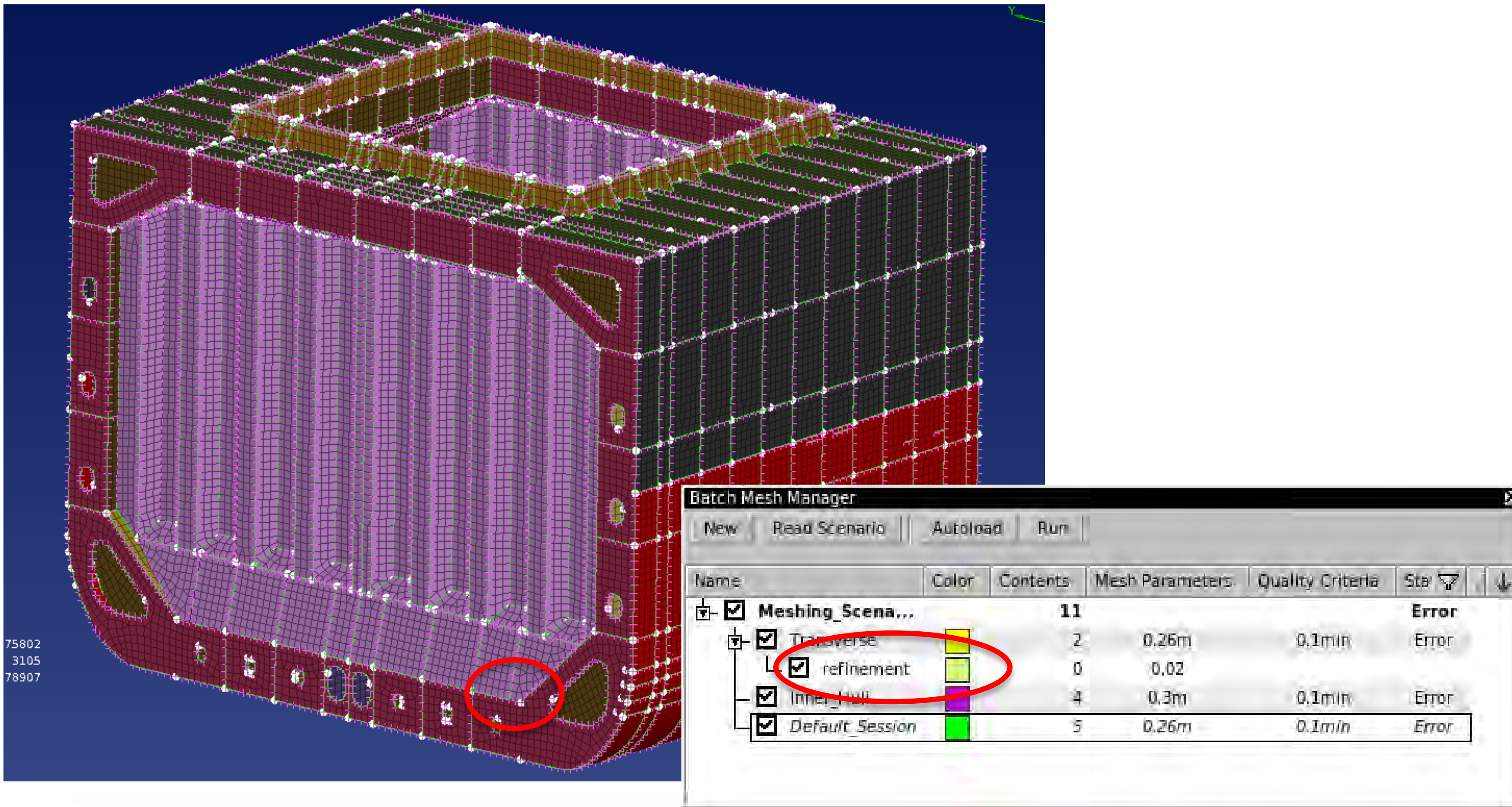


Batch meshing

Definition of meshing parameters and quality criteria

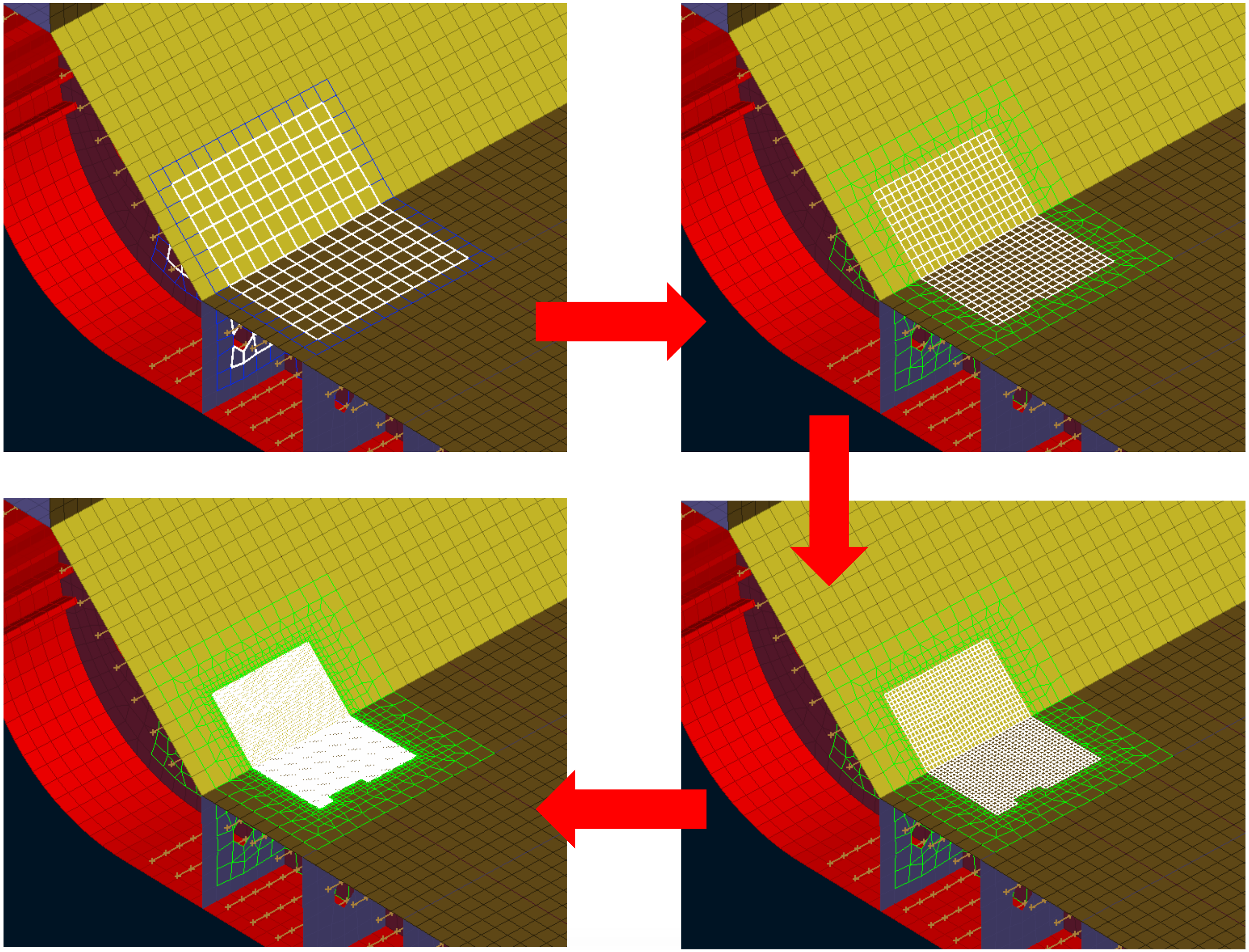
Features treatment and model simplification

Automatic meshing and quality improvement

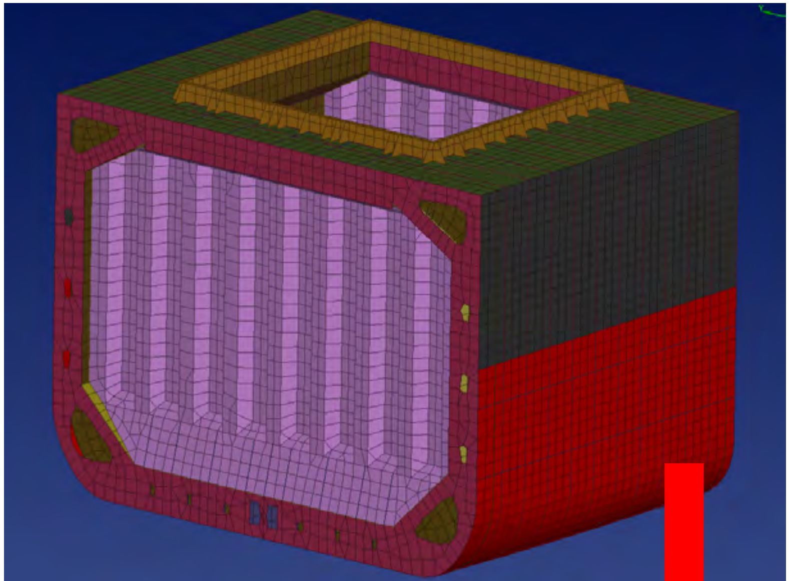


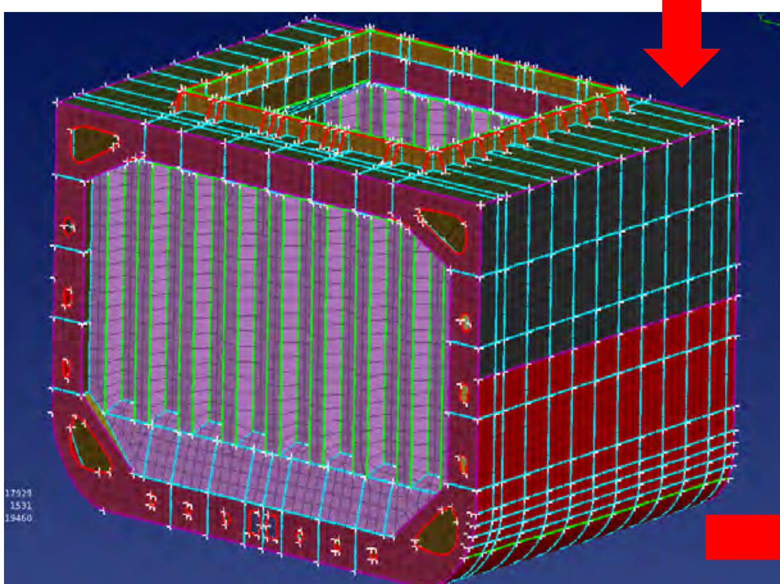
Local refinement

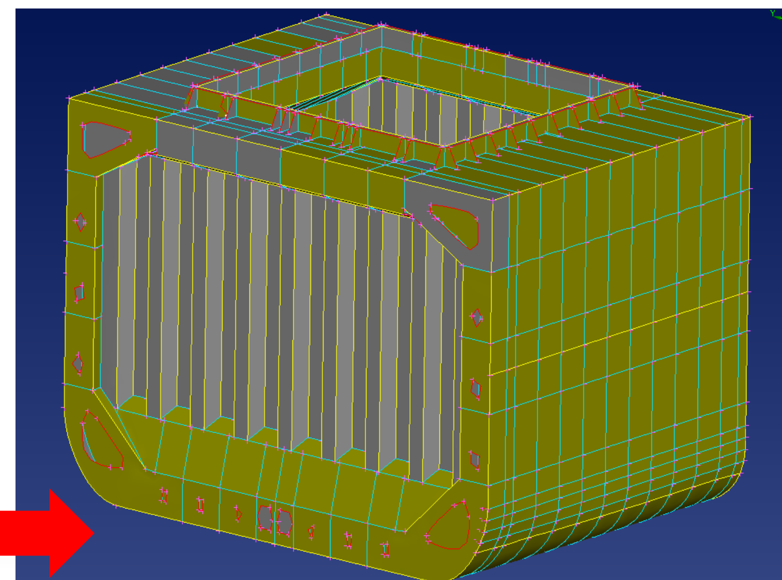
Local mesh refinement of geometry mesh and FE



Automatic definition of geometry from FE model



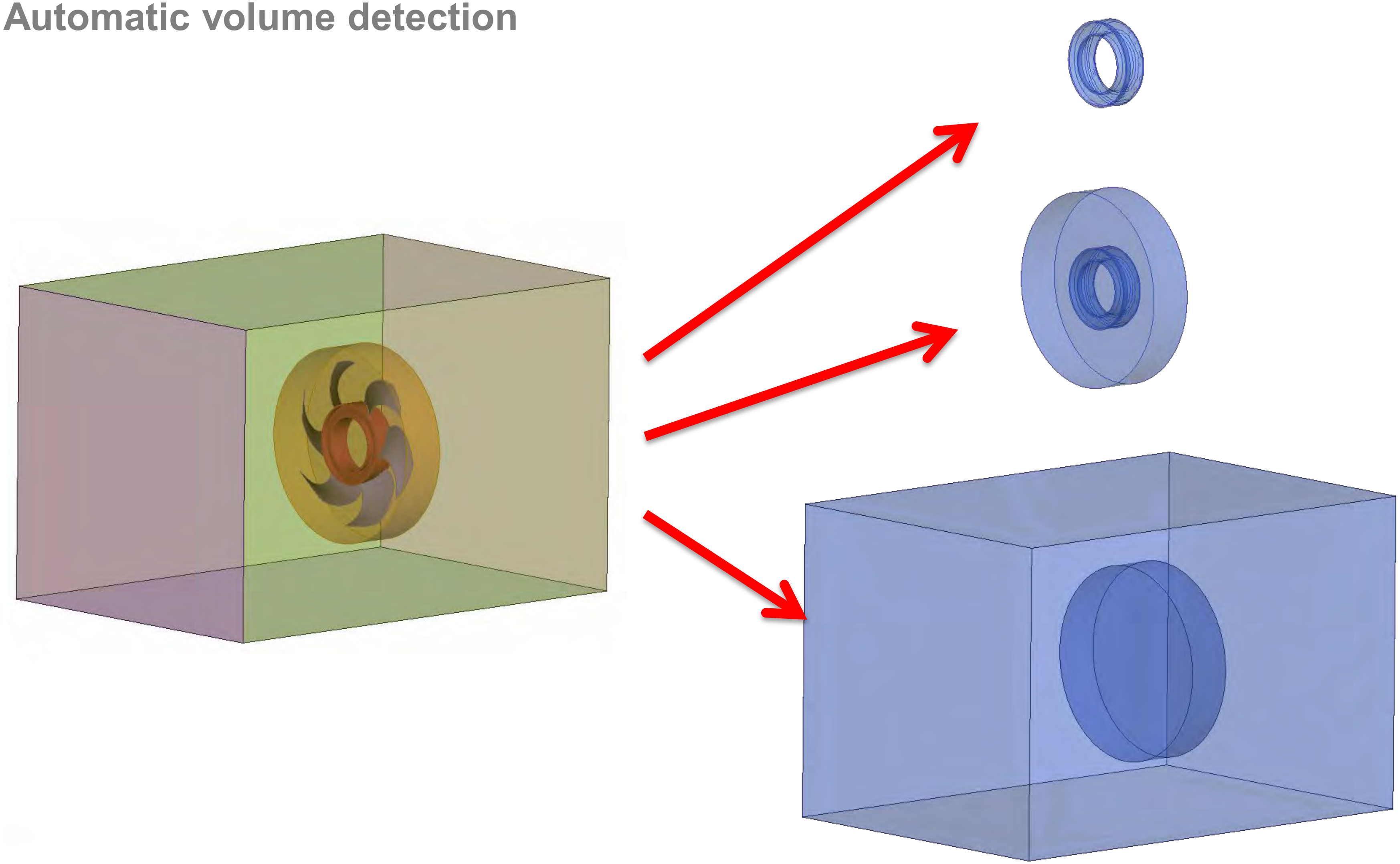




Volume Mesh

Volume Meshing

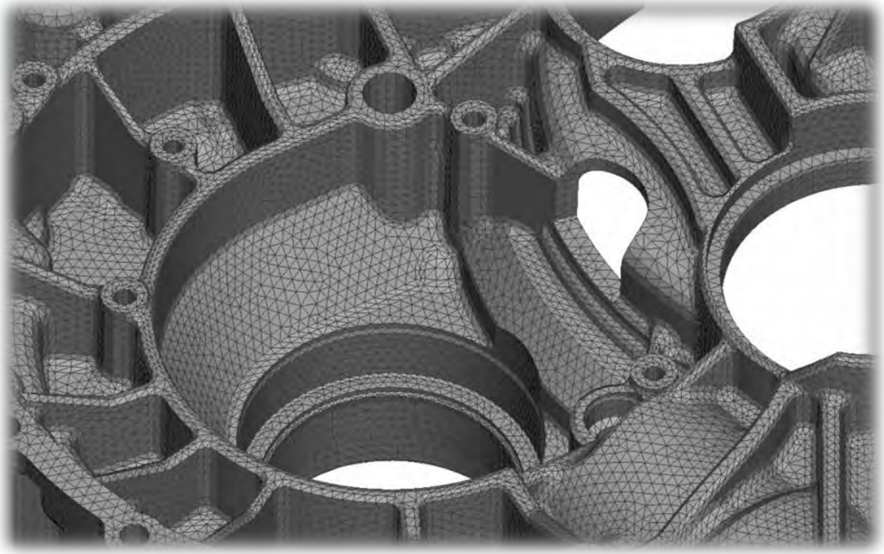
Automatic volume detection



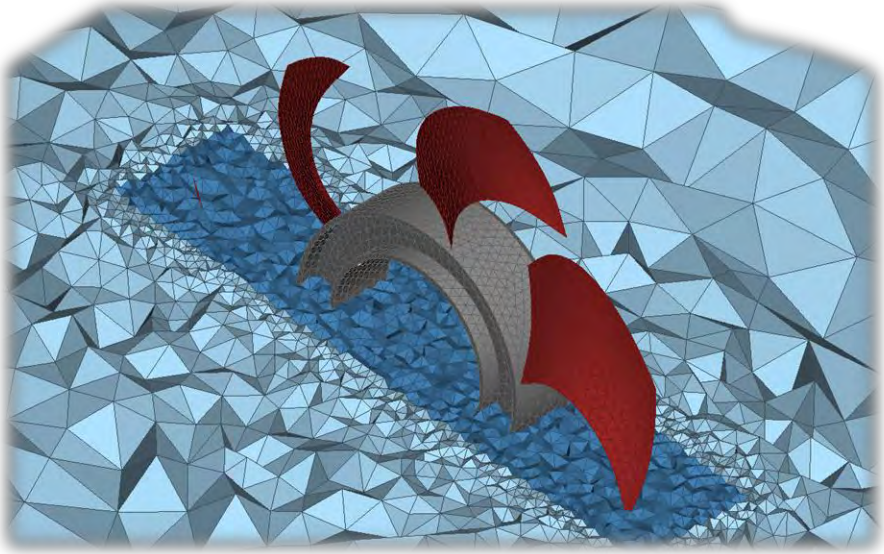
Detection of all valid volumes and sub-volumes

Volume Meshing

Tetrahedral Mesh



Structural

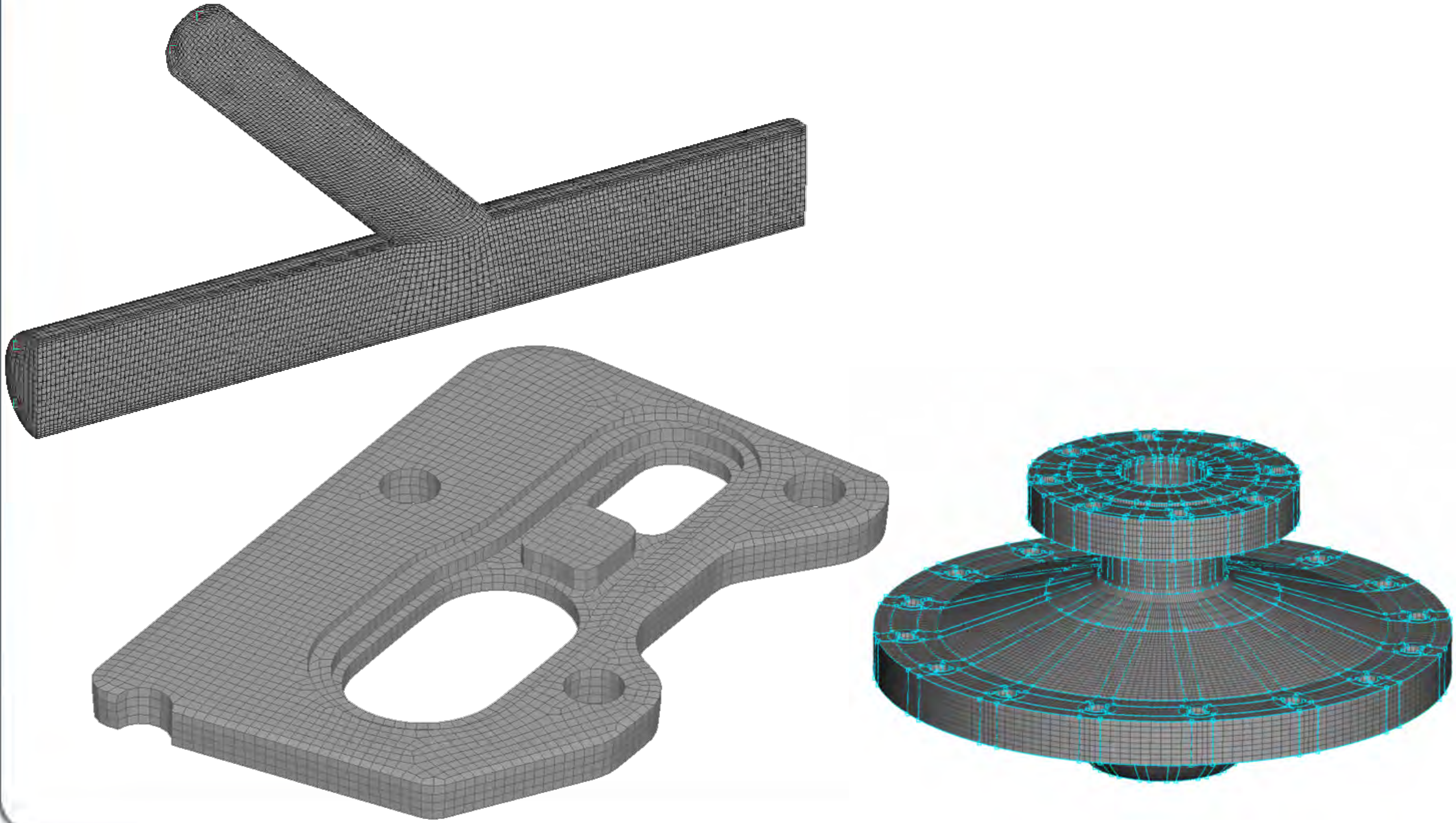


CFD

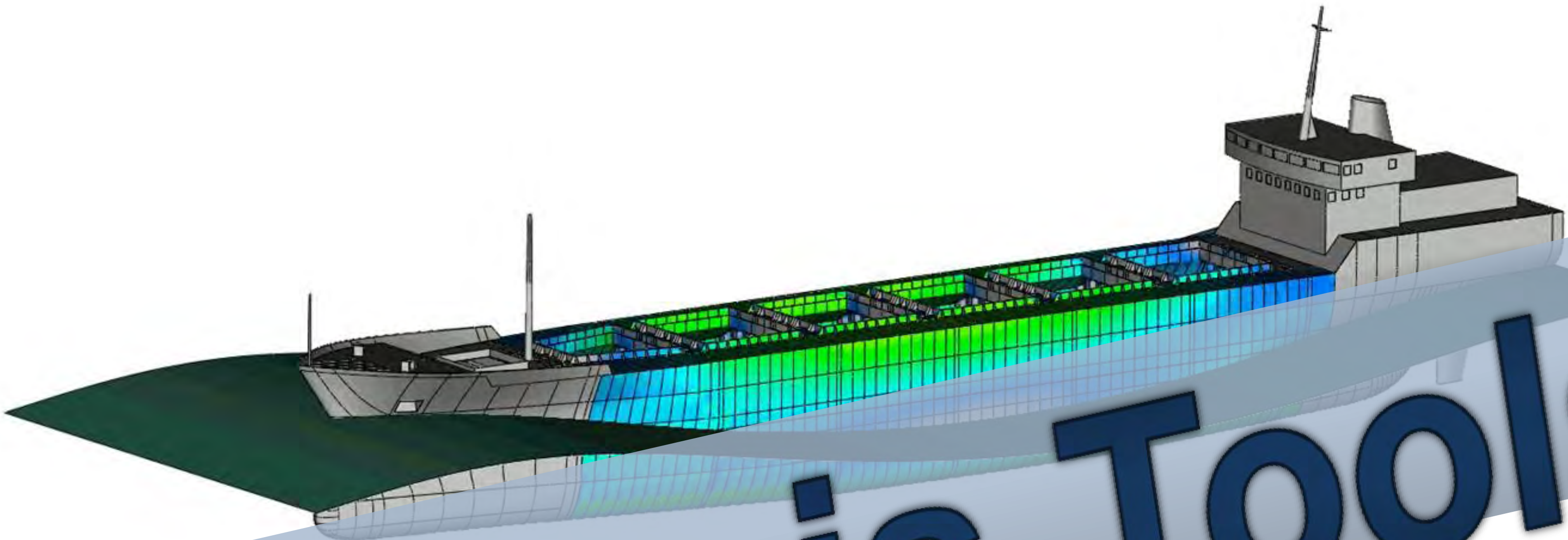
Fully automated through Batch Mesh

Volume Meshing

Hexa Meshing

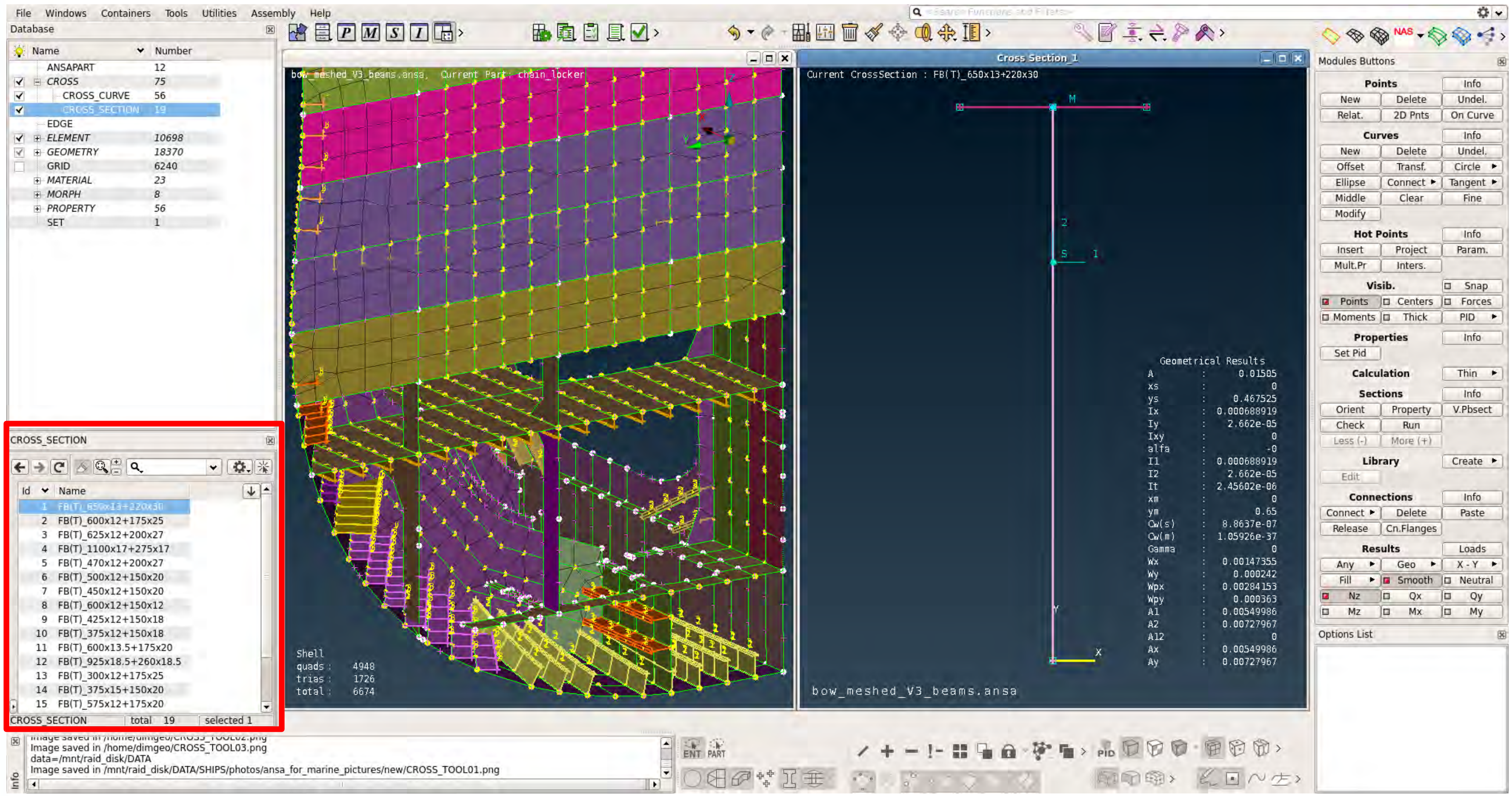


Analysis Tools



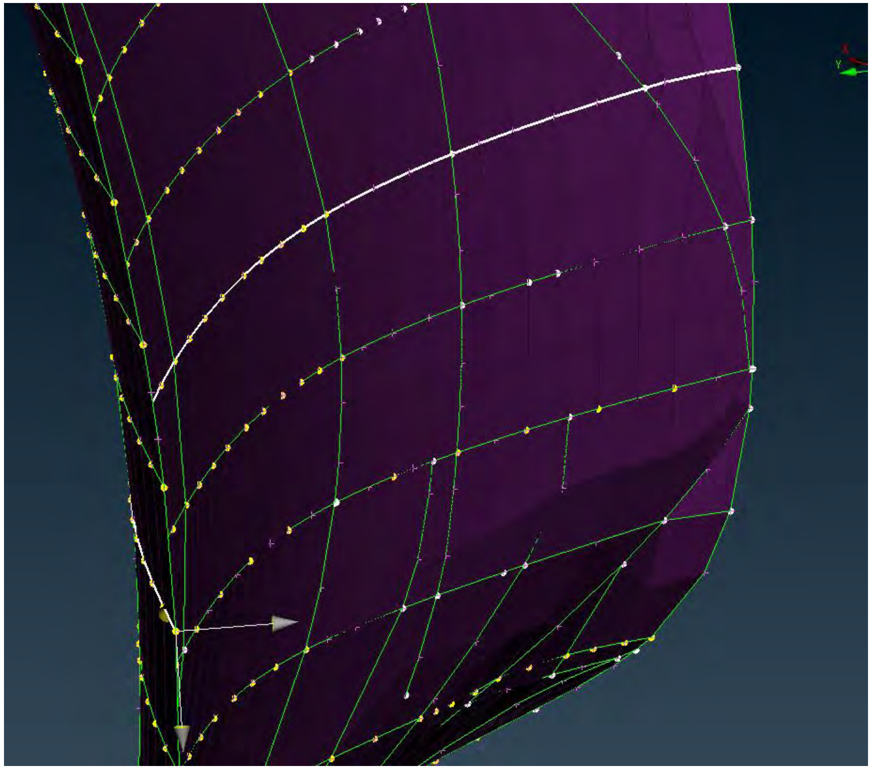
Stiffeners creation using beams

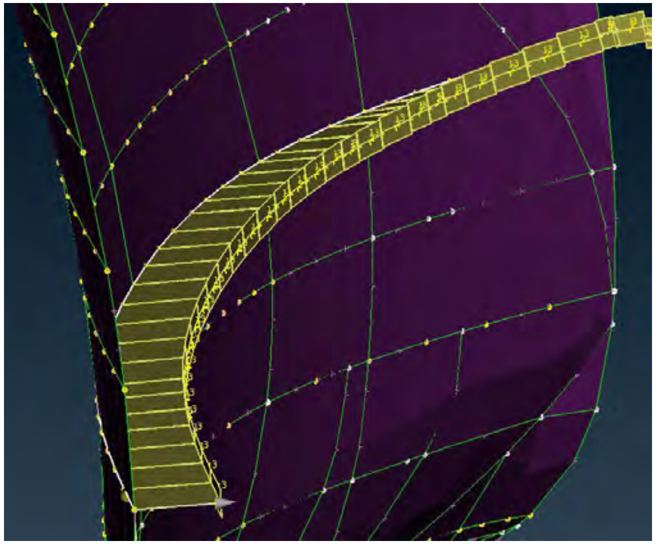
Creating database of cross sections of any shape

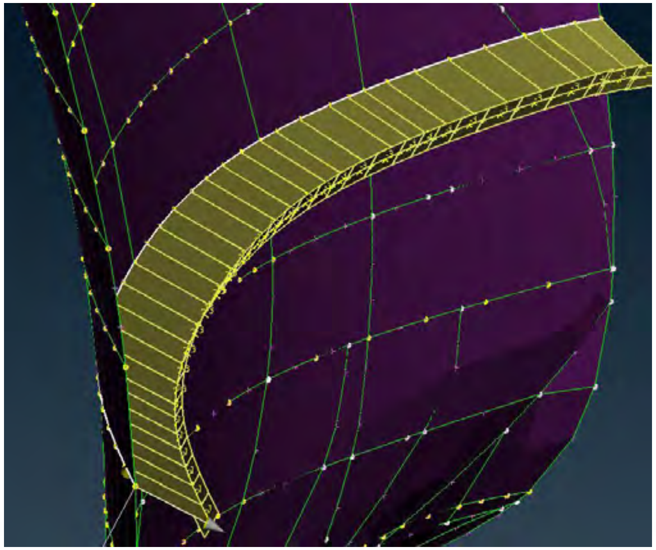


Stiffeners creation using beams

Creating database of cross sections of any shape

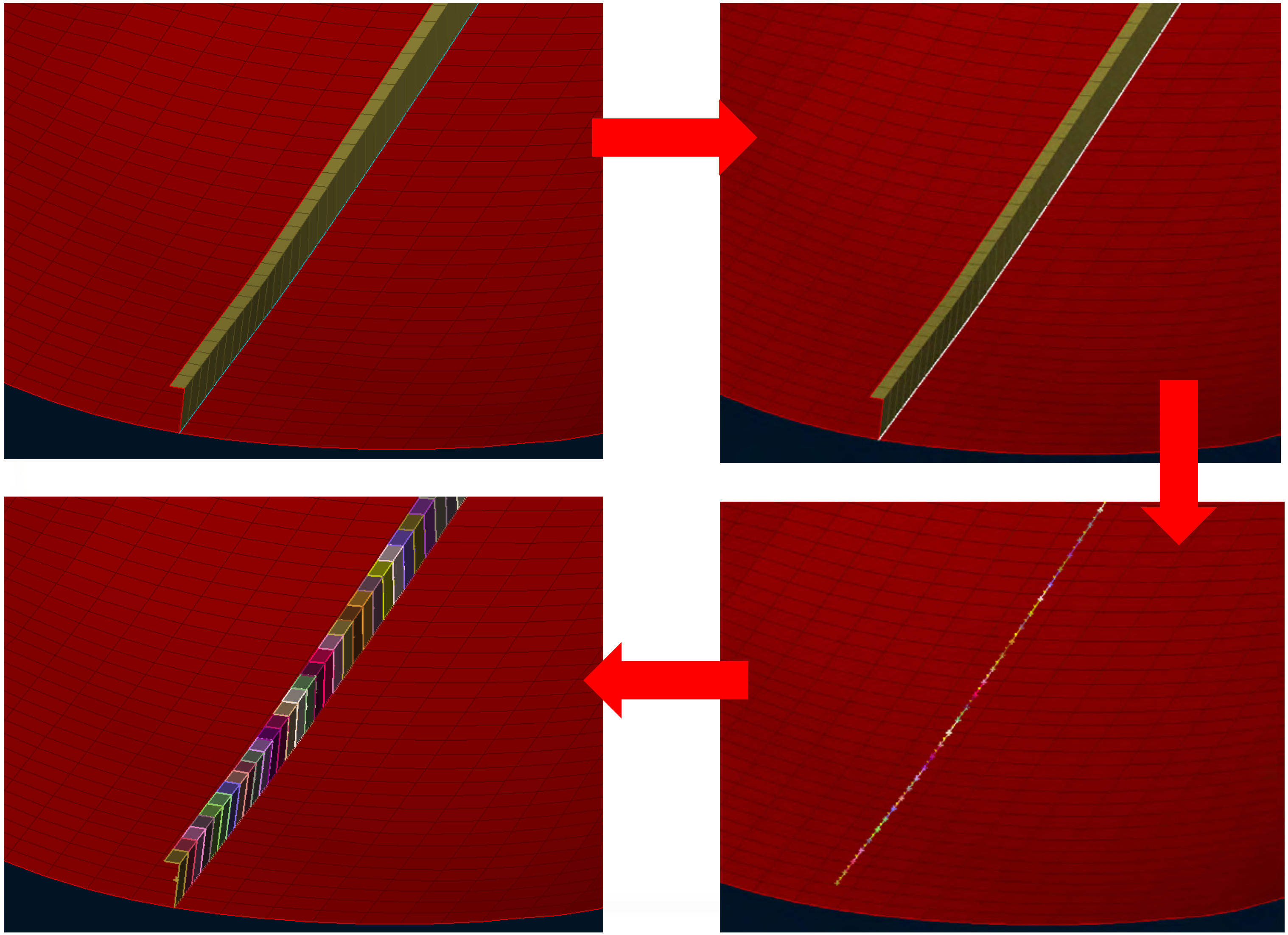






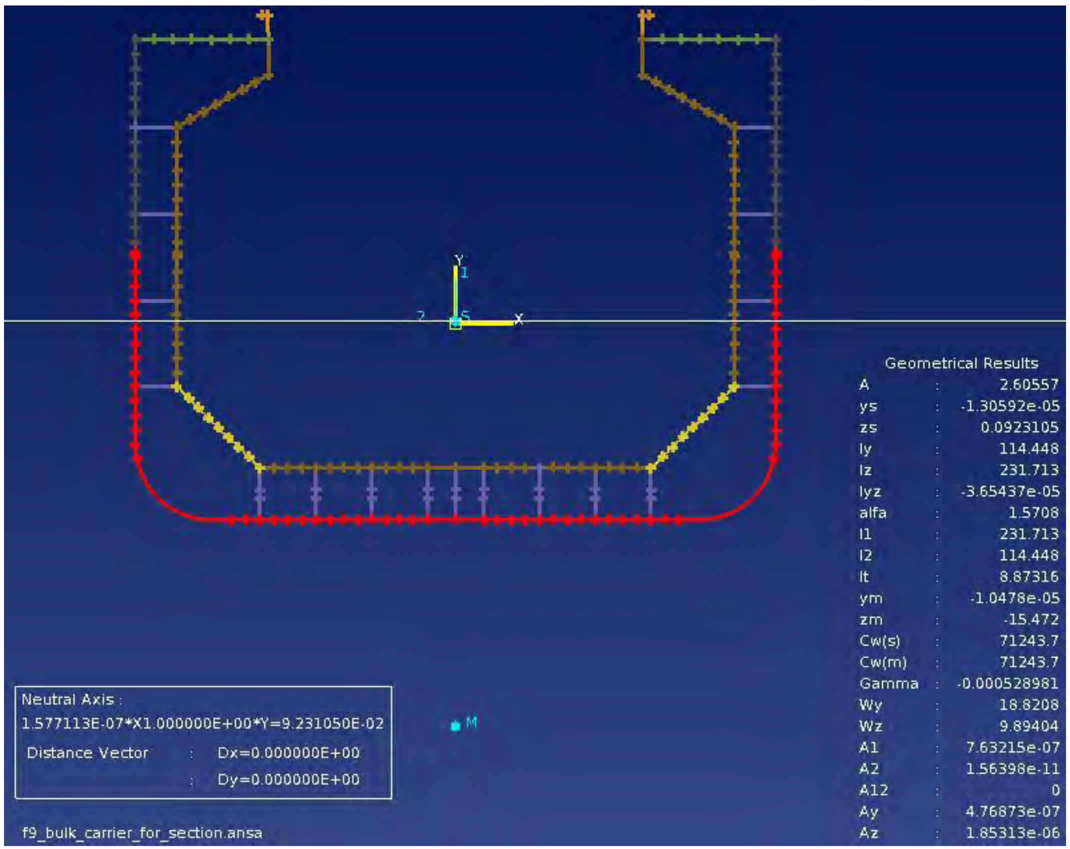
Stiffeners replacement with beams

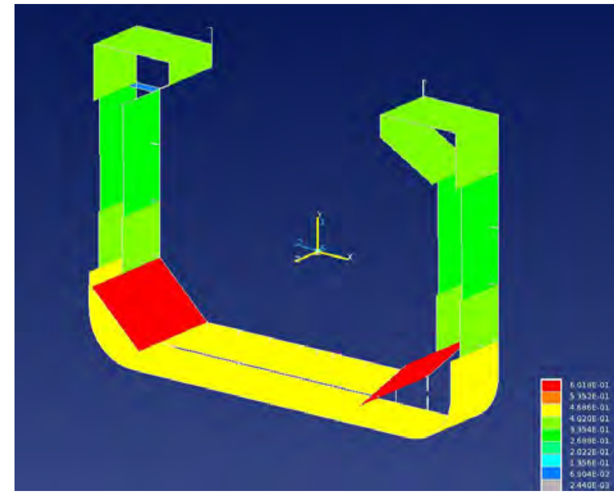
Replacement of standard cross section reinforcements “L”, “I”, etc. with beams

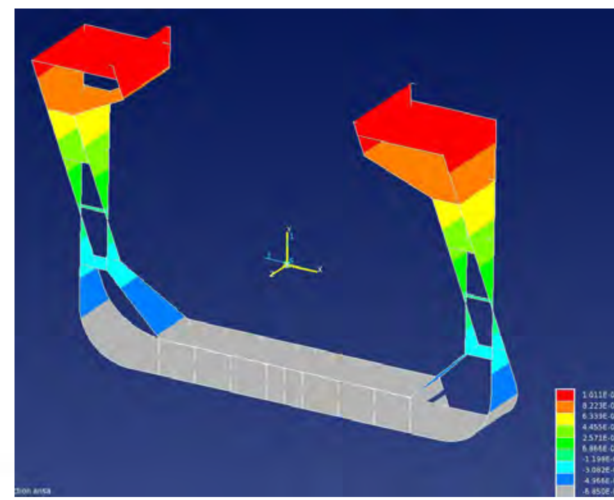


Calculating Cross Sections

- Extraction of Cross Sections from the geometrical model
- Editing of Cross Sections
- Calculating geometrical results (A, Iy, Iz, etc..) neutral axis stresses and moments

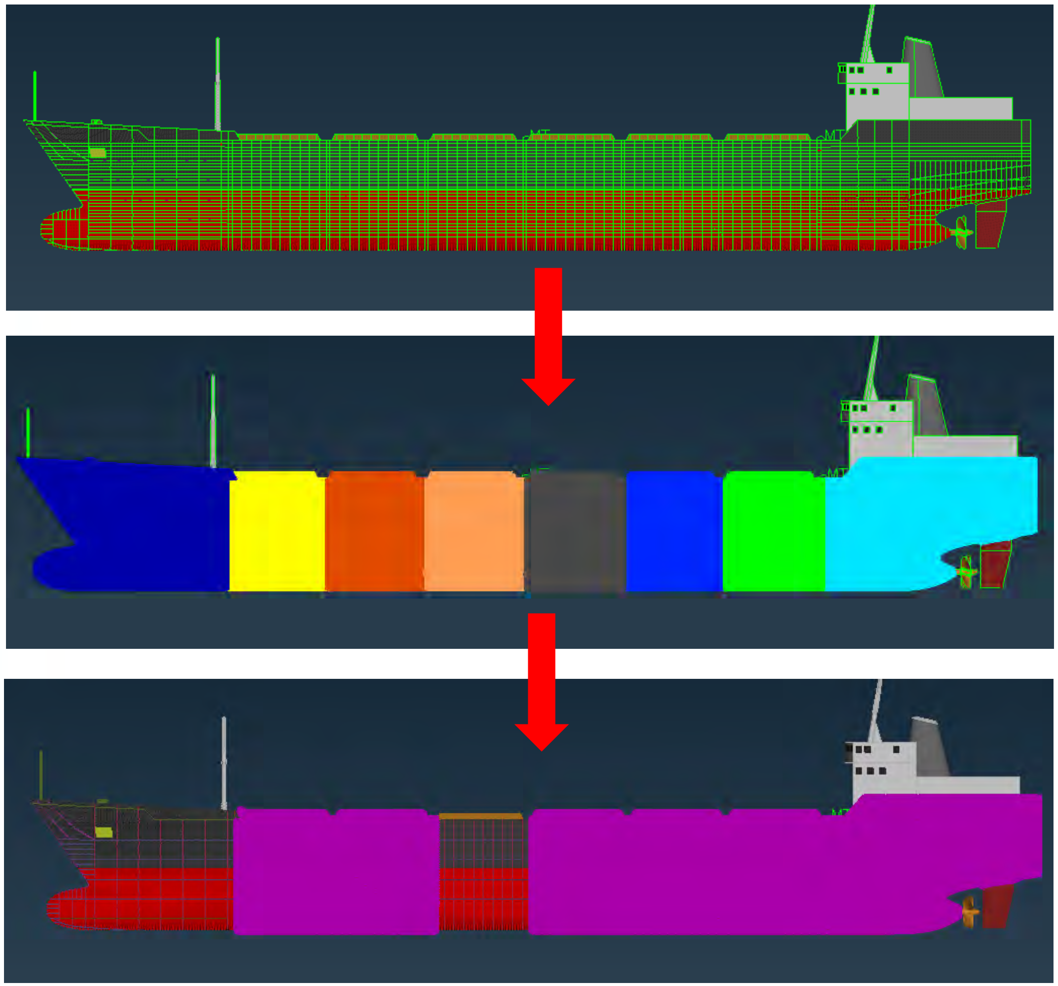


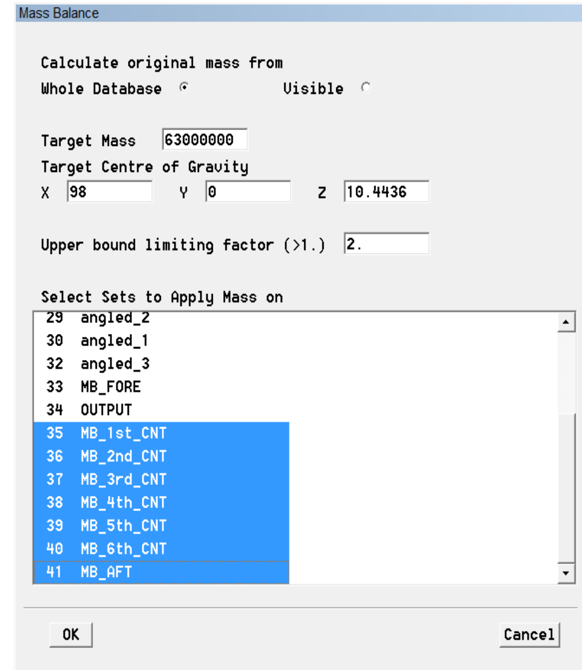


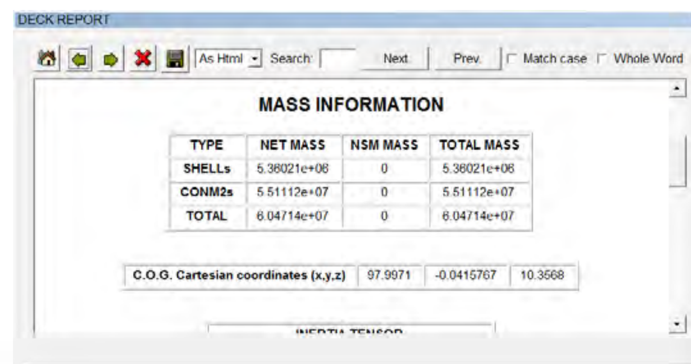


Mass distribution

Applying additional mass to model by fulfilling balance criteria







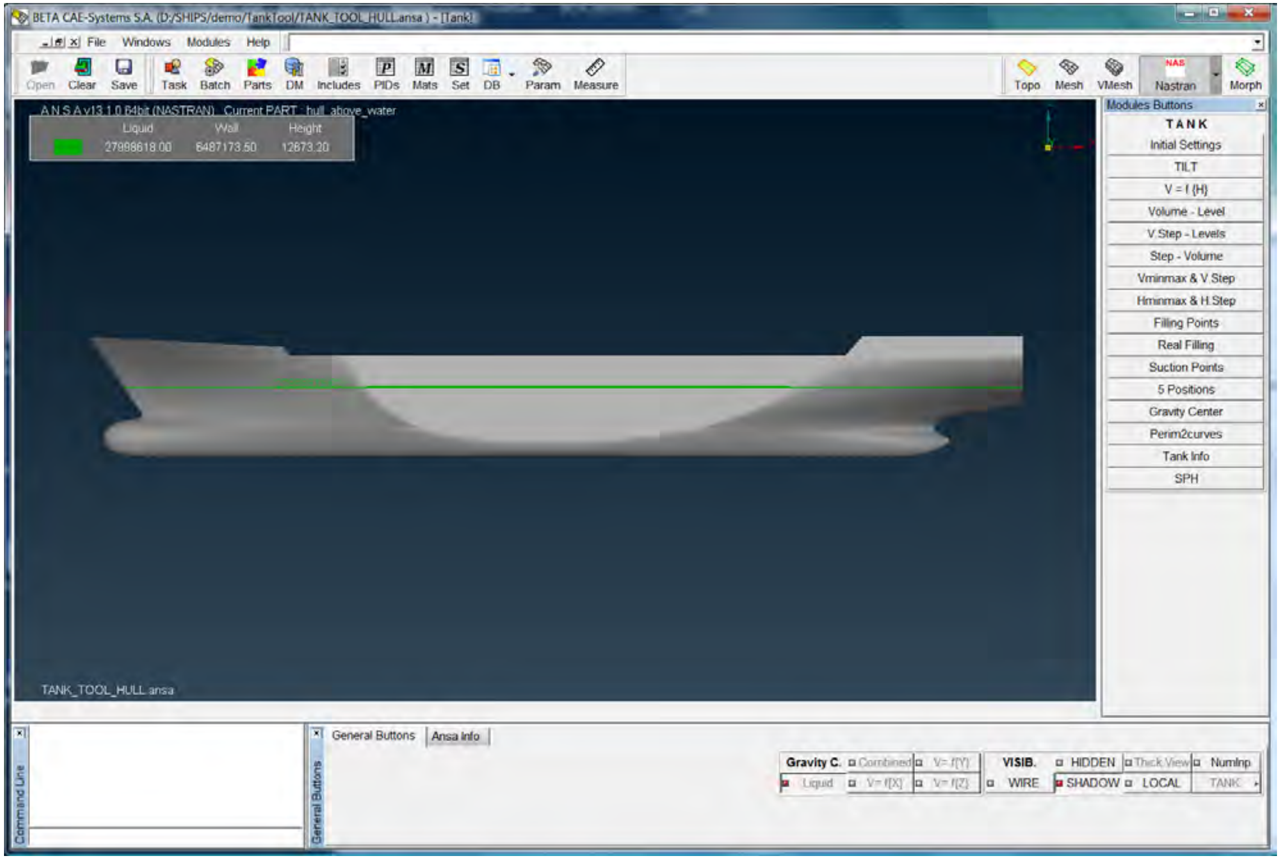
MASS INFORMATION

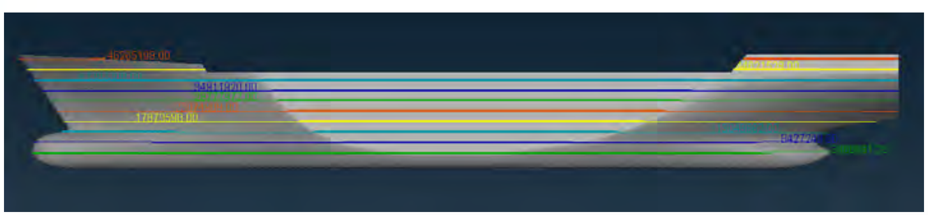
TYPE	NET MASS	NSM MASS	TOTAL MASS
SHELLs	5.36021e+06	0	5.36021e+06
CONM2s	5.51112e+07	0	5.51112e+07
TOTAL	6.04714e+07	0	6.04714e+07

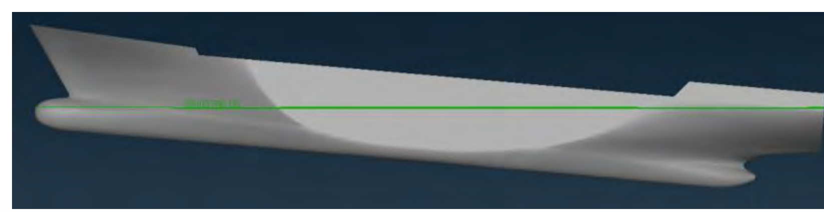
C.O.G. Cartesian coordinates (x,y,z)	97.9971	-0.0415767	10.3568

Waterline calculation

Calculating the waterline for variable ship loading







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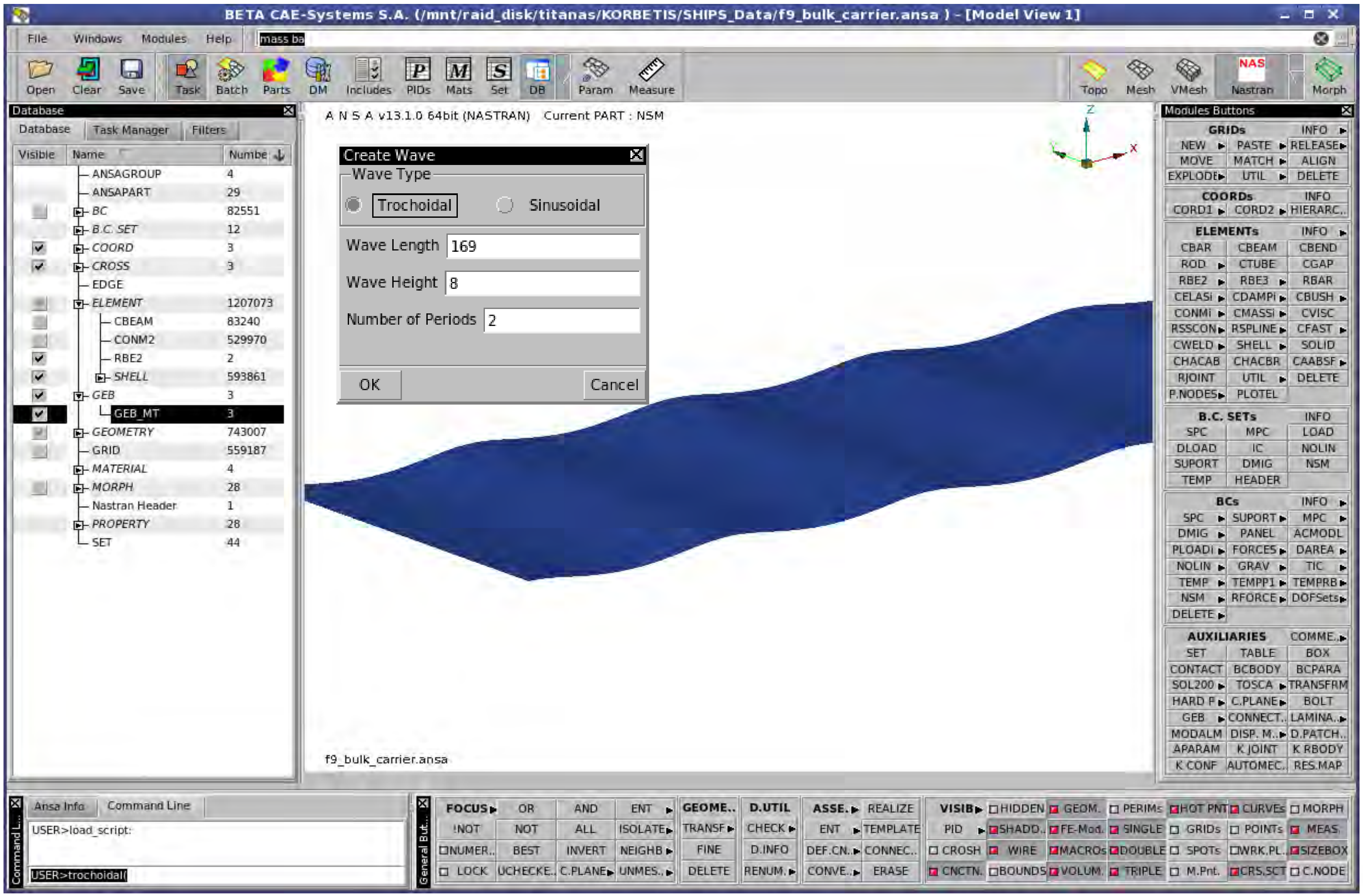
Wave creation

Sinusoidal or trochoidal wave profile can be defined as a 3D Curve or Face



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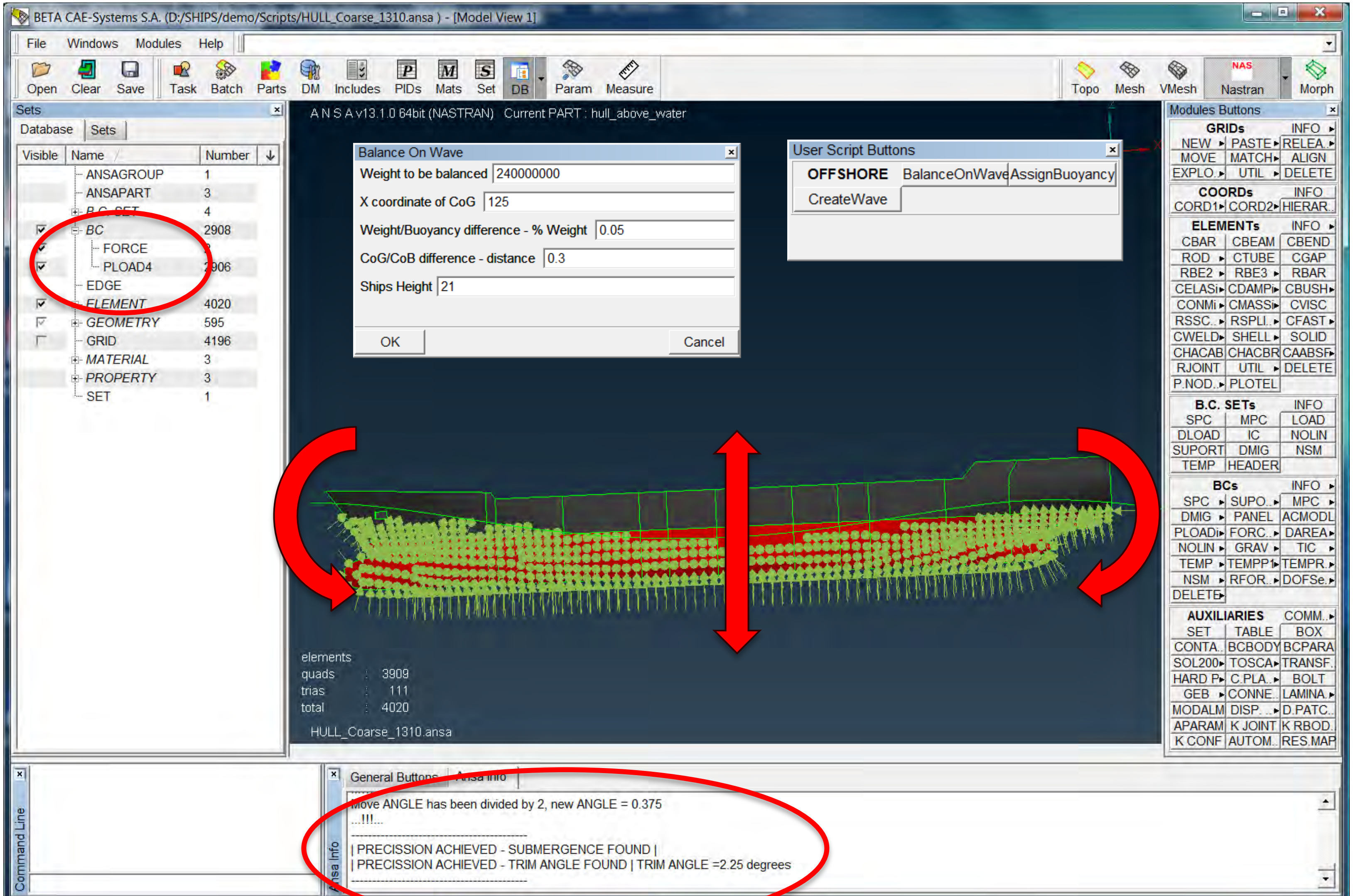
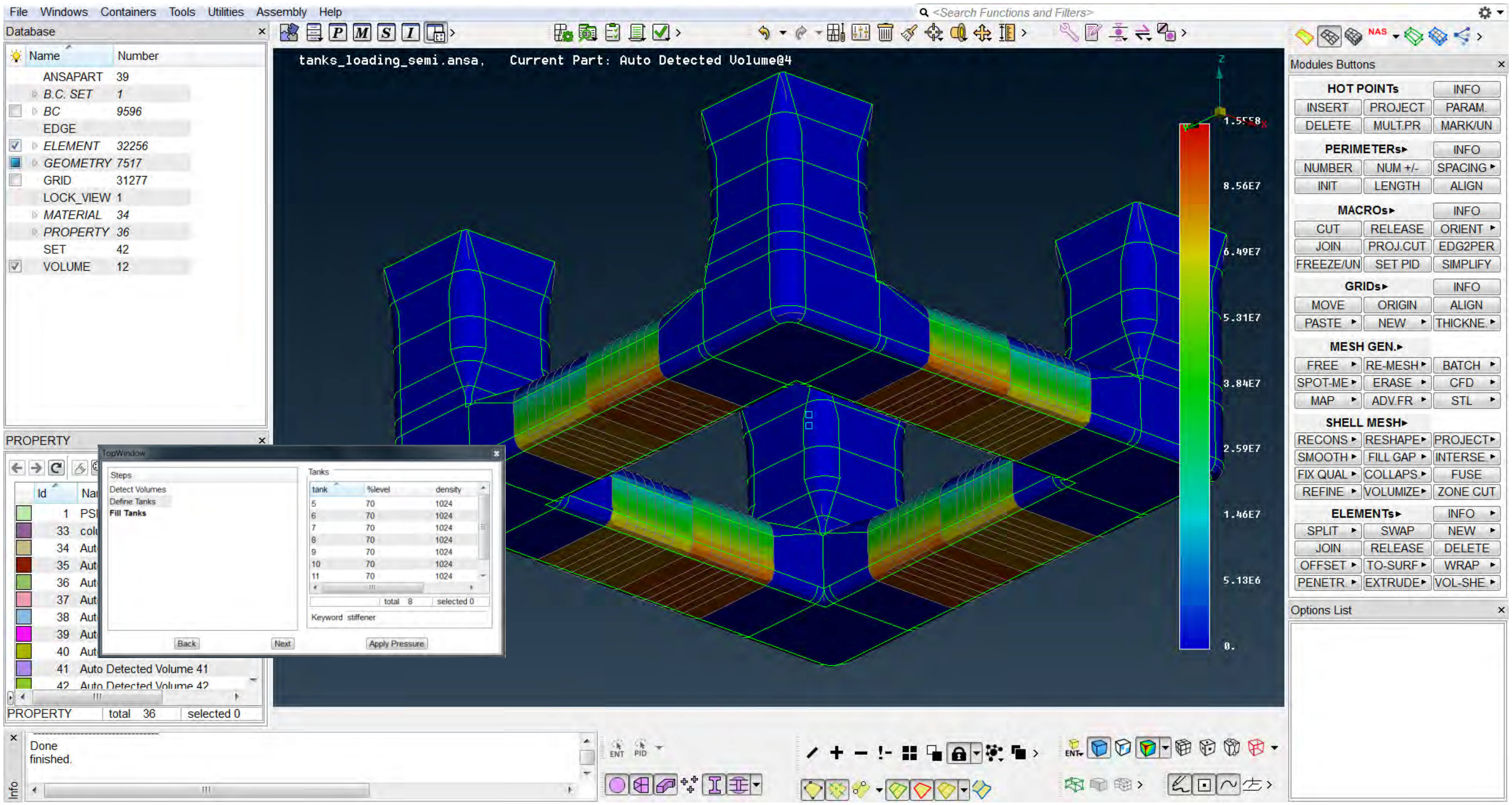
Static Equilibrium

The static position of the ship on the wave is calculated through ANSA scripting



Tanks Loading

Tanks recognition and cargo load definition using Pressure Loads



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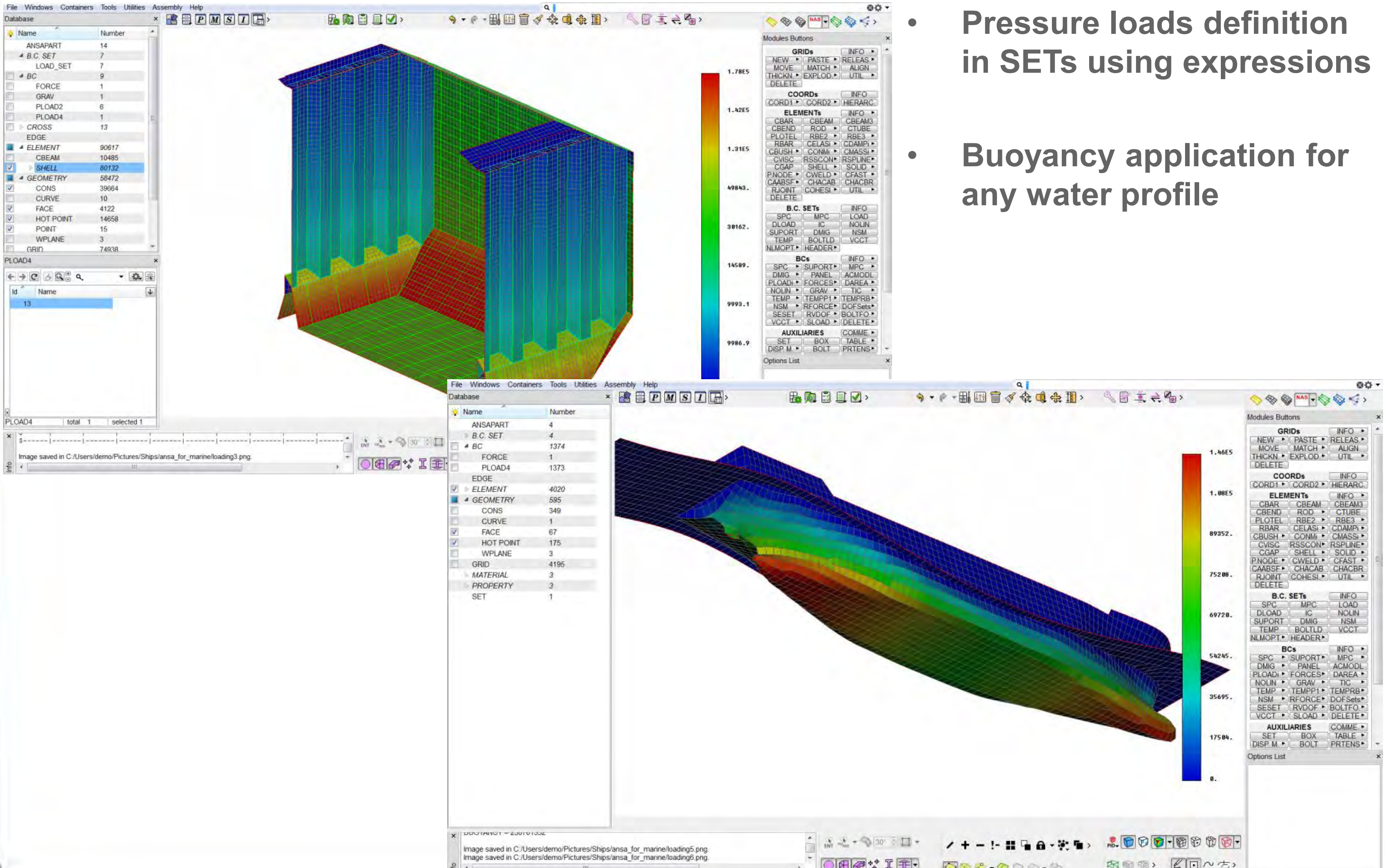
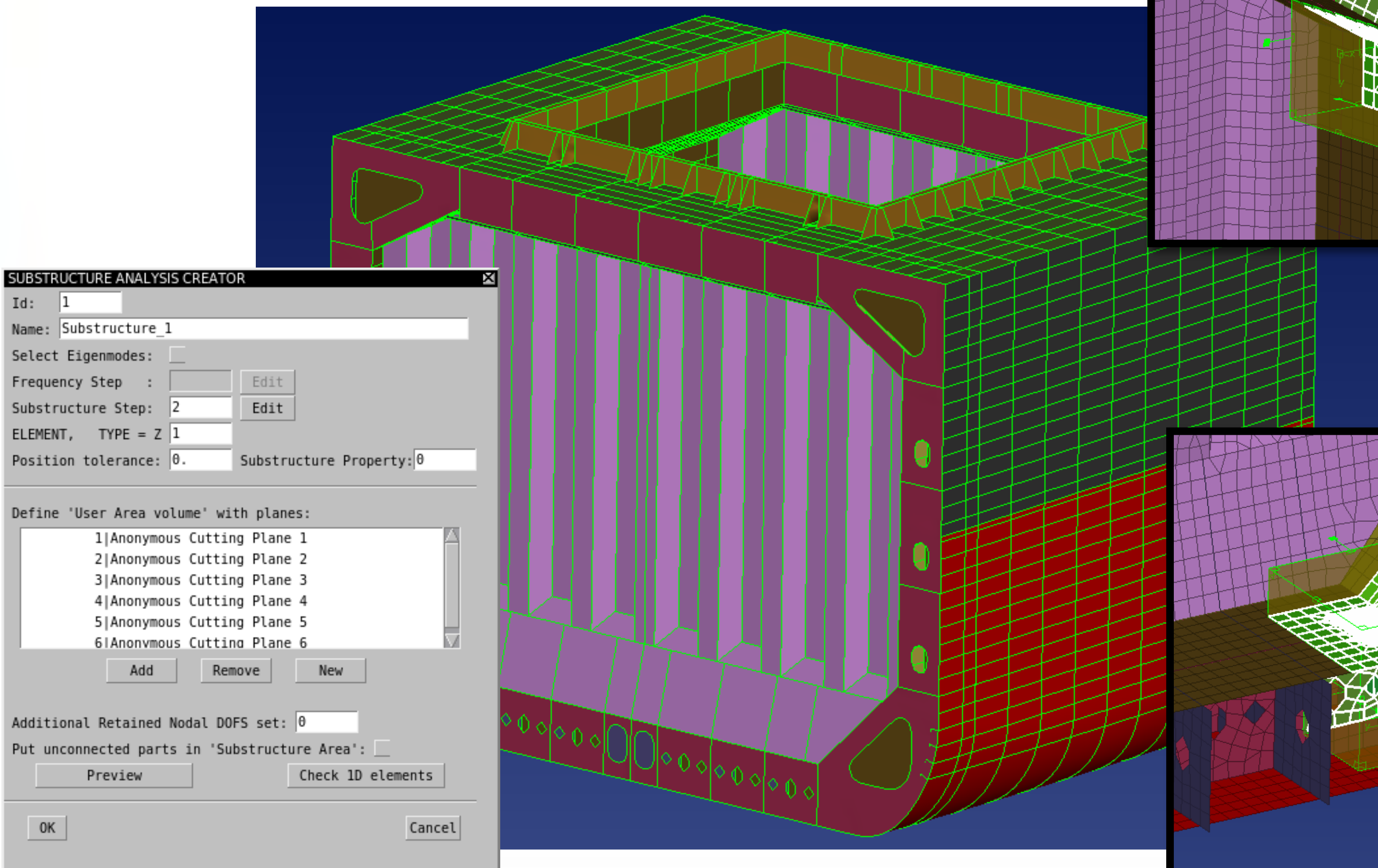
Pressure loads application

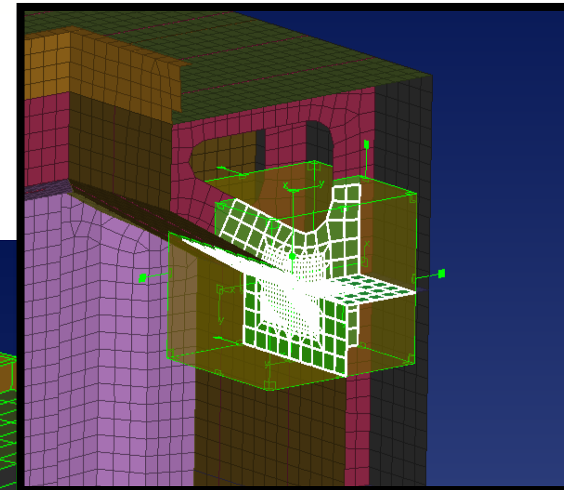


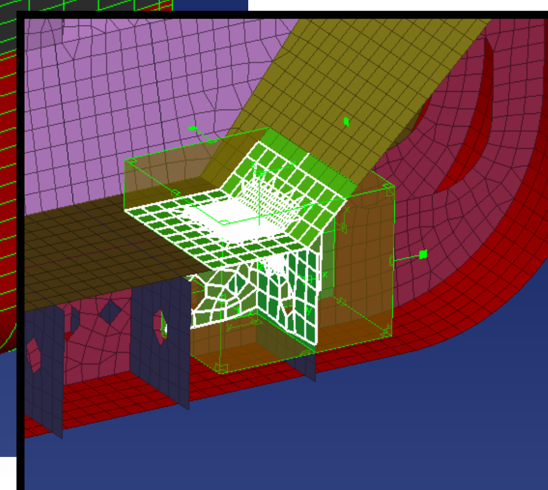
- Pressure loads definition in SETs using expressions
- Buoyancy application for any water profile

Sub-structuring and Sub-modeling

- Local refinement at the areas of interest
- Output local and global models separately
- Merging local and global back to one model

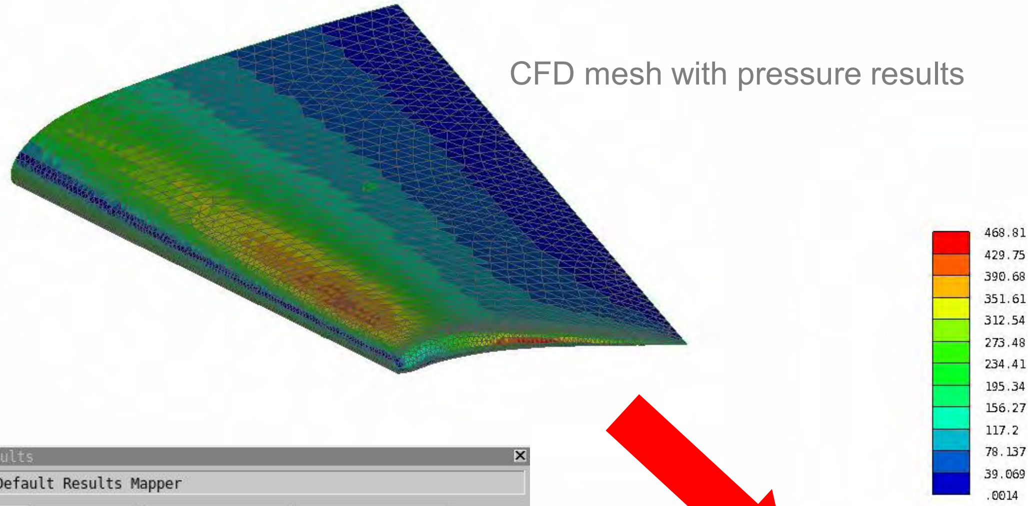




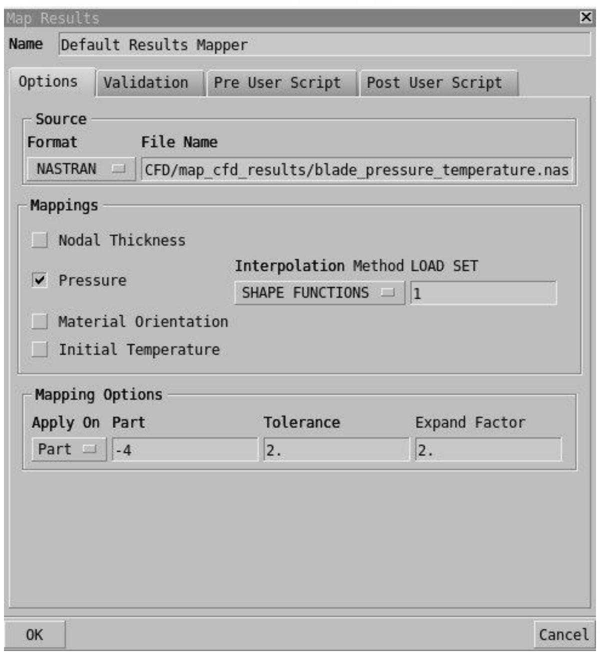


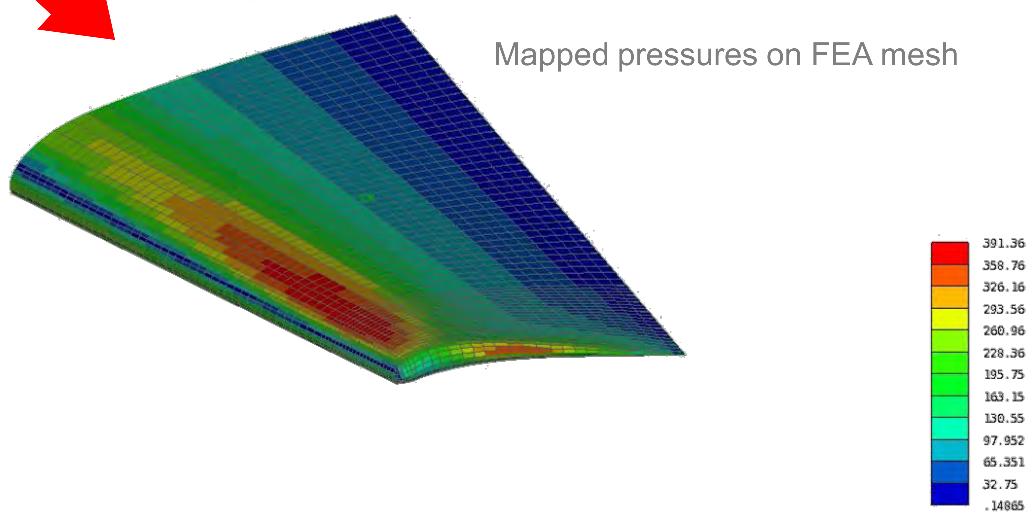
Mapping CFD results to FEA models

Map pressure or temperature results from a CFD simulation to an FEA model



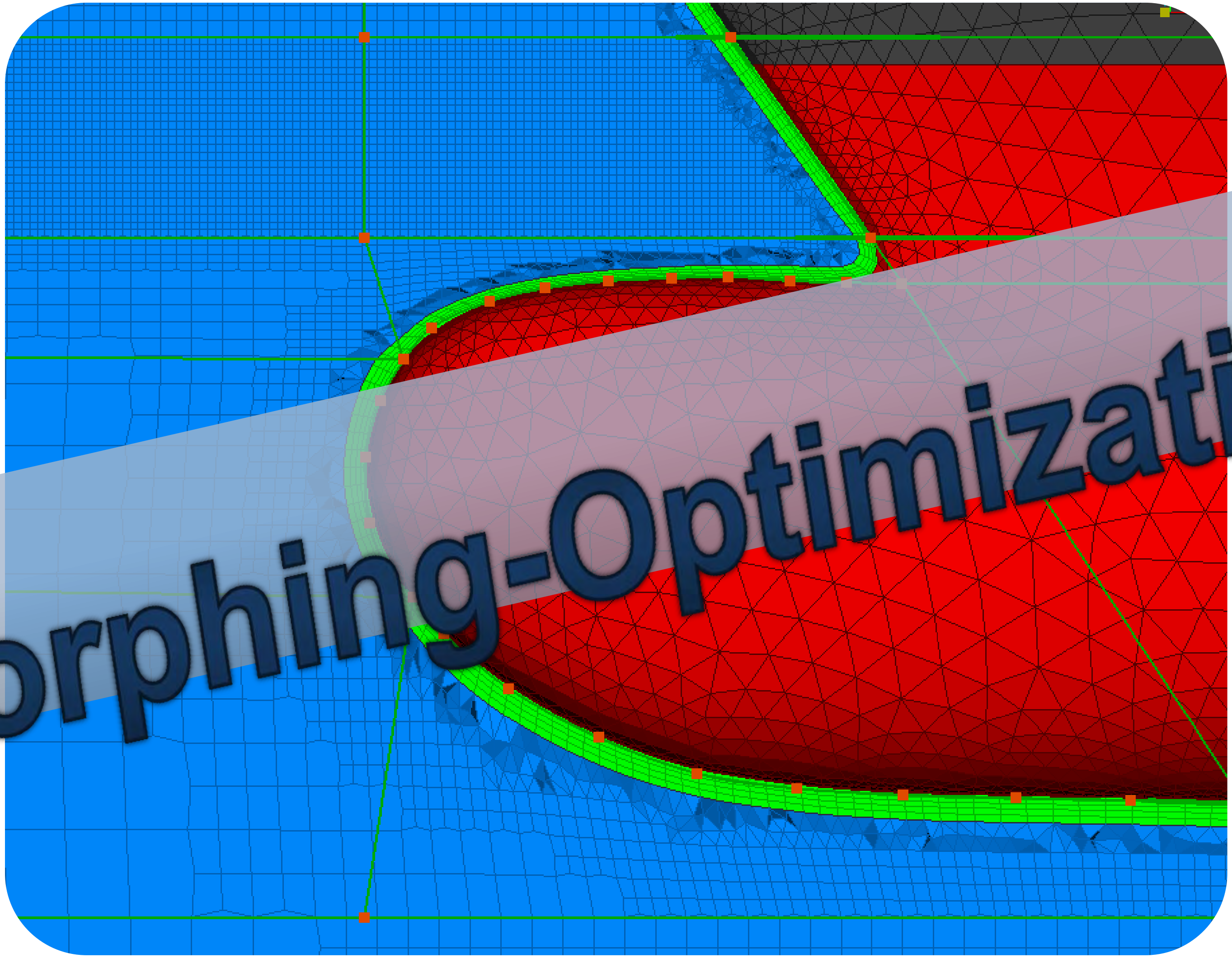
CFD mesh with pressure results





Mapped pressures on FEA mesh

Morphing-Optimization



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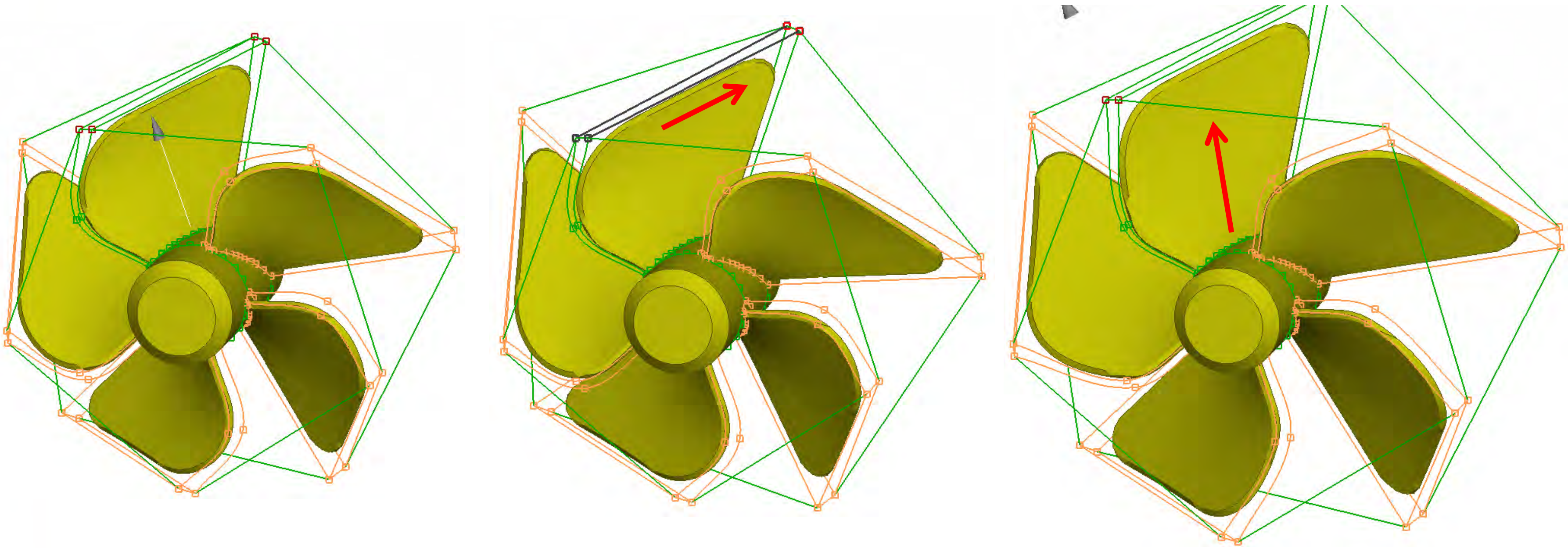
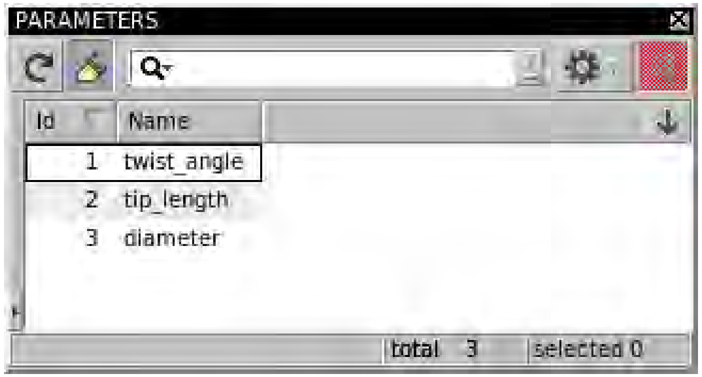
Shape optimization using the Morphing Tool

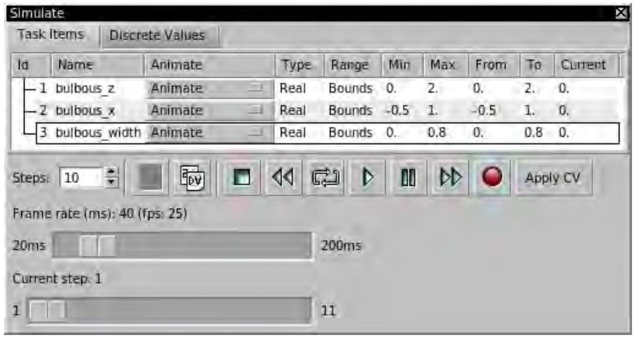
Parametric morphing applied on FE or geometry

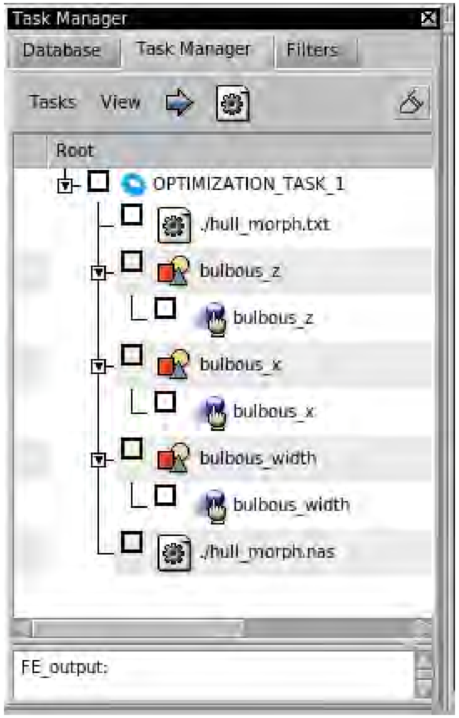


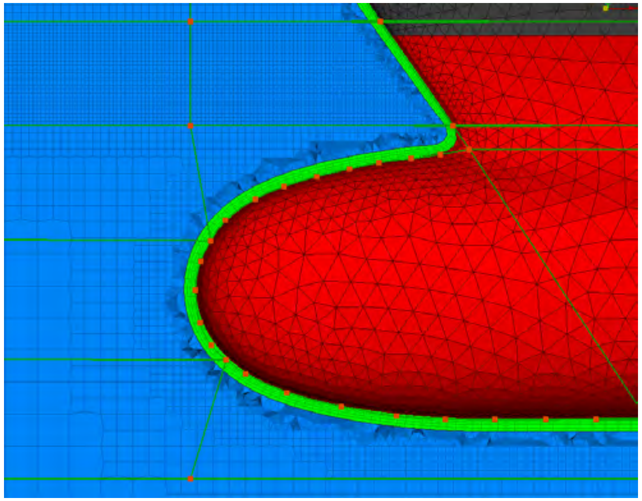


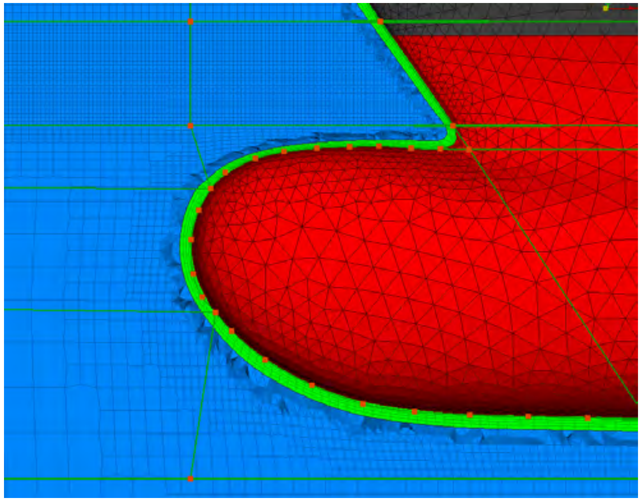
Shape optimization of the bulbous bow

- Morphing Tool controls model and fluid mesh simultaneously
- Shaping is performed without the need of re-meshing
- Design Variables are defined at the Optimization Task
- Morphing results are simulated



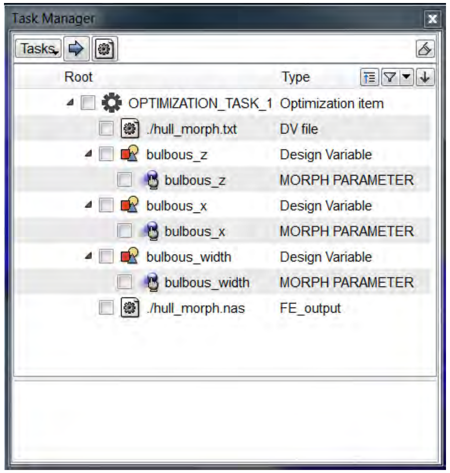


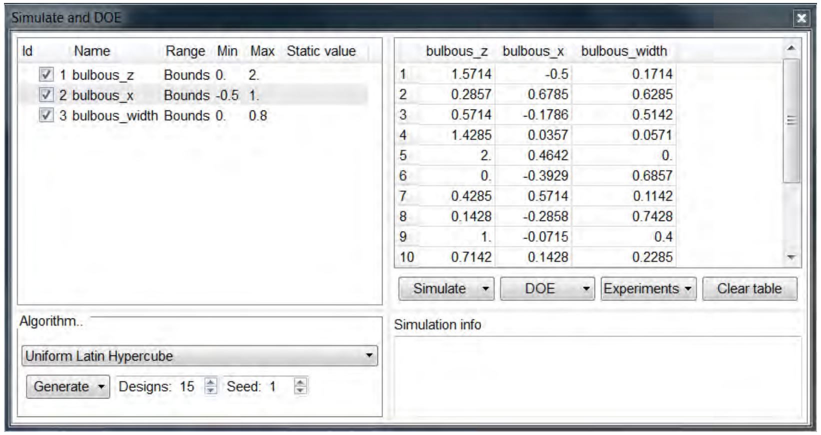


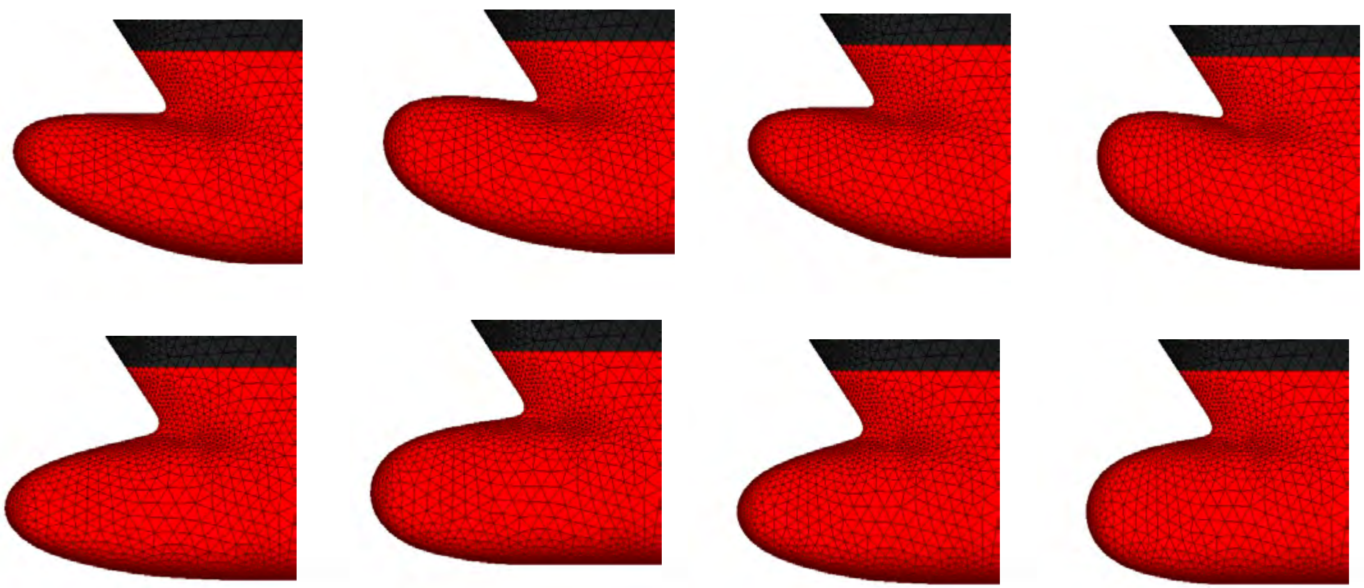


Shape optimization of the bulbous bow

Definition of Design of Experiments

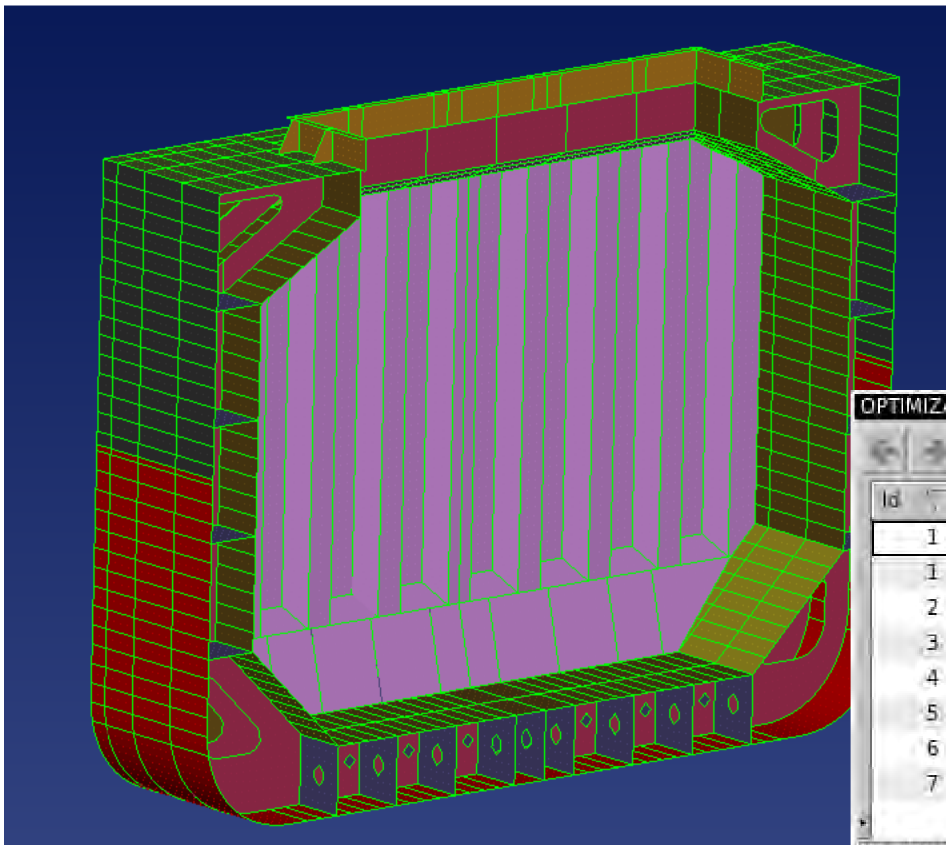


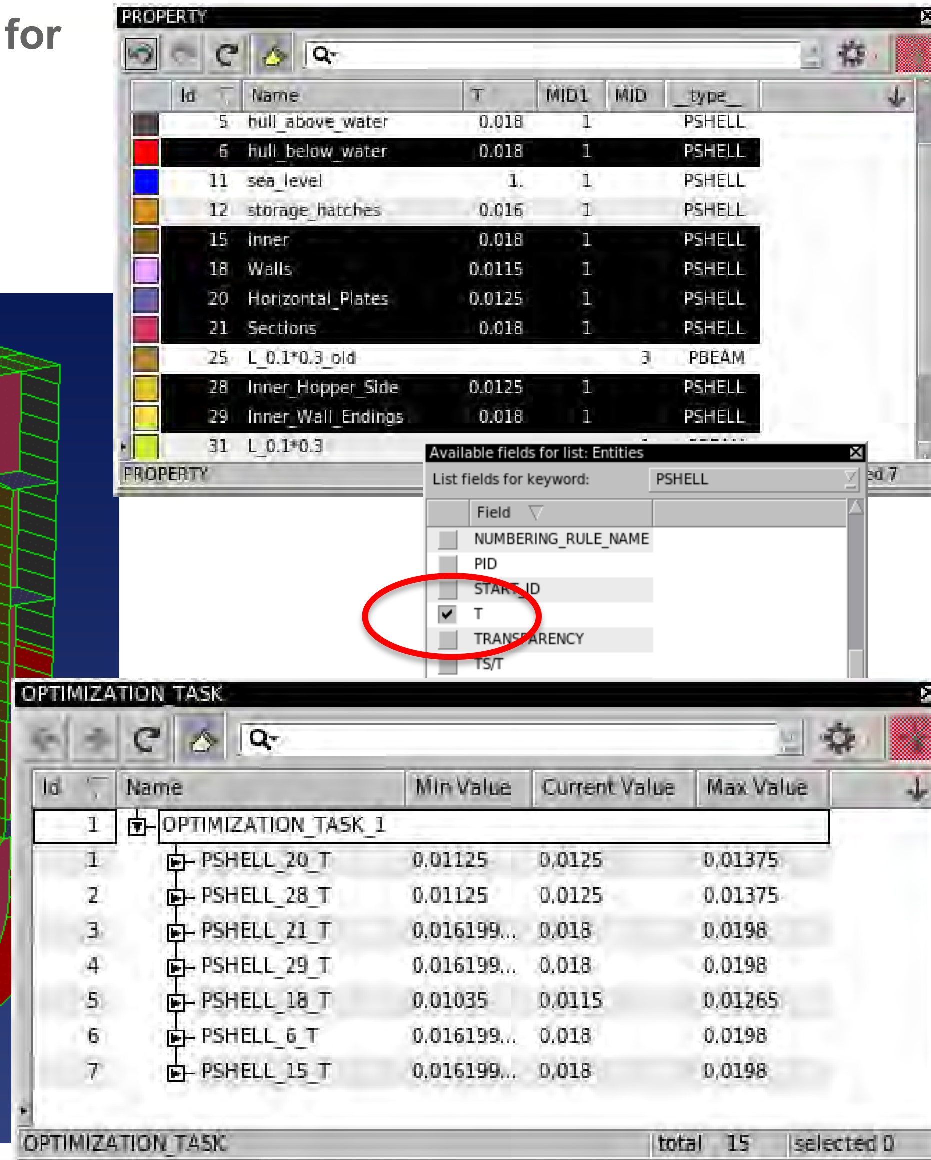




Shell thickness optimization

Automatic definition of design variables for shell thickness and creating the Optimization Task

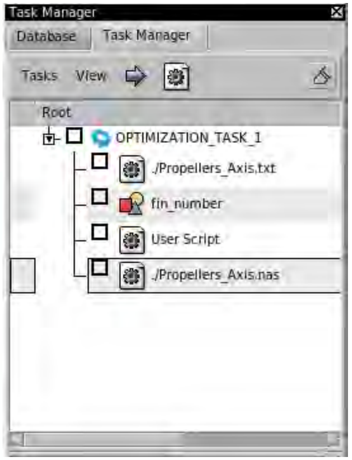


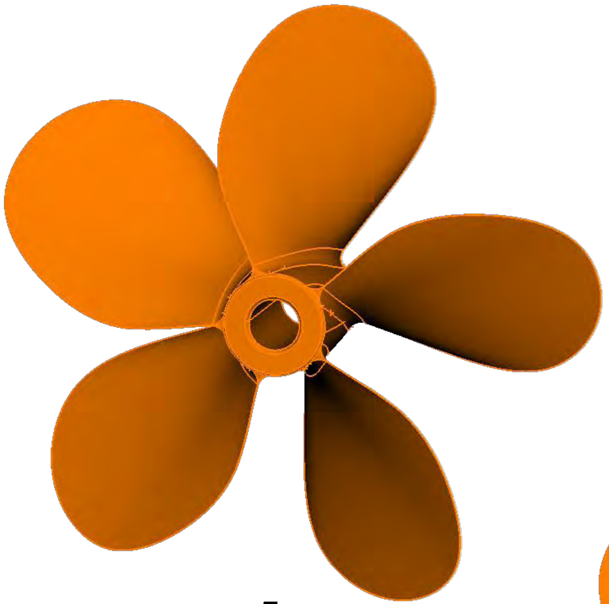


Creating / importing features parametrically

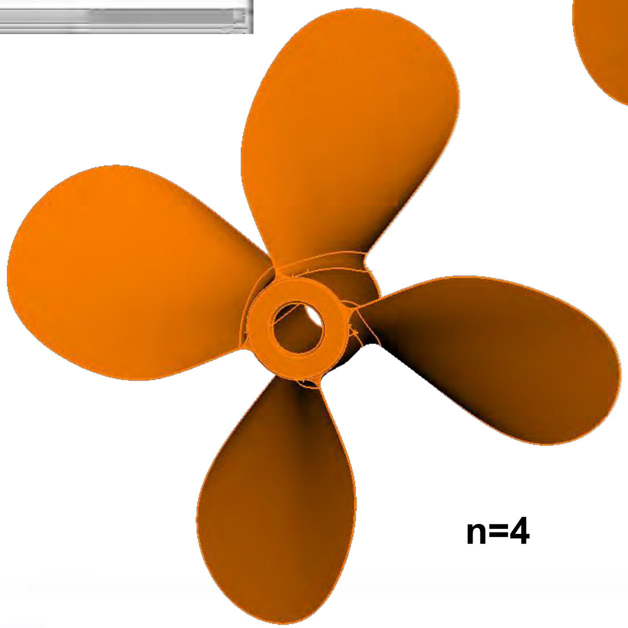
Defining the fin number of a propeller as design variable

A new shape is created just by changing the design variable value

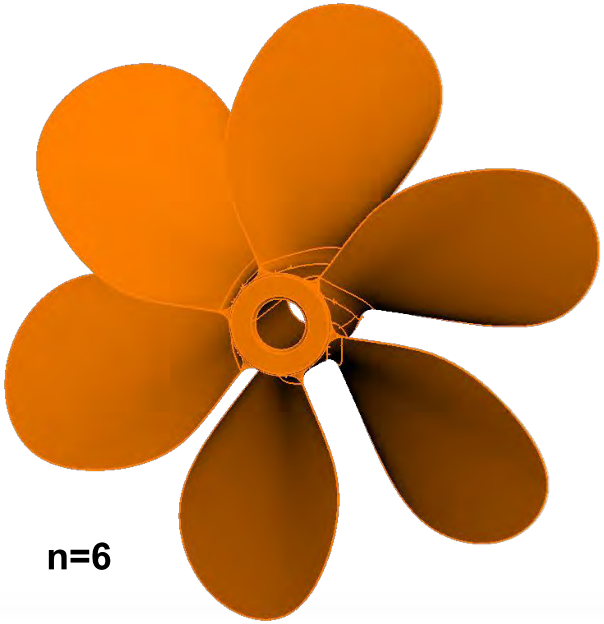




n=5

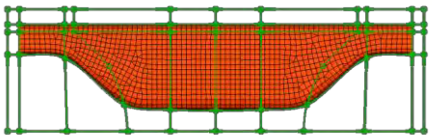


n=4



n=6

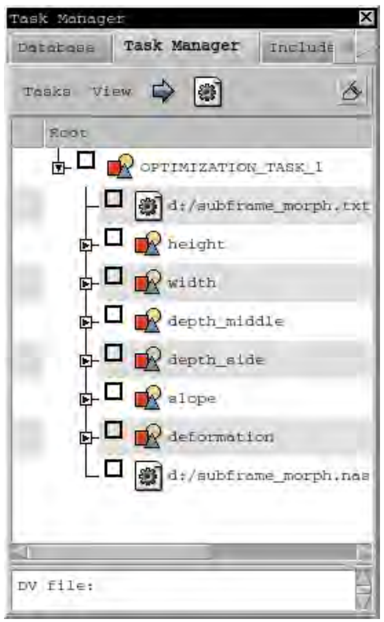
Coupling ANSA and μETA to parametric optimizers

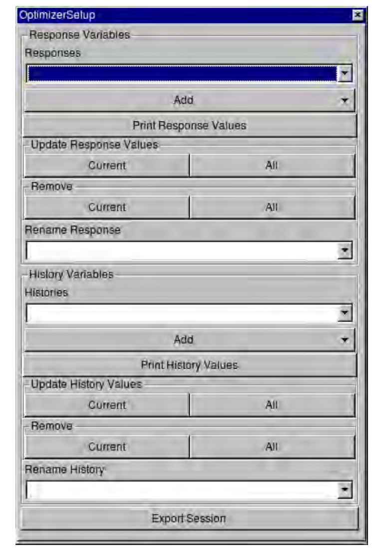


OPTIMIZER

LS-OPT
modeFRONTIER
Optimus
Isight
HEEDS

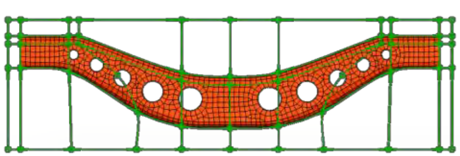
ANSA Optimization Task

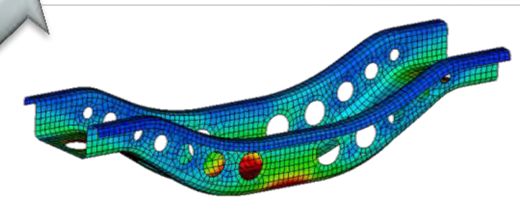




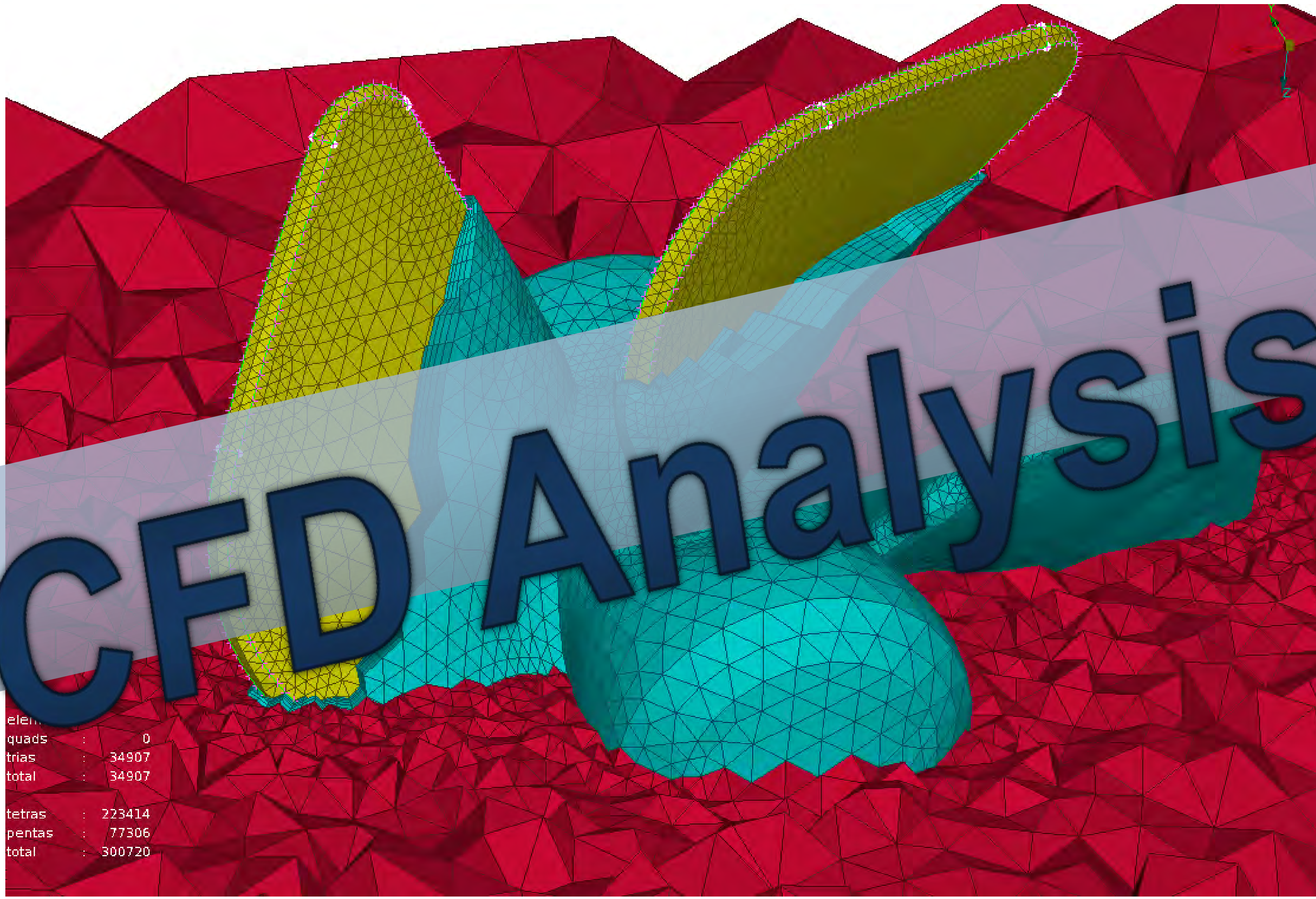
μETA OptimizerSetup

SOLVER



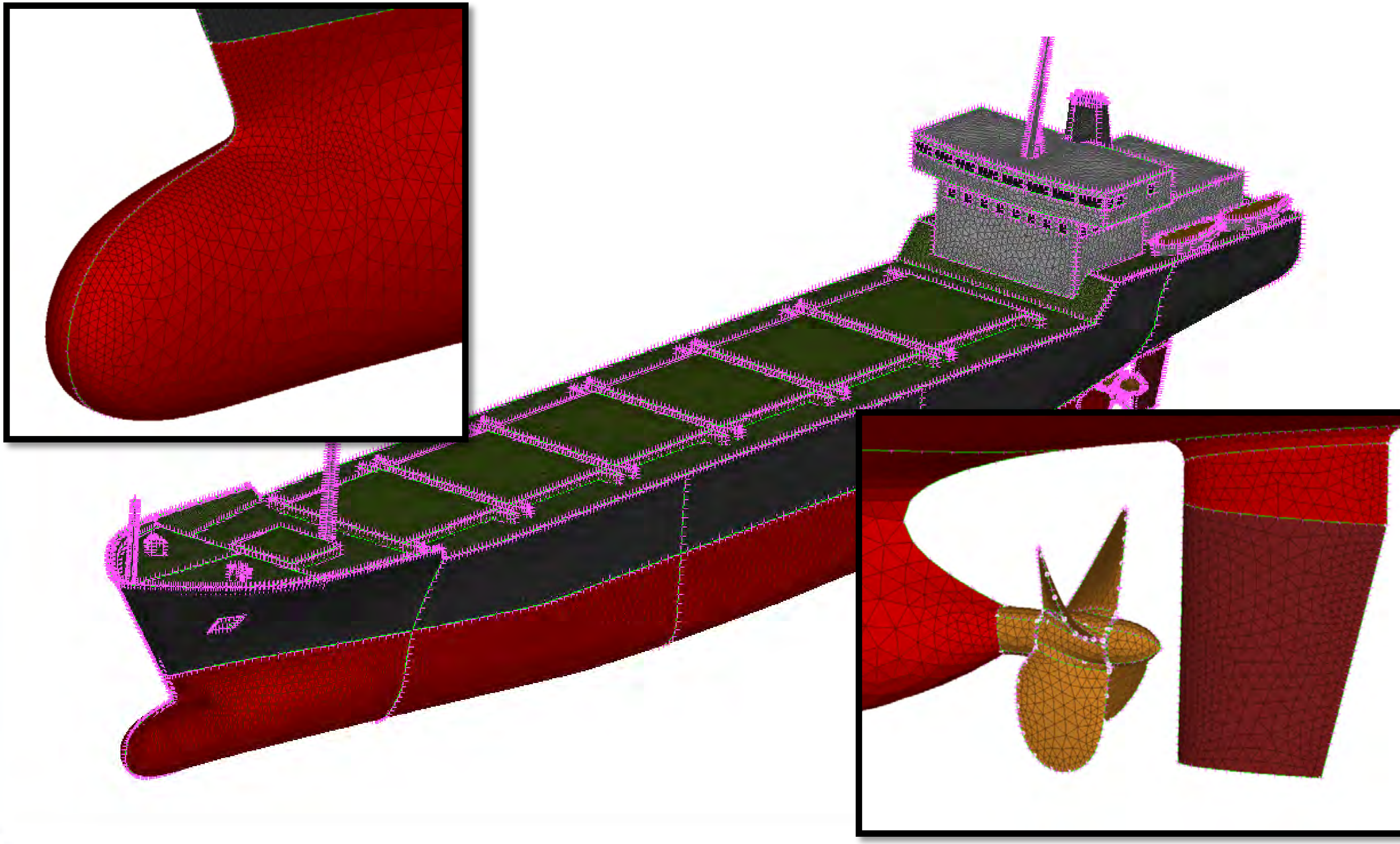


CFD Analysis



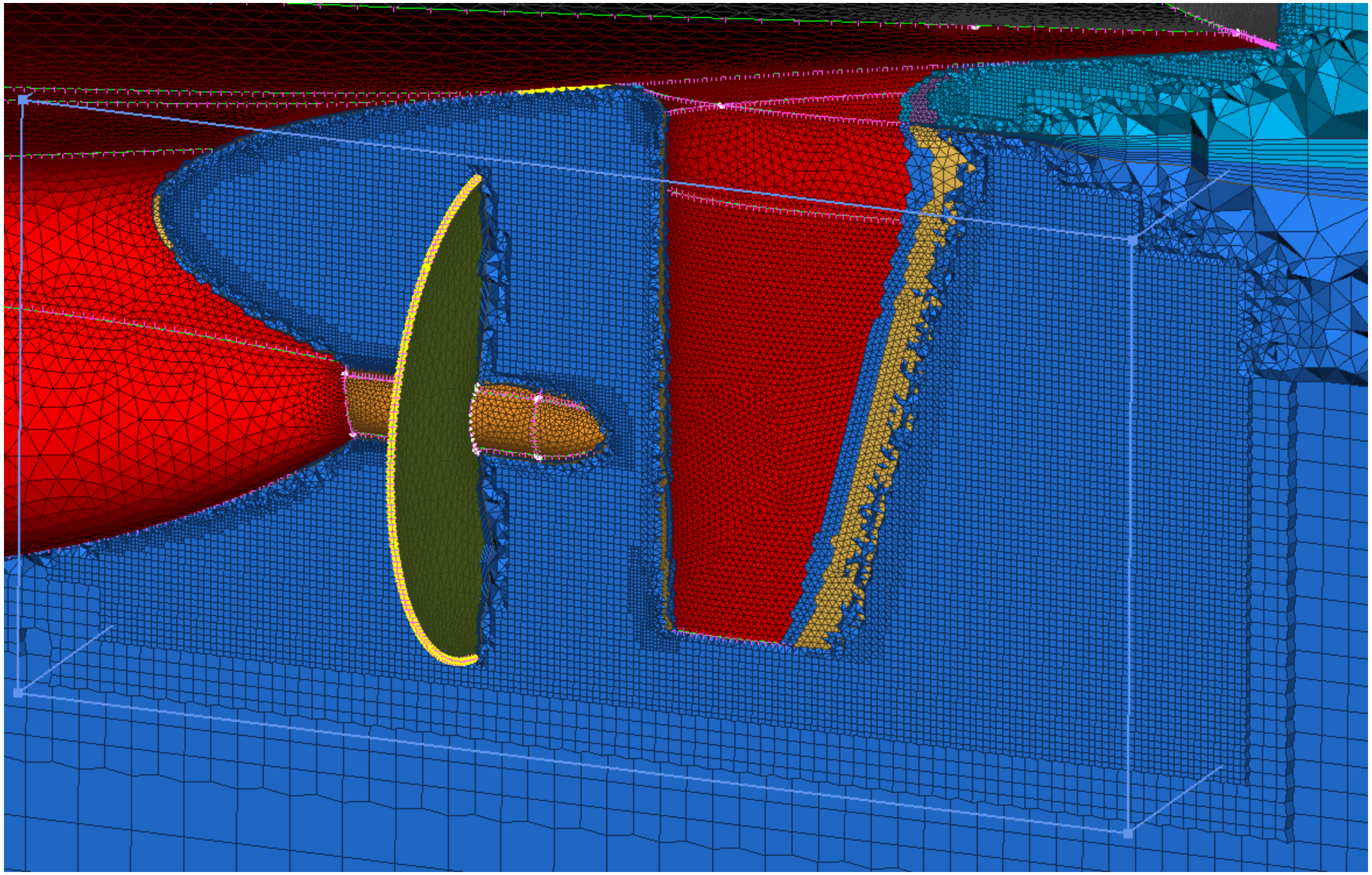
Model definition for CFD analysis

Fully automatic Curvature Dependant surface meshing with user controlled growth rate, min & max element size and mesh feature angle



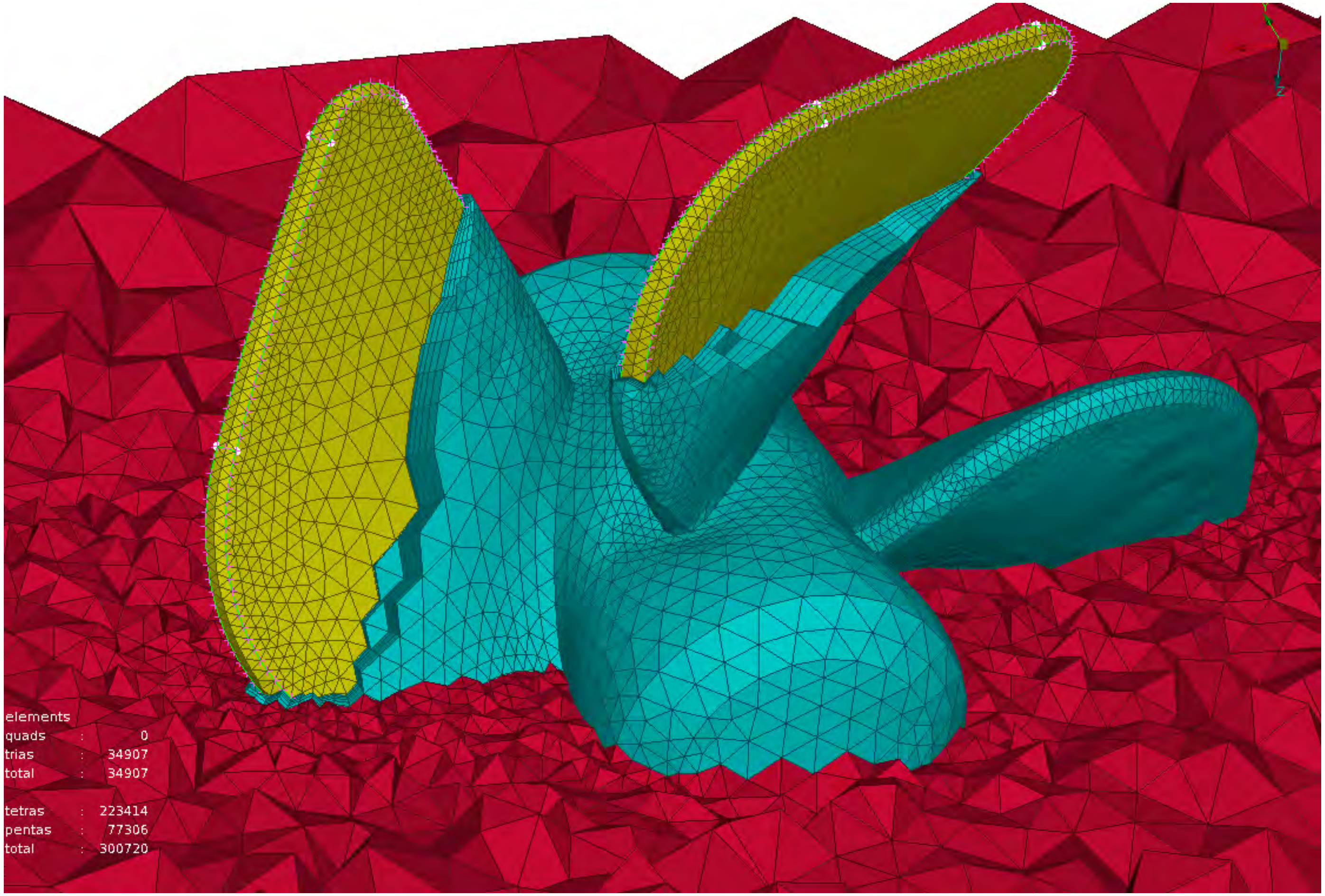
Model definition for CFD analysis

Local refinement using SIZE BOXES



Boundary layers generation

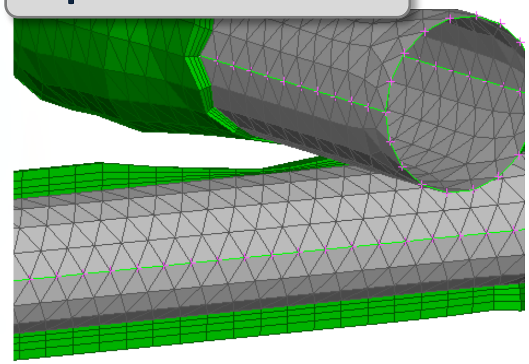
- Auto exclude or collapse areas
- Controlled Layer Squeezing to avoid intersections
- Layers from selected areas with different settings
- Layers from zero-thickness walls



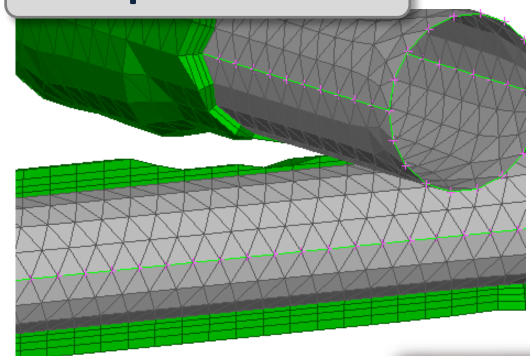
CFD Analysis

Advanced boundary layers generation

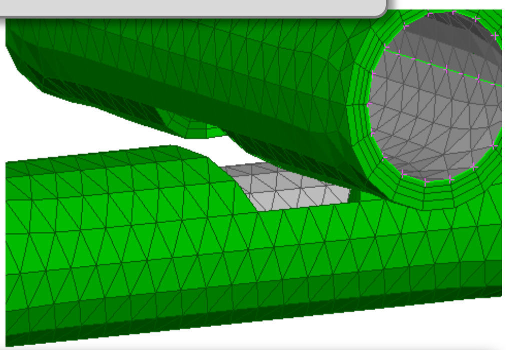
Squeeze



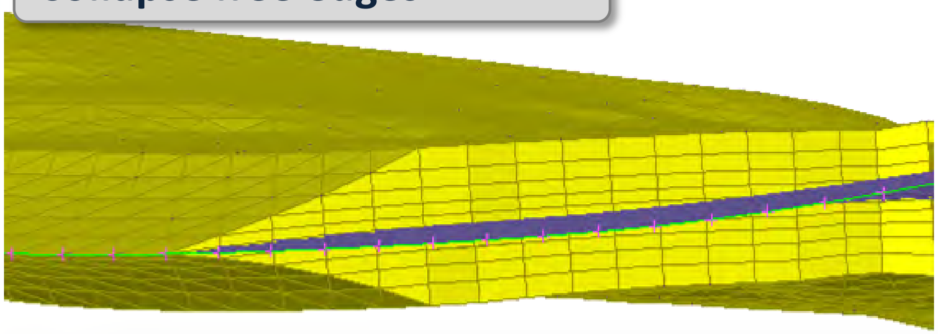
Collapse

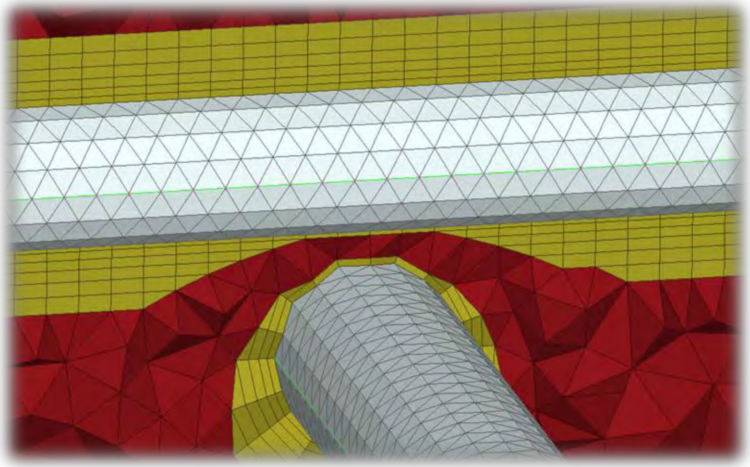


Exclude

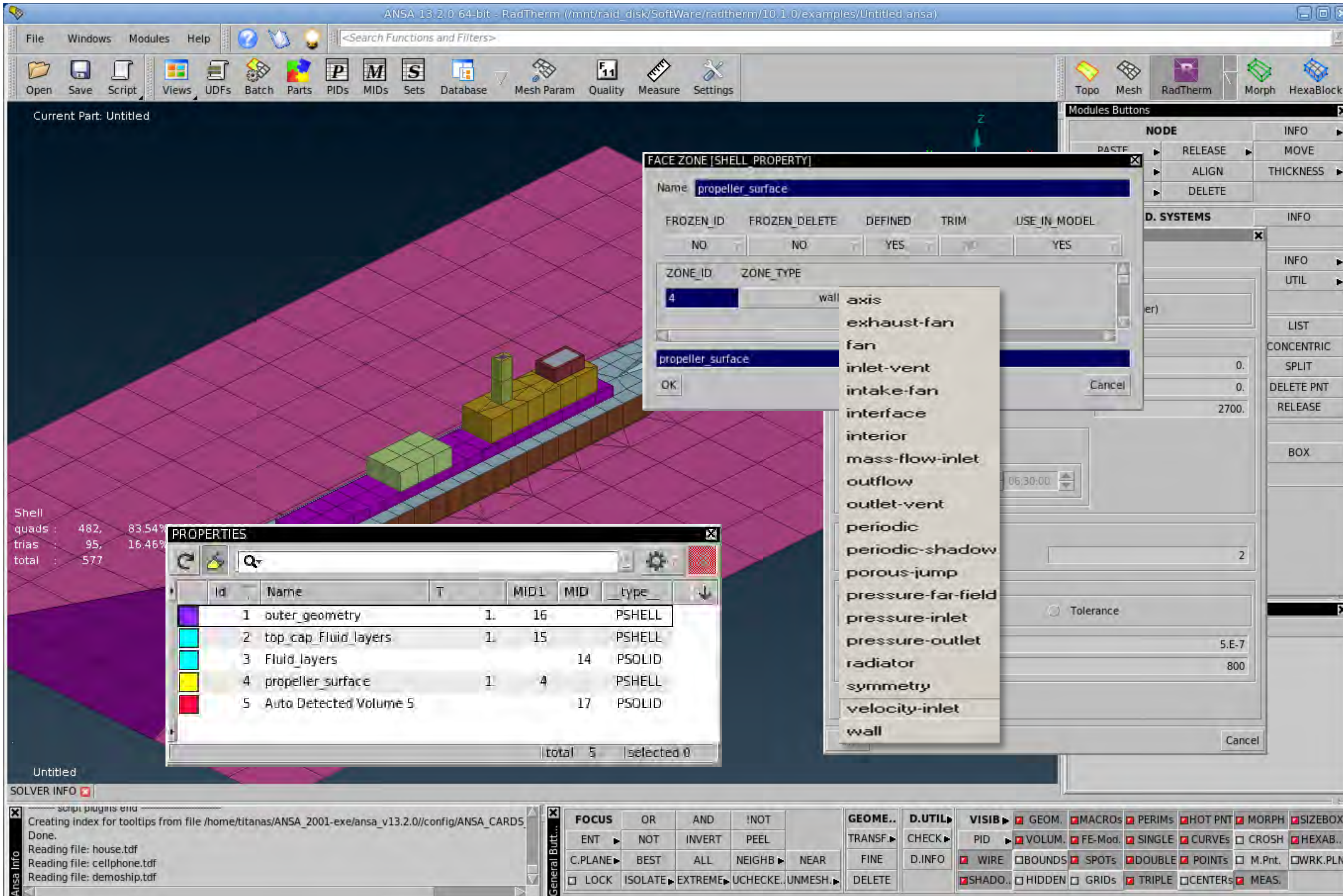


Collapse free edges



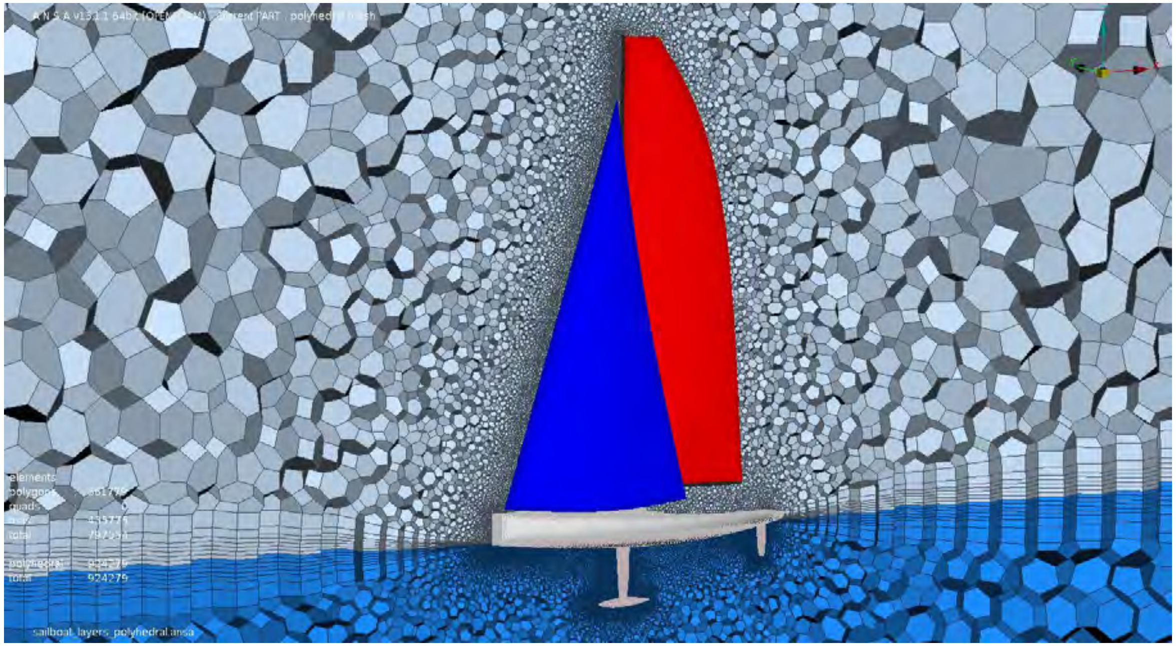


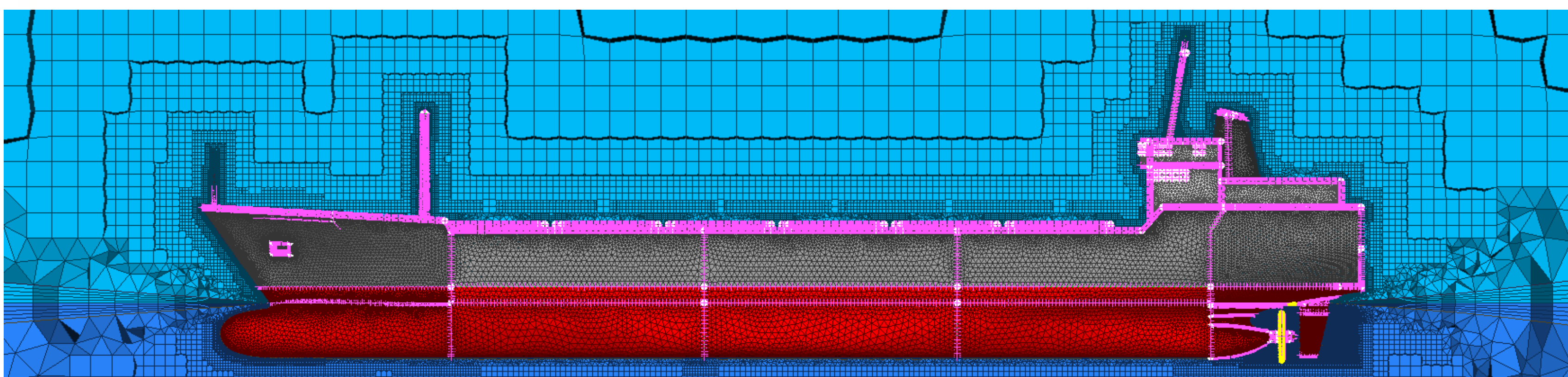
Boundary Condition type specification for various CFD solvers



Model definition for CFD analysis

Fast and robust volume meshing for all types of elements (tetra, pyramid, prism, hexa and polyhedron)





Model definition for CFD analysis

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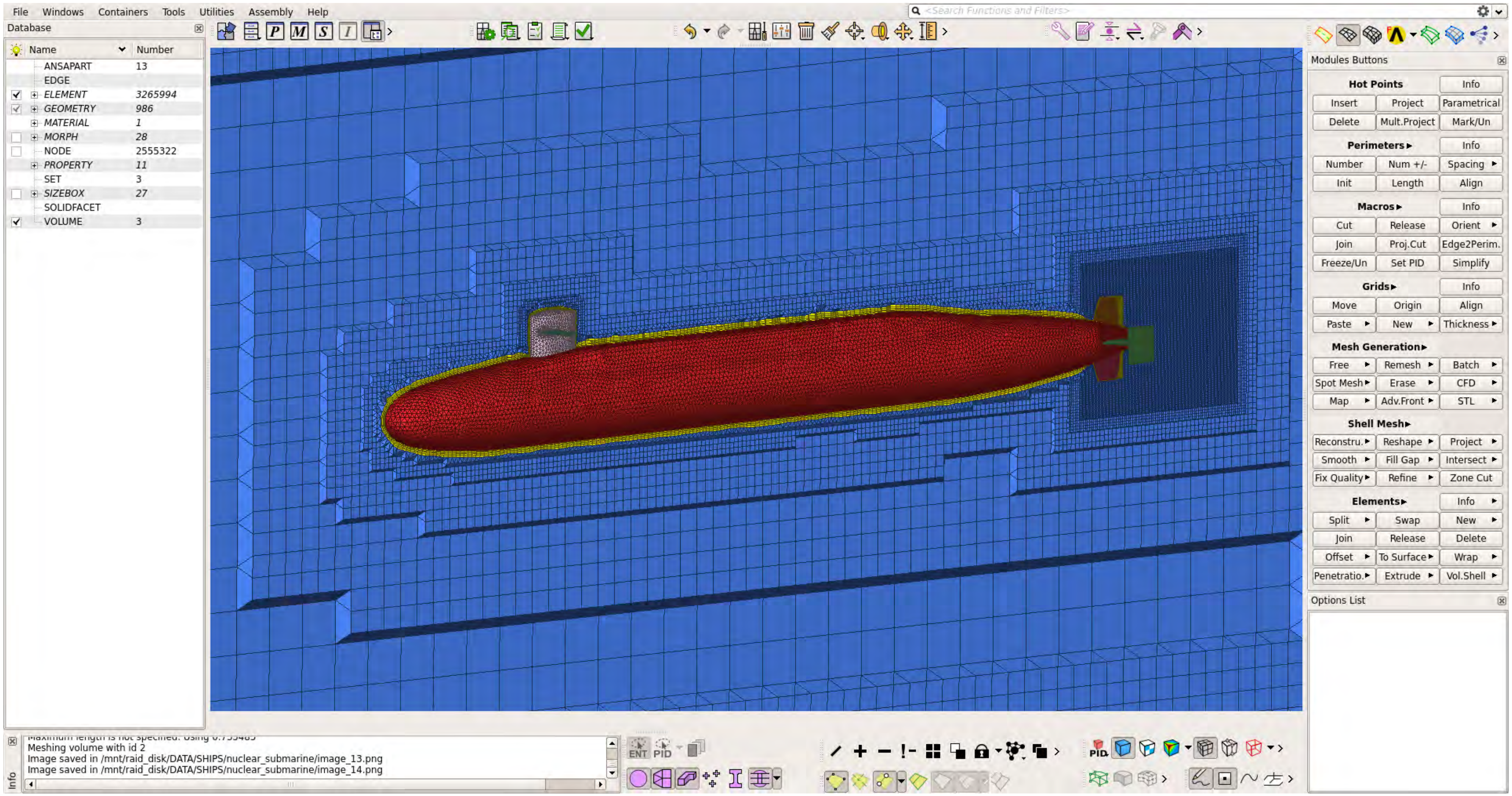

Model definition for CFD analysis

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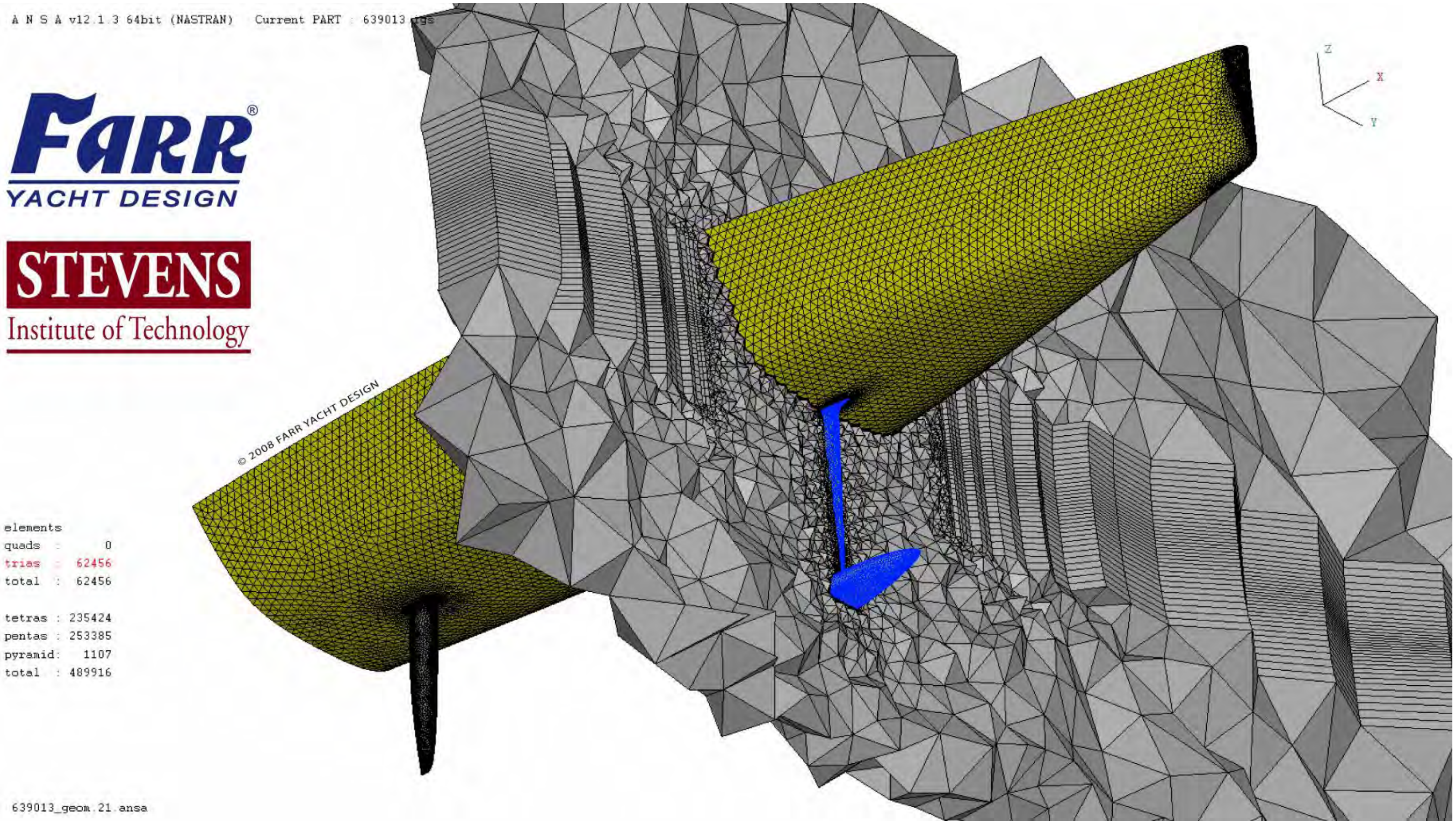
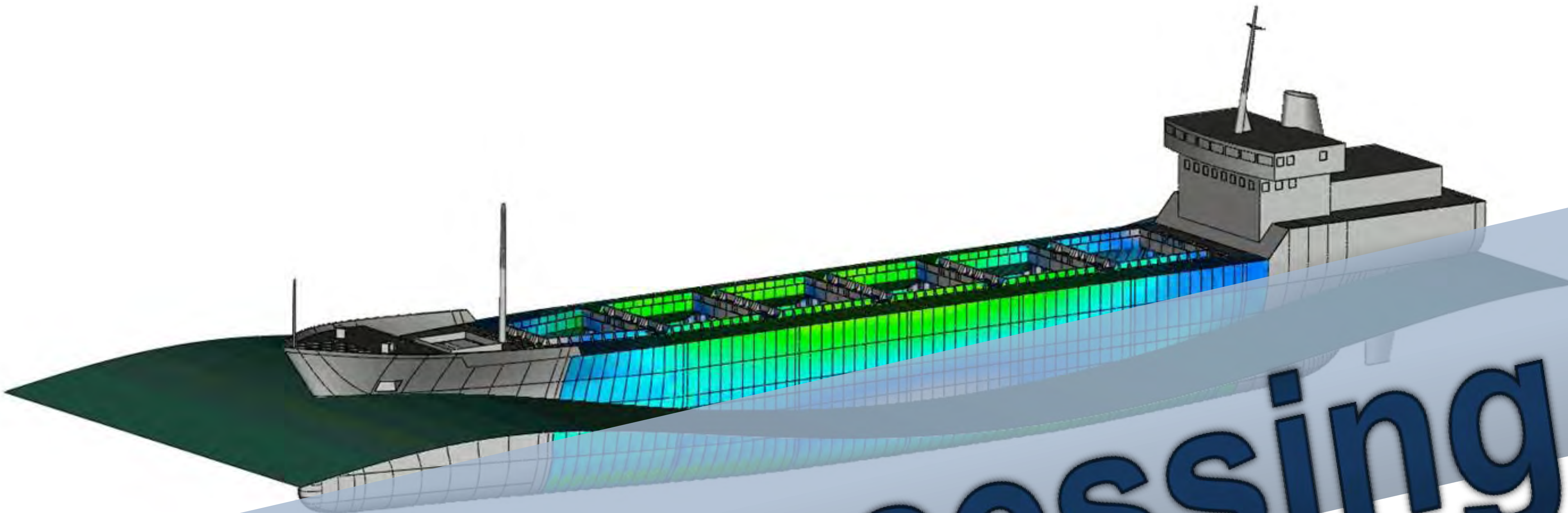


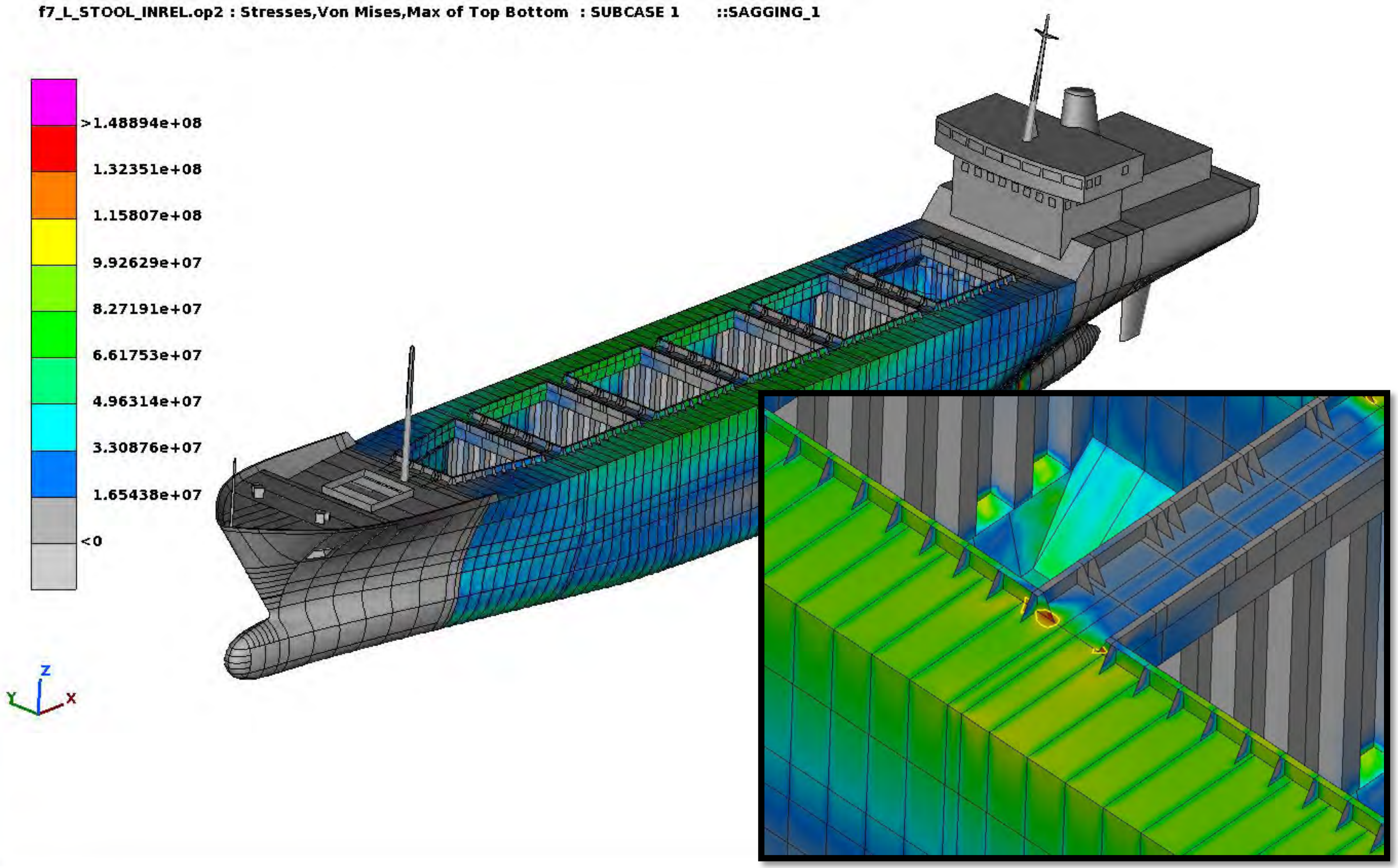
Courtesy of Farr Yacht Design



Post Processing

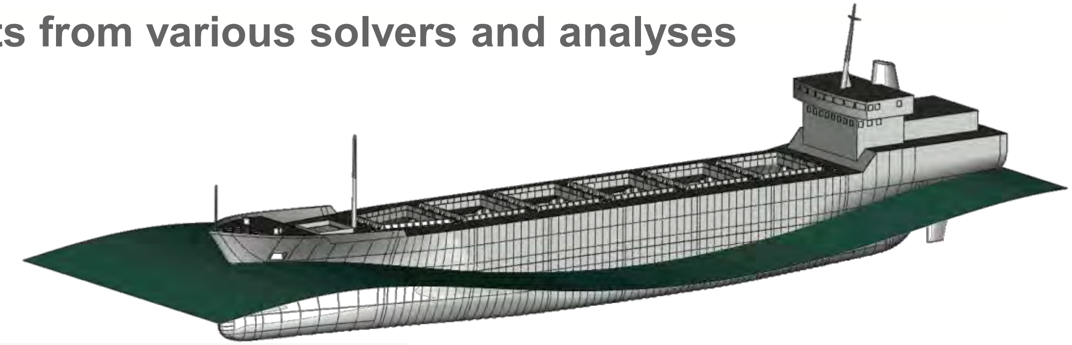
Viewing results in μETA

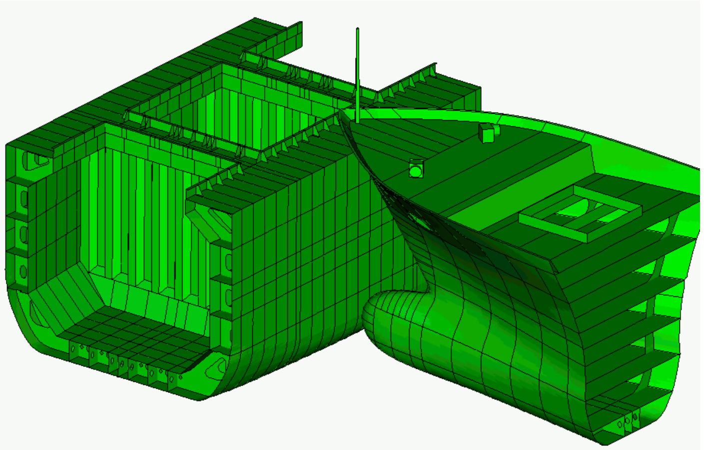
Global and local stress inspection

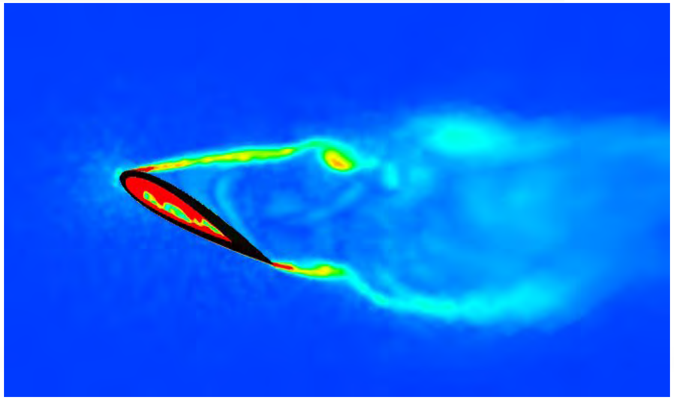


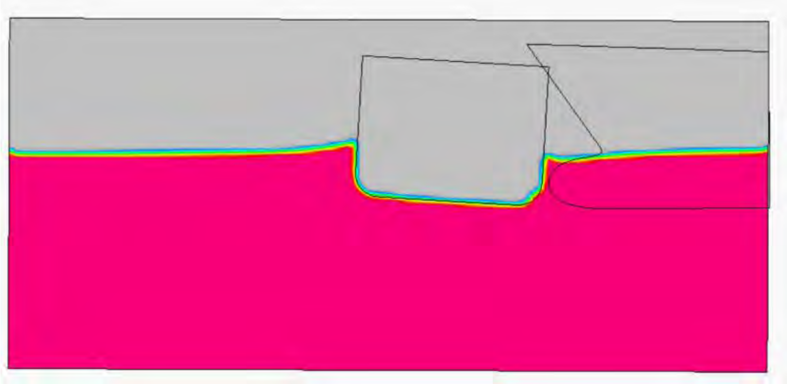
Viewing results in μETA

Supports results from various solvers and analyses







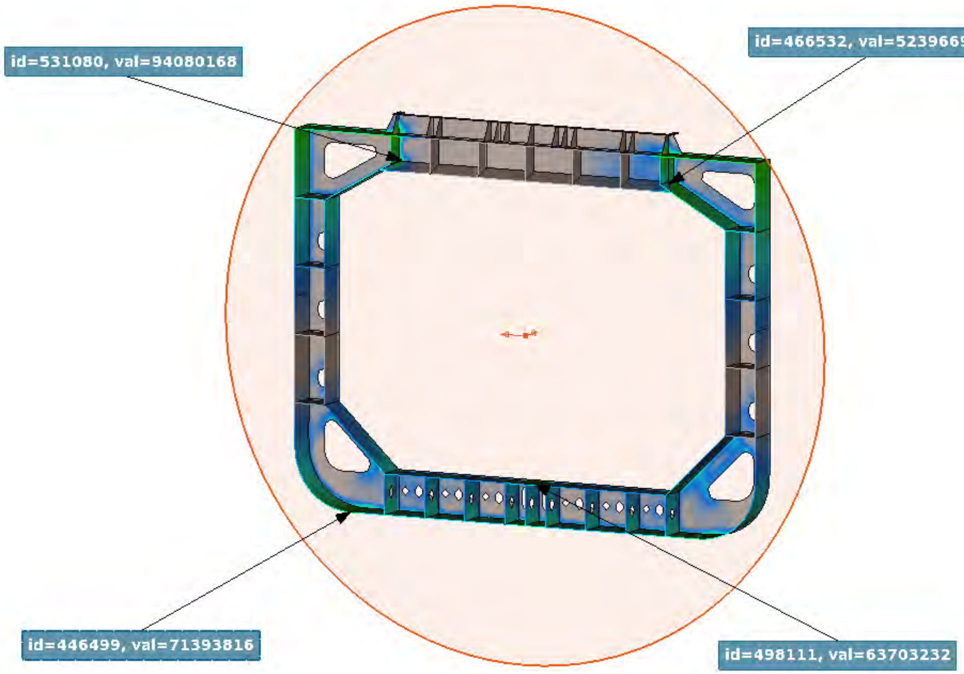


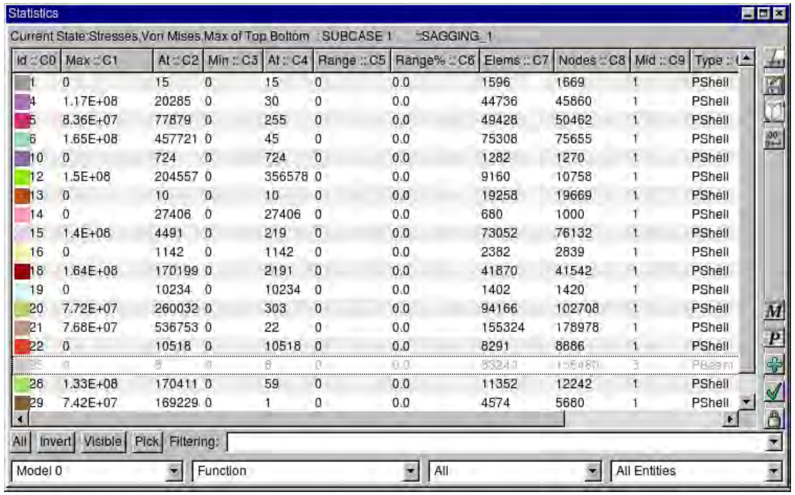
Results for:

- Static
- Dynamic
- CFD
- ALE

μETA Reporting capabilities

Creating sections, annotations, statistics, reports…




Statistics

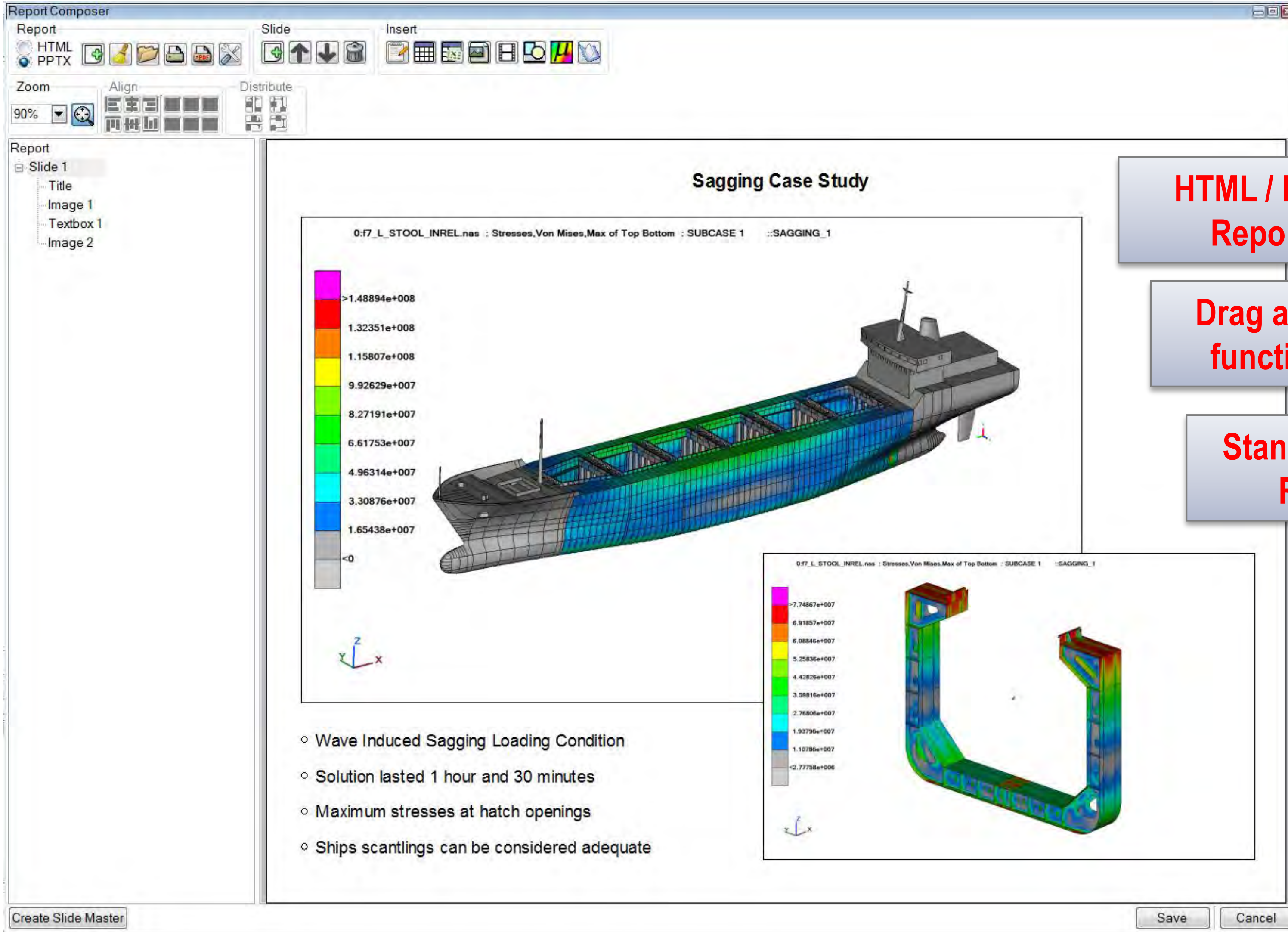
Current State:Stresses,Von Mises,Max of Top Bottom :SUBCASE 1 :SAGGING_1

Id :: C0	Max :: C1	At :: C2	Min :: C3	At :: C4	Range :: C5	Range% :: C6	Elems :: C7	Nodes :: C8	Mid :: C9	Type :: (
1	0	15	0	15	0	0.0	1596	1669	1	PShell
4	1.17E+08	20285	0	30	0	0.0	44736	45860	1	PShell
5	8.36E+07	77879	0	255	0	0.0	49428	50462	1	PShell
6	1.65E+08	457721	0	45	0	0.0	75308	75655	1	PShell
10	0	724	0	724	0	0.0	1282	1270	1	PShell
12	1.5E+08	204557	0	356578	0	0.0	9160	10758	1	PShell
13	0	10	0	10	0	0.0	19258	19669	1	PShell
14	0	27406	0	27406	0	0.0	680	1000	1	PShell
15	1.4E+08	4491	0	219	0	0.0	73052	76132	1	PShell
16	0	1142	0	1142	0	0.0	2382	2839	1	PShell
18	1.64E+08	170199	0	2191	0	0.0	41870	41542	1	PShell
19	0	10234	0	10234	0	0.0	1402	1420	1	PShell
20	7.72E+07	260032	0	303	0	0.0	94166	102708	1	PShell
21	7.68E+07	536753	0	22	0	0.0	155324	178978	1	PShell
22	0	10518	0	10518	0	0.0	8291	8886	1	PShell
25	0	8	0	8	0	0.0	53240	156480	3	PBeam
28	1.33E+08	170411	0	59	0	0.0	11352	12242	1	PShell
29	7.42E+07	169229	0	1	0	0.0	4574	5680	1	PShell

All | Invert | Visible | Pick | Filtering:

Model 0 | Function | All | All Entities

μETA Reporting capabilities

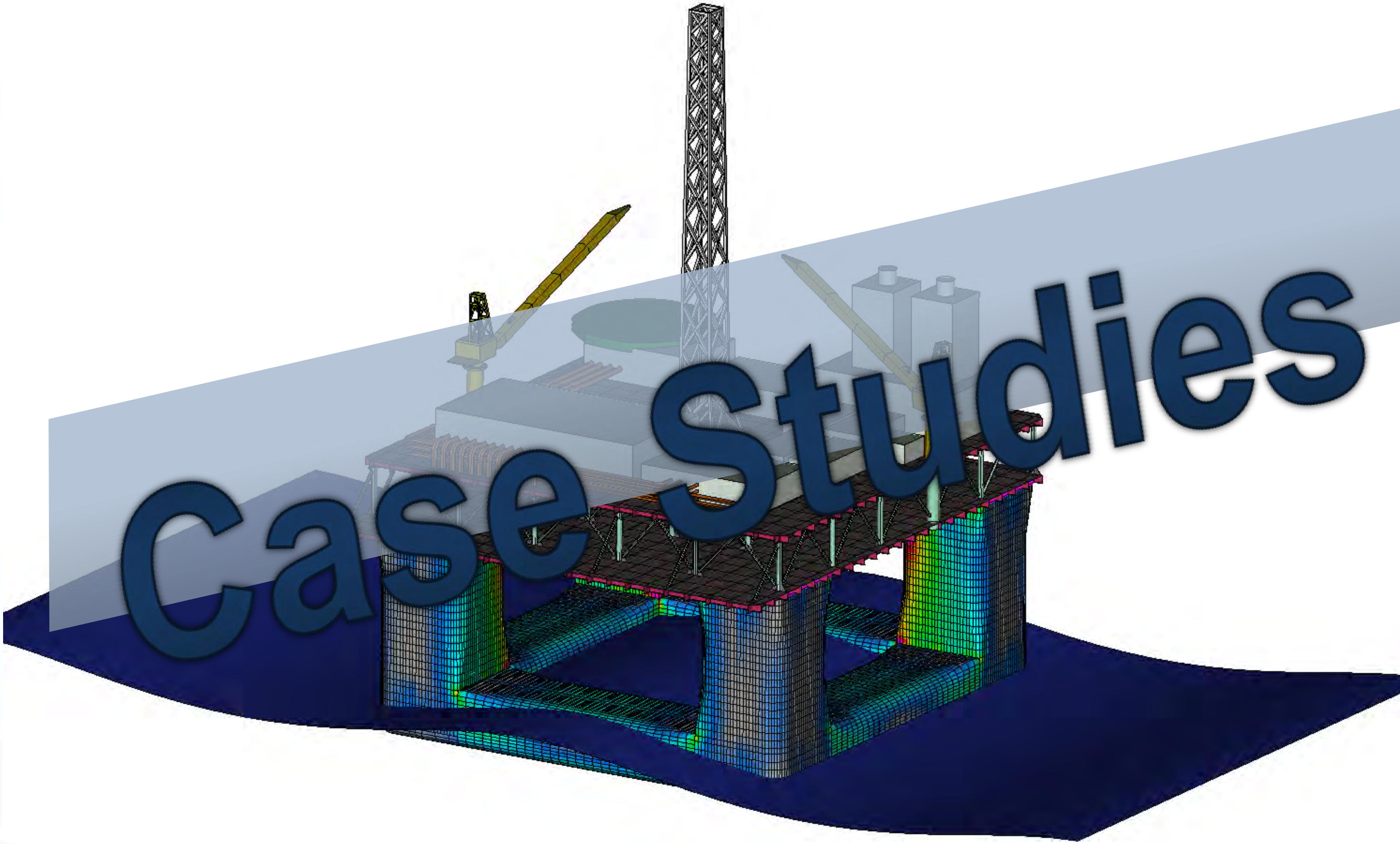


HTML / PPTX Reports

Drag and Drop functionality

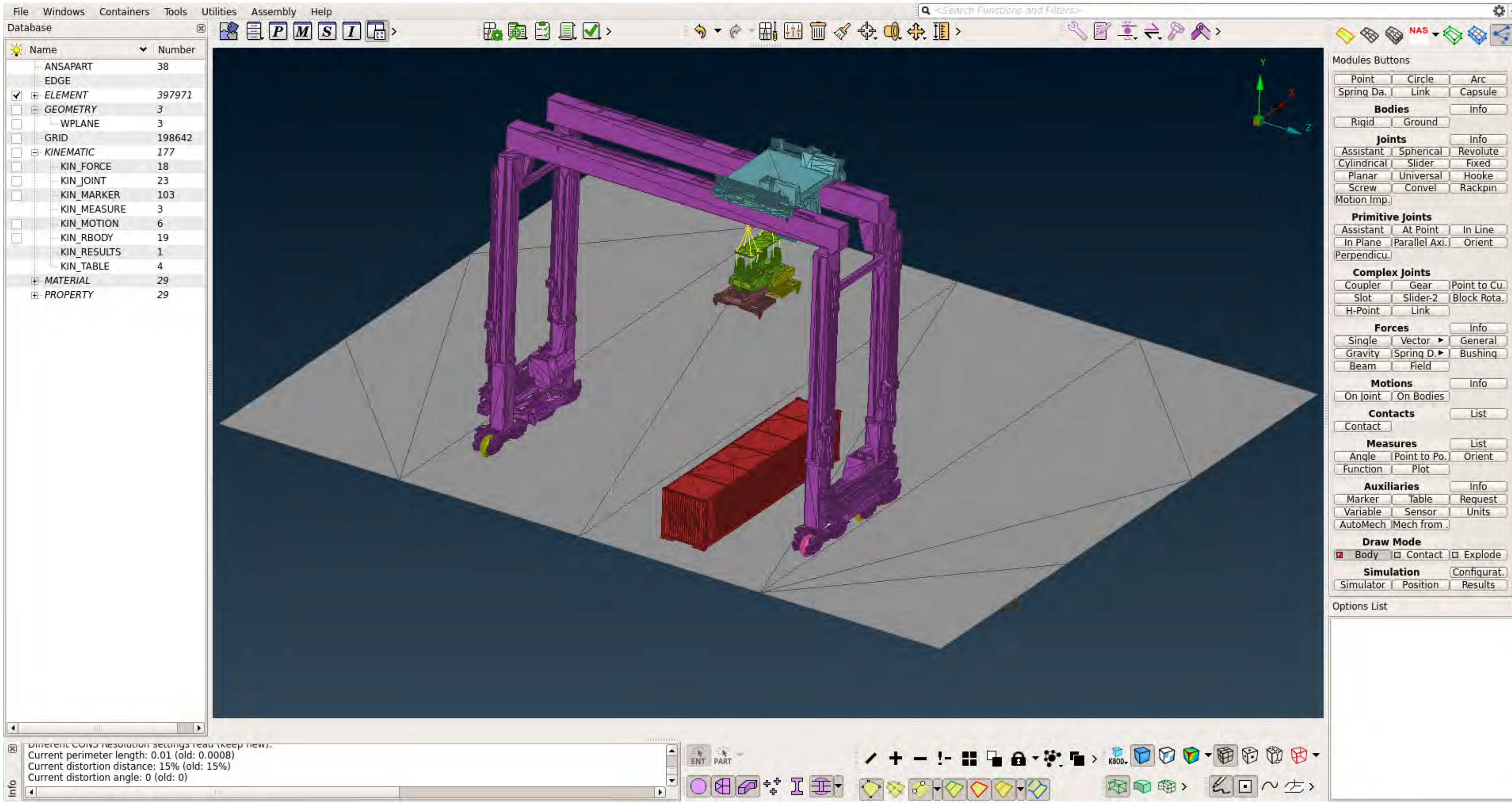
Standard Model Reports

Case Studies



Crane Lifting simulations with the Kinetics Module

Kinetic mechanism definition



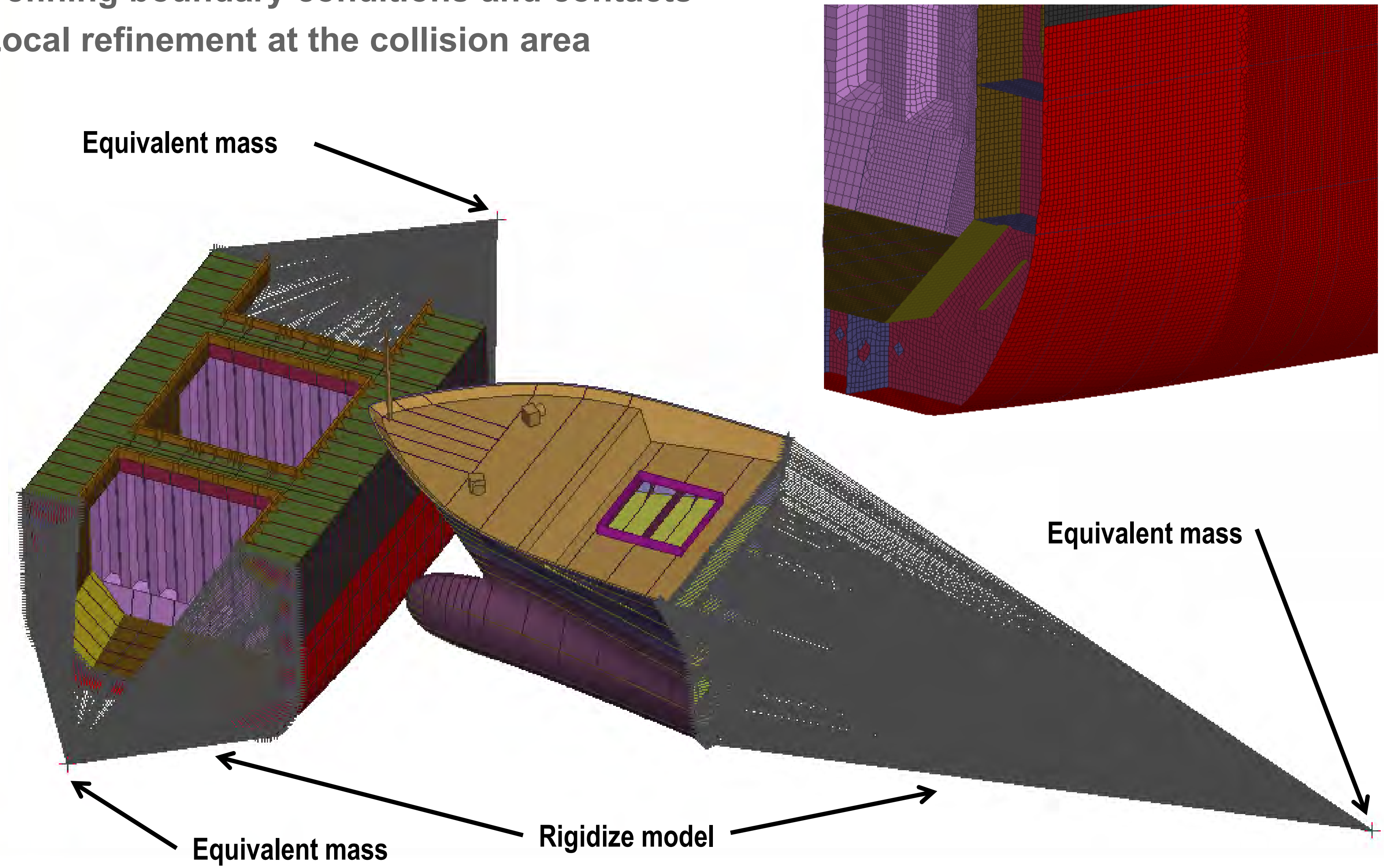
- ✓ 19 bodies
- ✓ 5 sliders
- ✓ 2 spherical
- ✓ 8 revolute
- ✓ 8 links
- ✓ 6 imposed motions
- ✓ 18 spring dampers

Ship collision analysis

Replacing part of the model with rigid body and equivalent mass

Defining boundary conditions and contacts

Local refinement at the collision area



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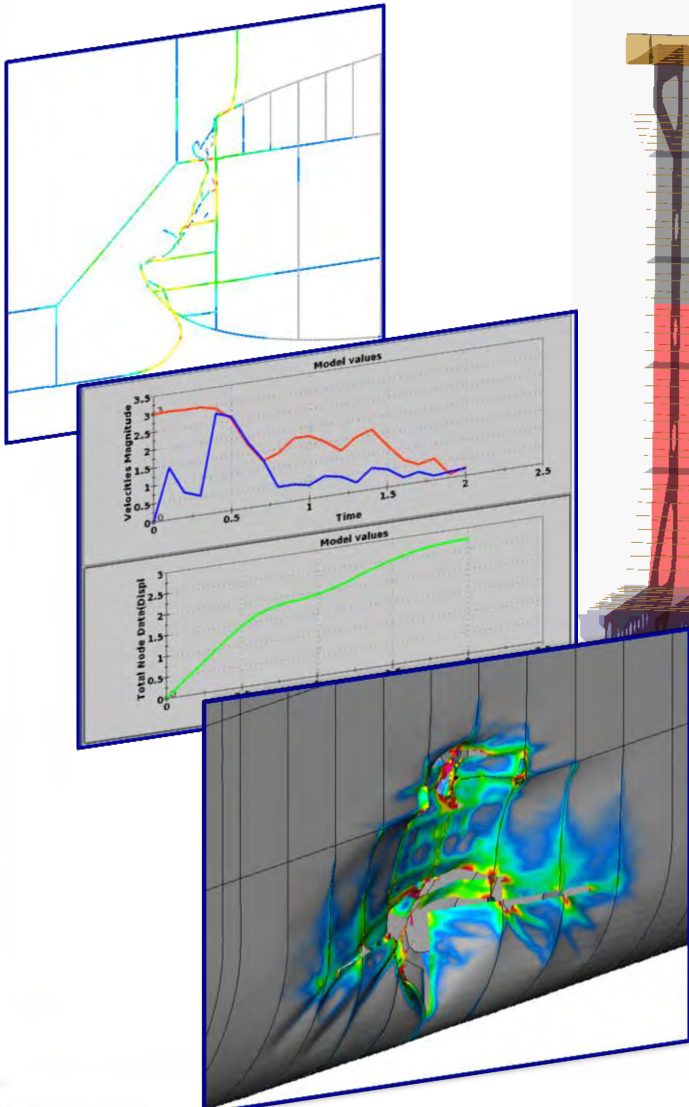
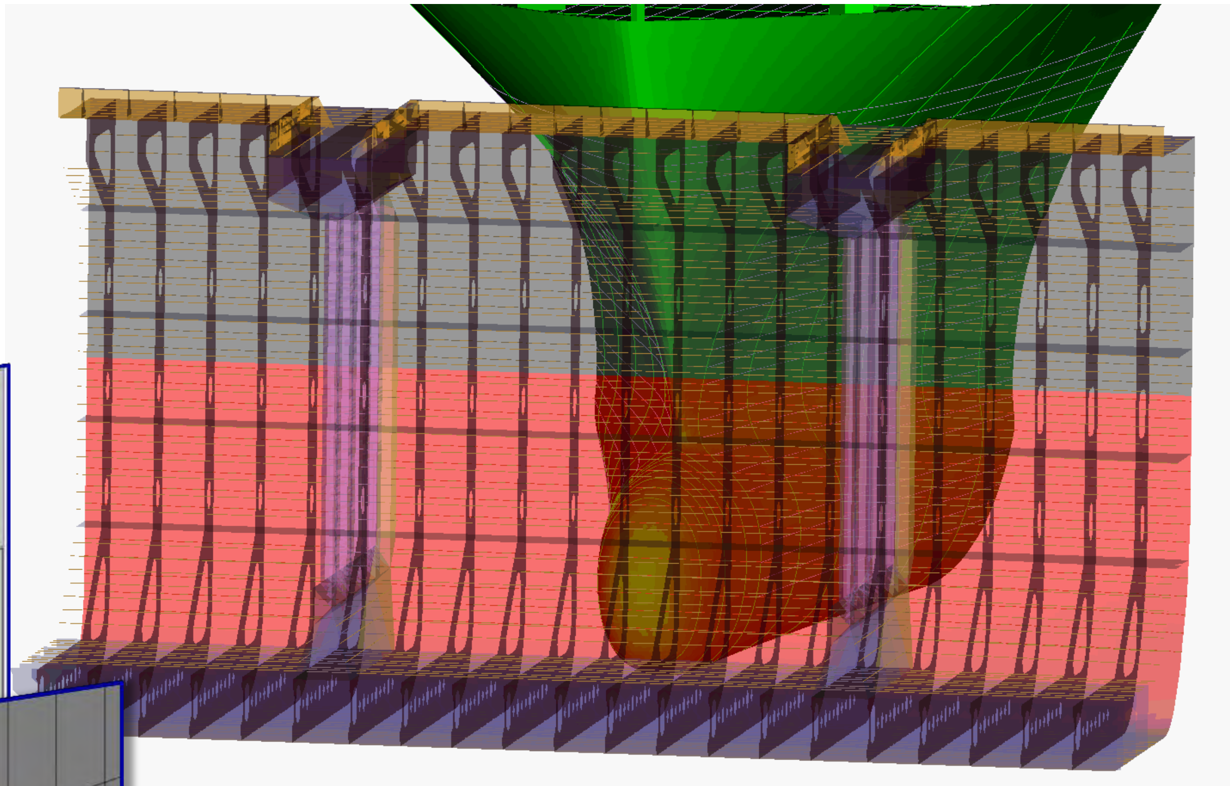
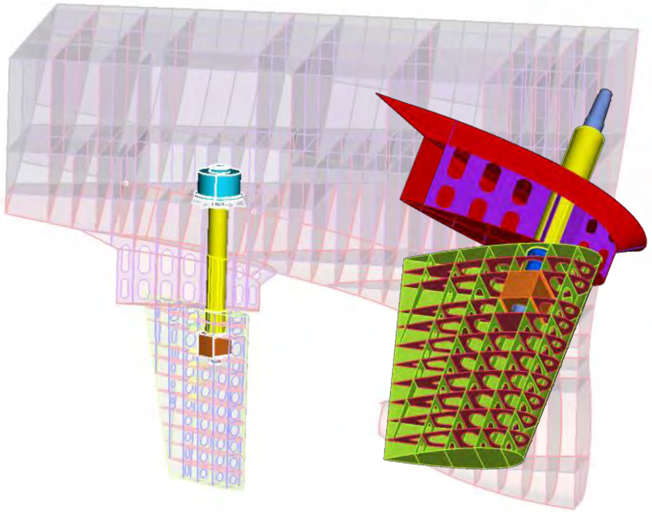
Ship collision analysis

Viewing results with μETA

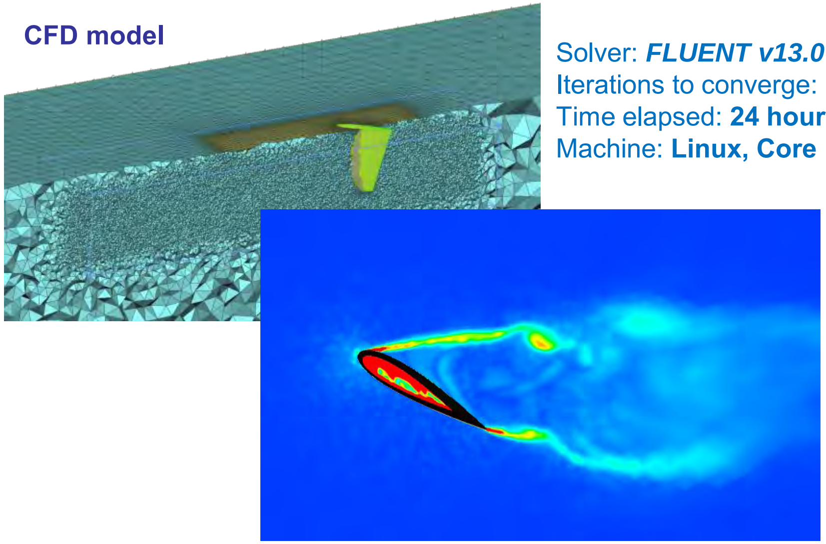




Rudder Optimization Study

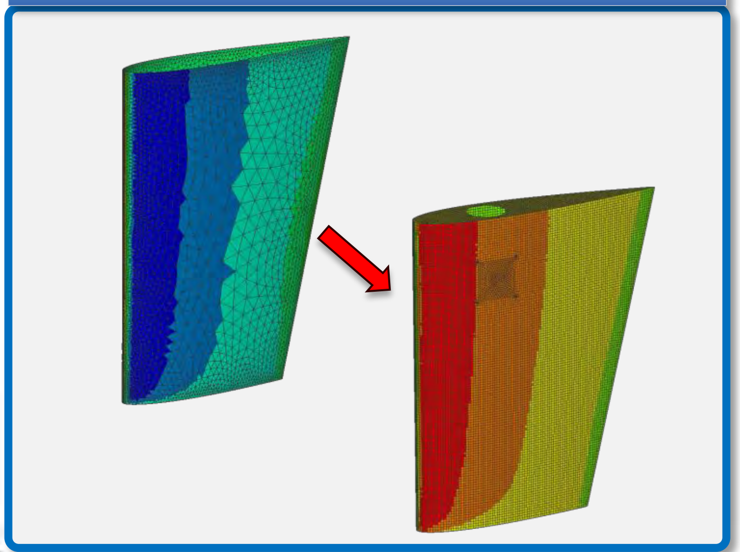


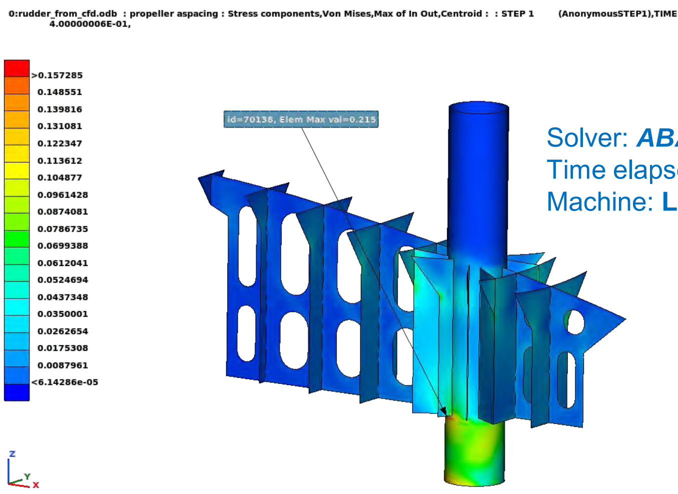
CFD model



Solver: ***FLUENT v13.0***
Iterations to converge: **~1000**
Time elapsed: **24 hours**
Machine: **Linux, Core i7 8 CPUs**

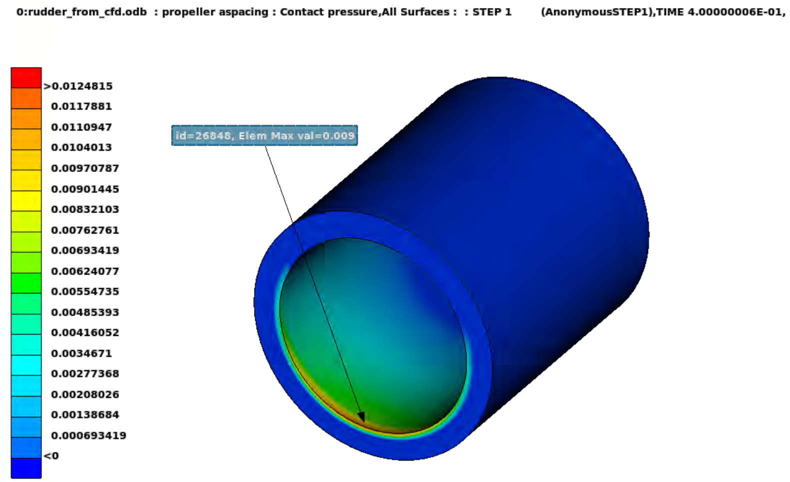
Results Mapping Tool

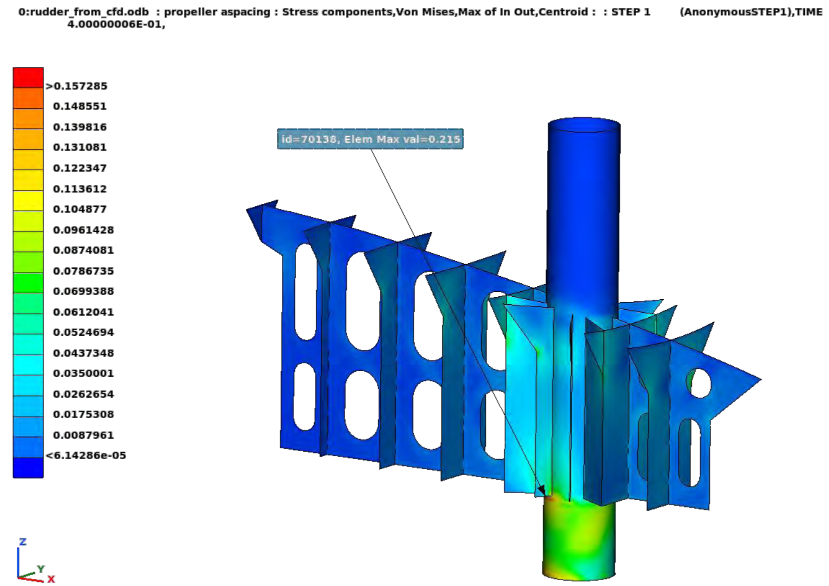


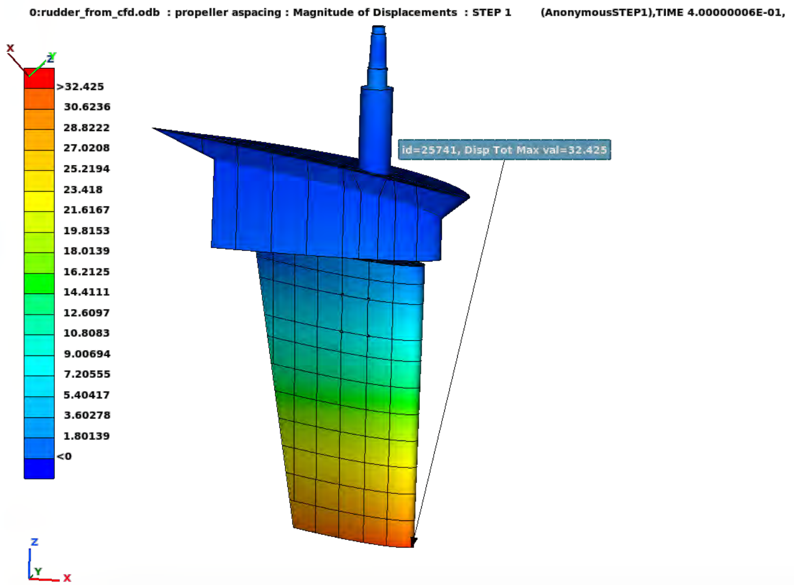


Solver: ***ABAQUS v 6.10***
Time elapsed: **30 min**
Machine: **Linux, Core i7 8 CPUs**

Rudder Optimization Study







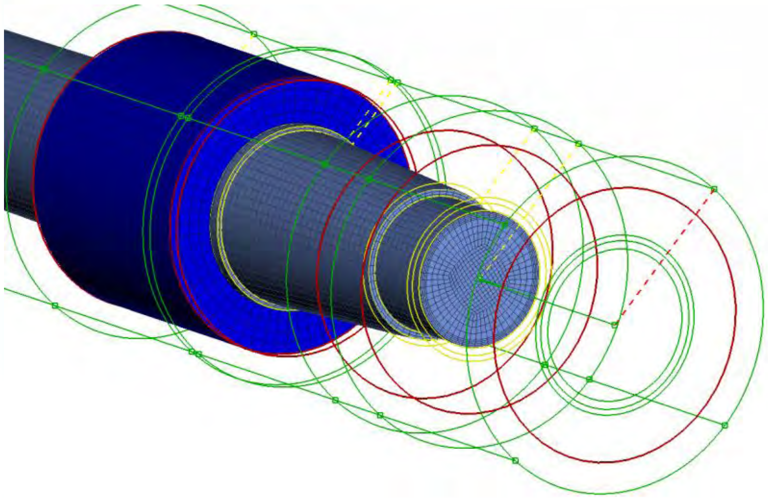
Objectives

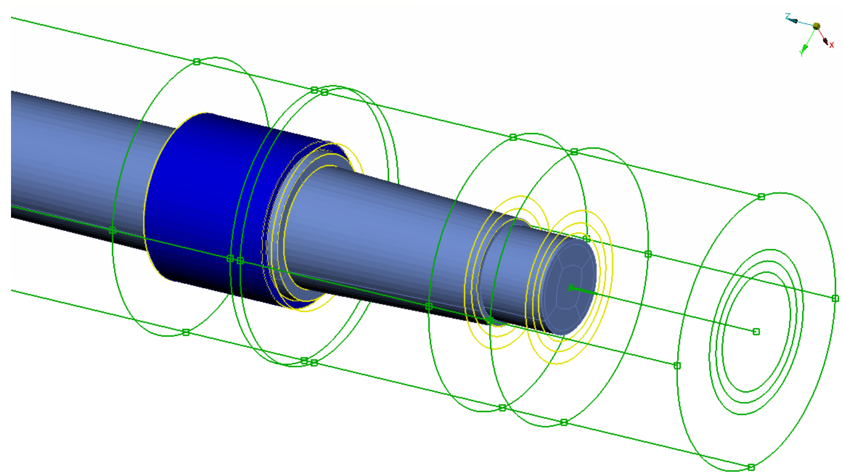
- ✓ Minimize maximum contact pressure
- ✓ Minimize Model mass

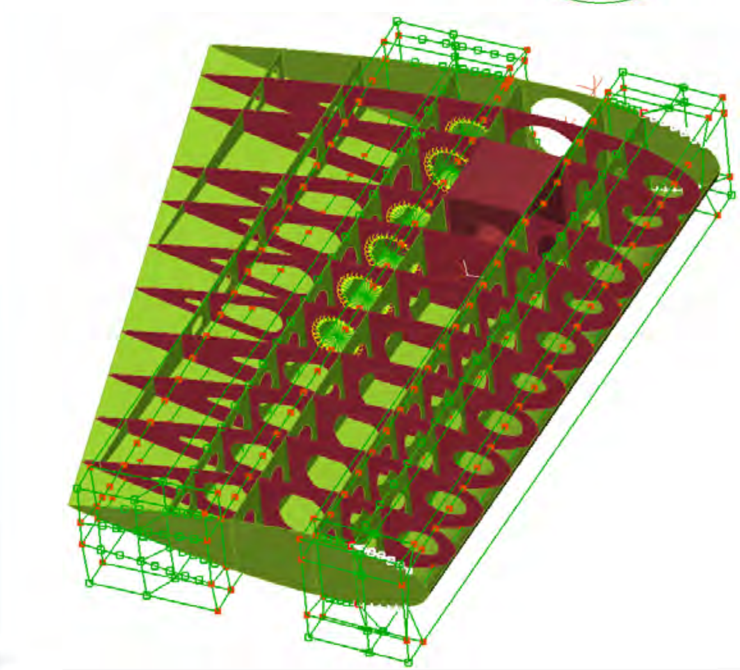
Constraints

- ✓ Maximum stresses
- ✓ Maximum deflection

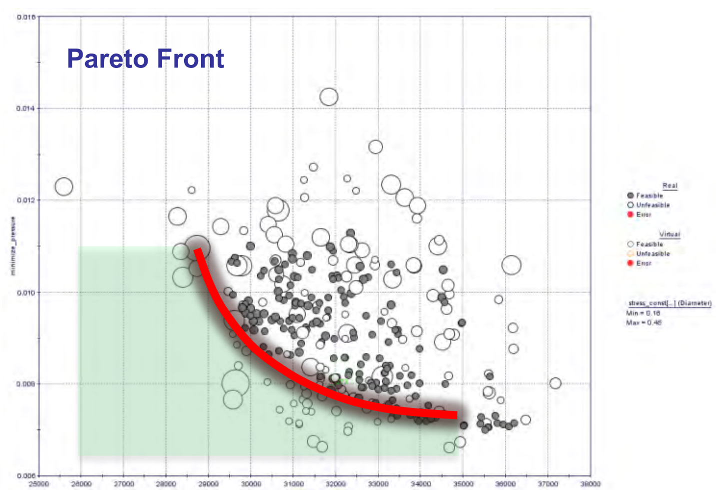
Rudder Optimization Study



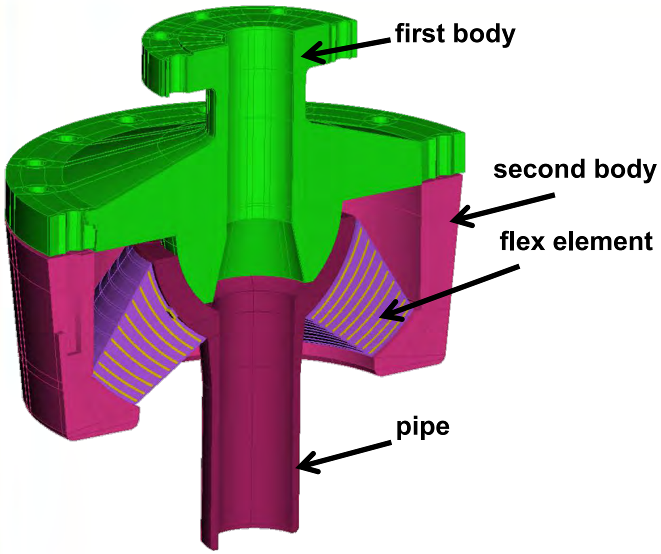




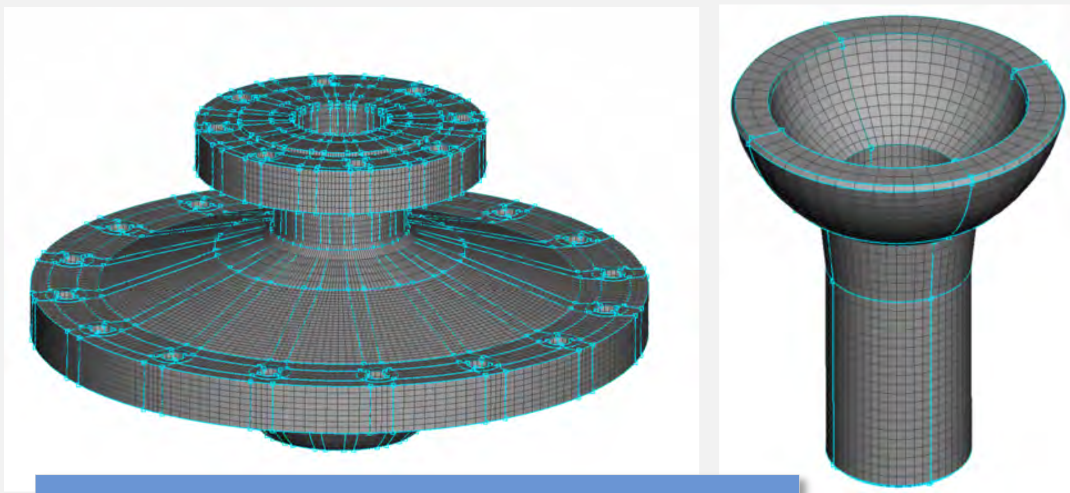
- ✓ **12.5% Maximum pressure reduction**
- ✓ **7.98% Mass reduction**



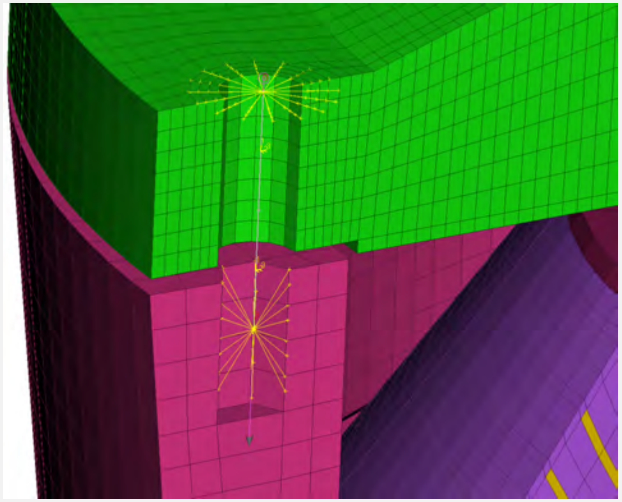
Flex Joint Contact analysis



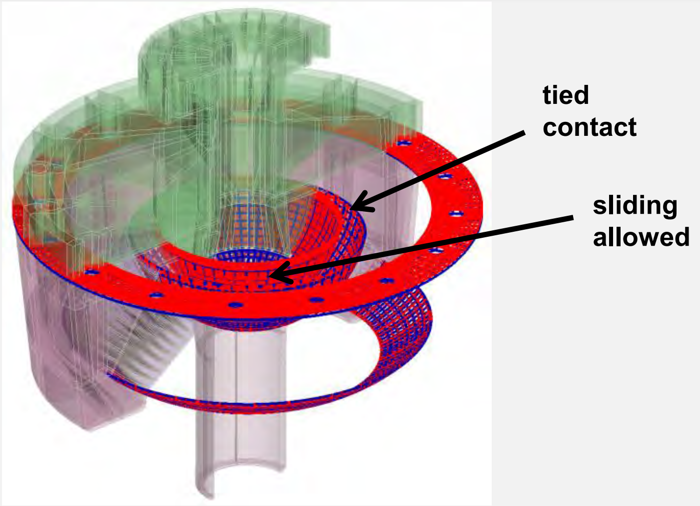
Pure Hexahedral Mesh Creation



Automated Bolts recognition



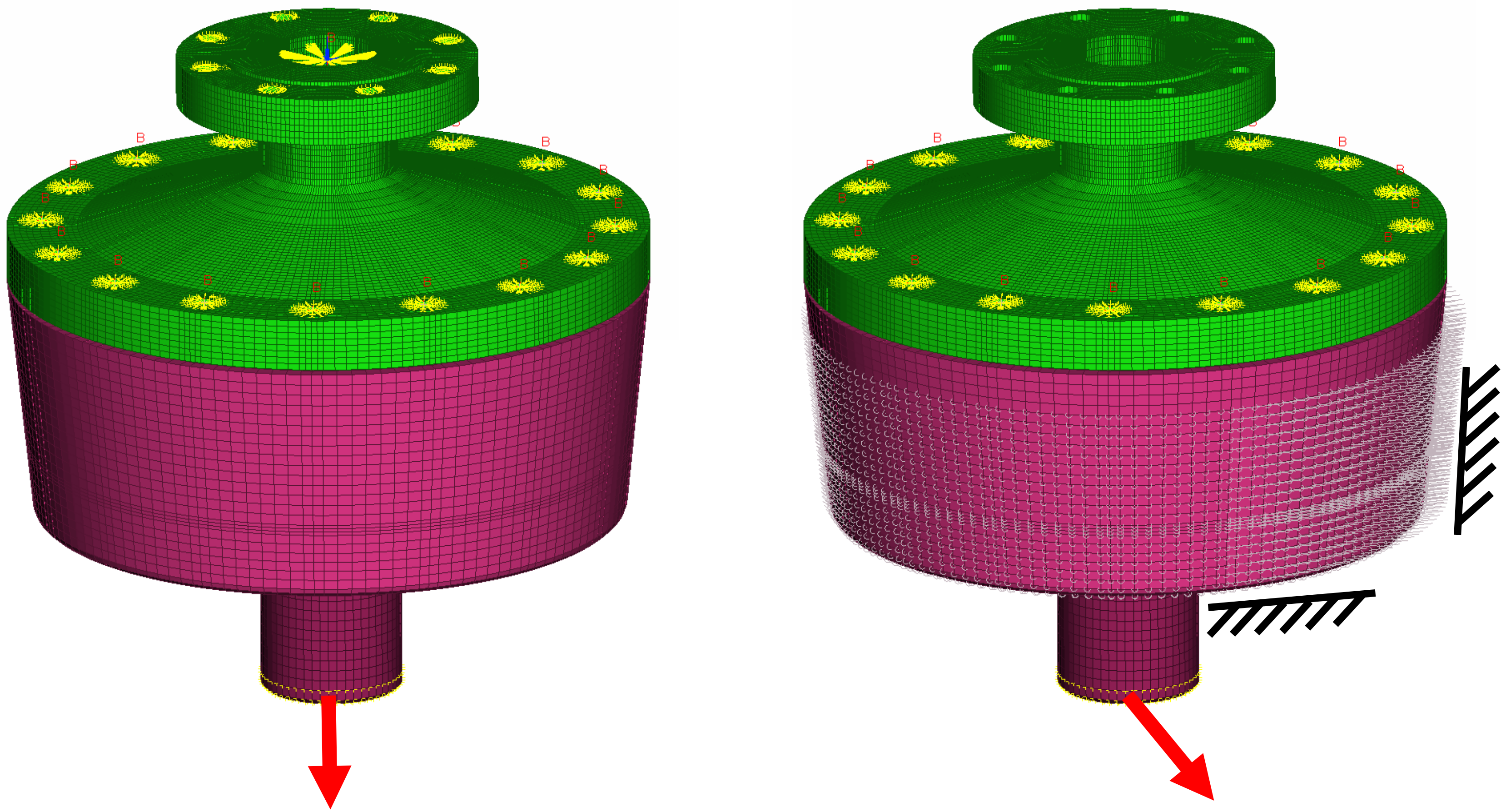
Automated Contact Detection



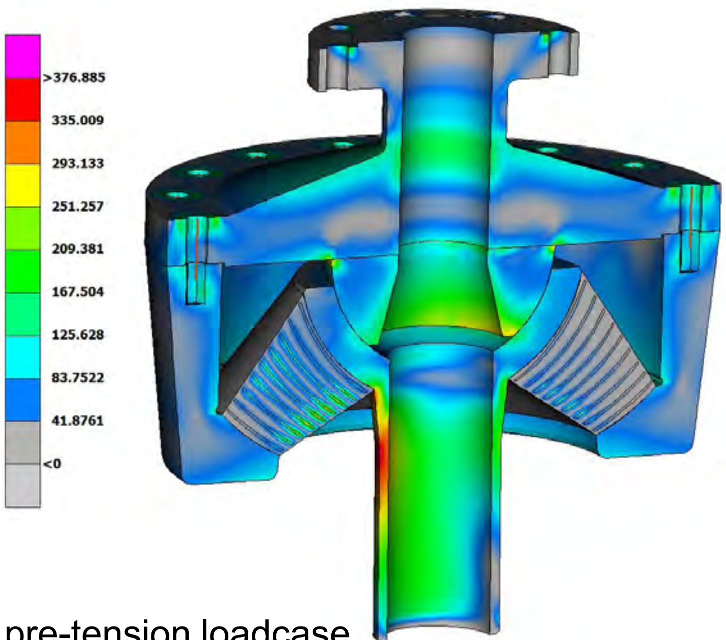
Boundary conditions

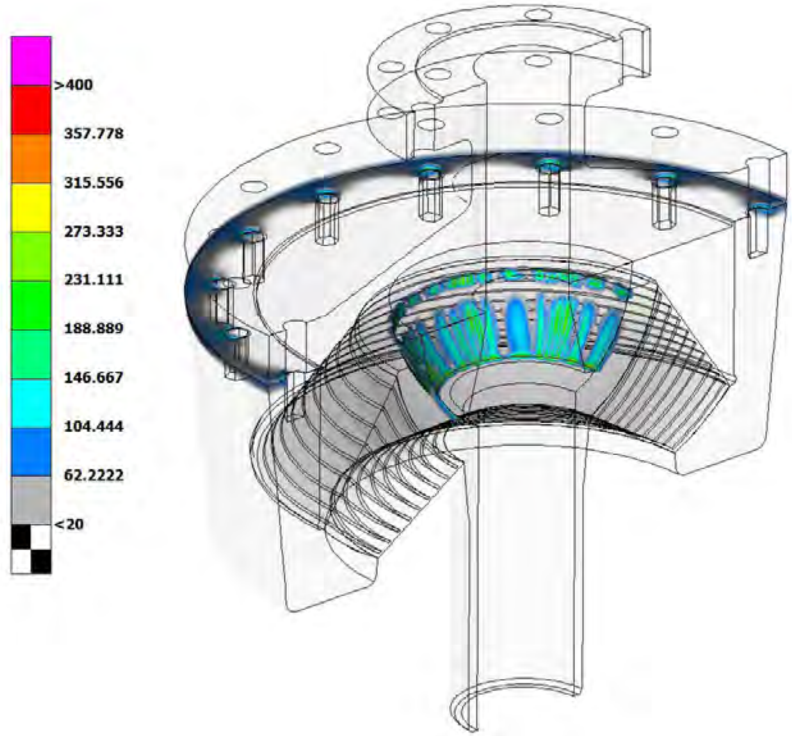
1st load case: axial riser force

2nd load case: bending riser force

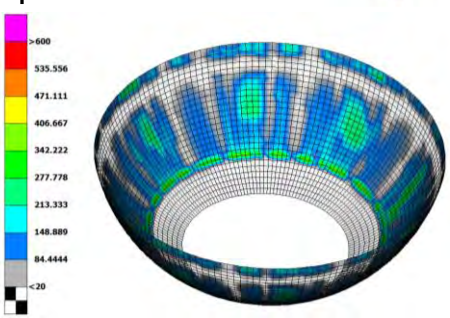


Flex Joint Contact analysis

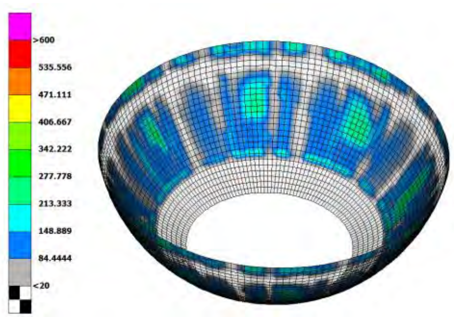




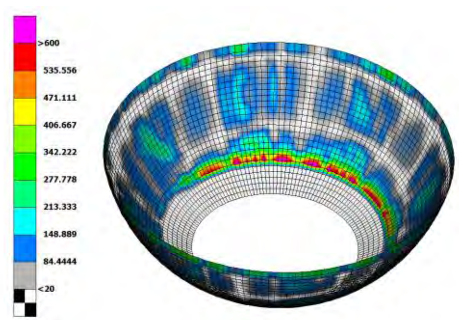
pre-tension loadcase



axial force loadcase

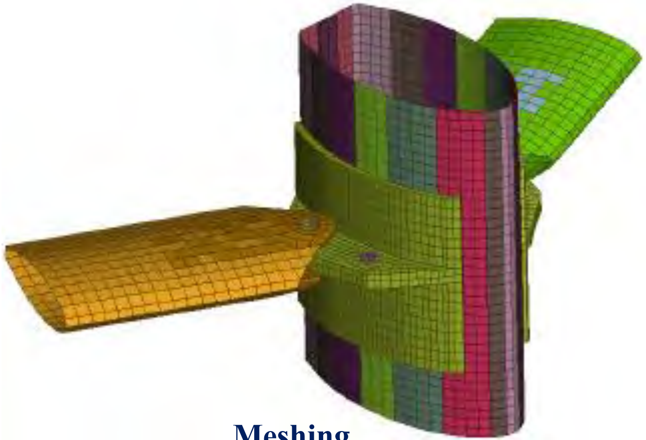


bending force loadcase

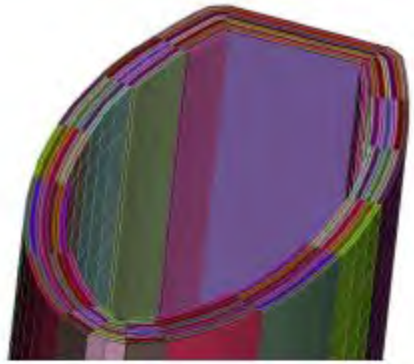


Safran Open 60’ race yacht composite mast modelling for crashworthiness analysis

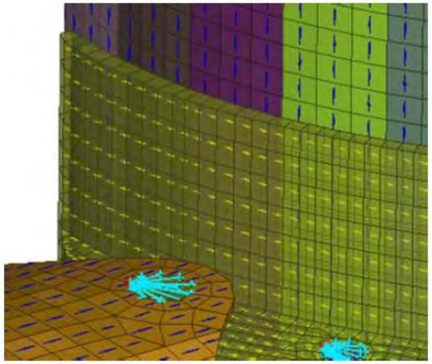
Mast modelling



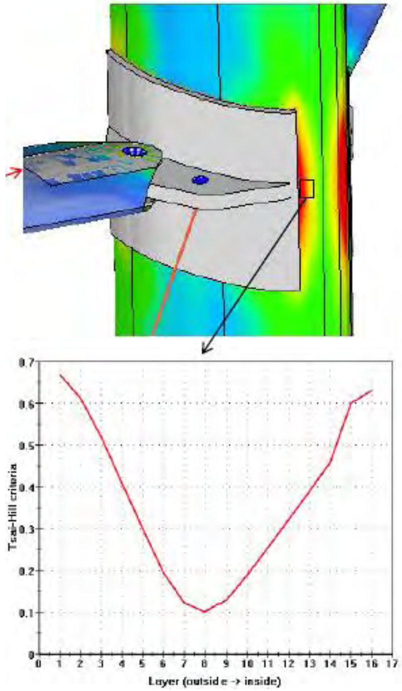
Meshing



Composite materials



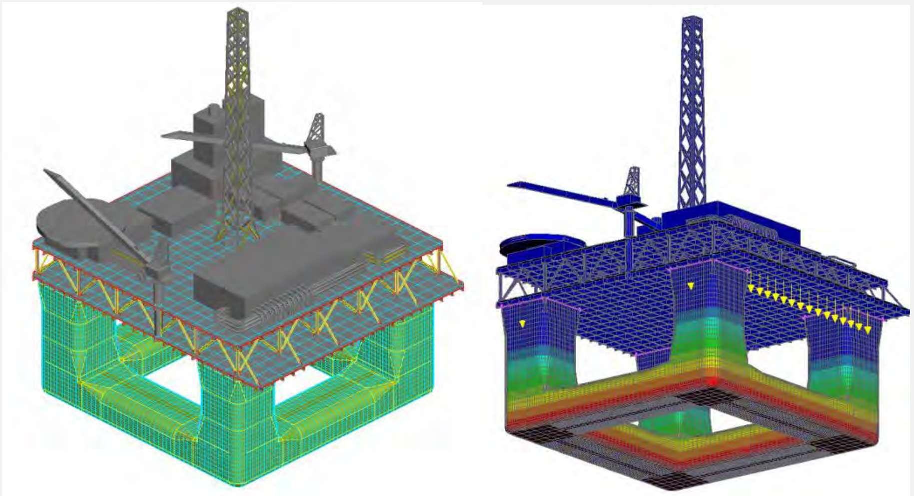
Elements orientation

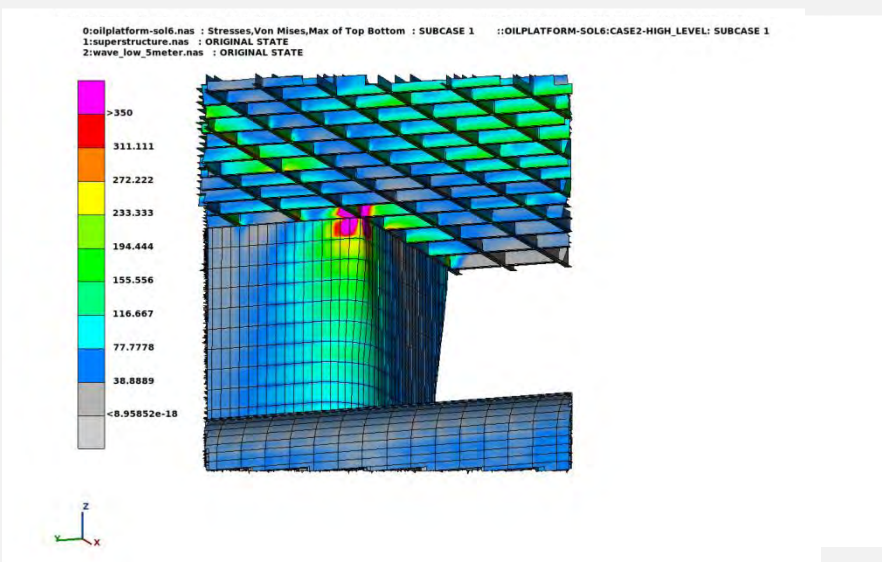


ANSA and μETA contribution to the study of Safran Open 60’ race yacht crashworthiness
Philippe Biagi, Safran Engineering Services, 4th ANSA & μETA International Conference, 2011

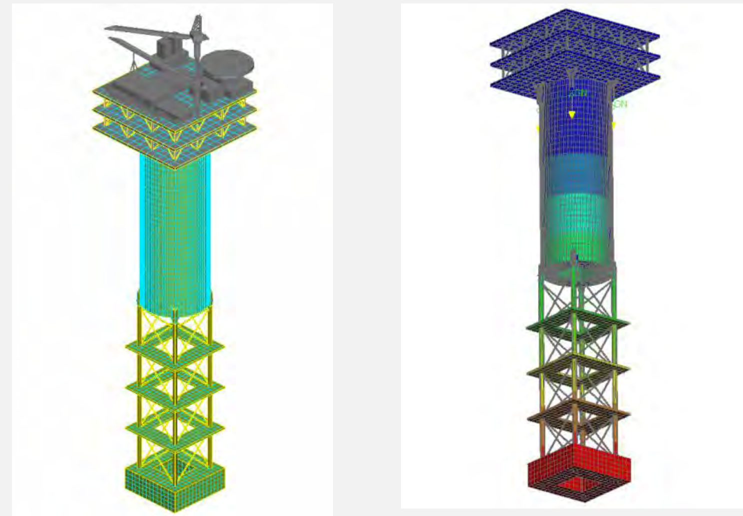
Static Analysis for Offshore Models

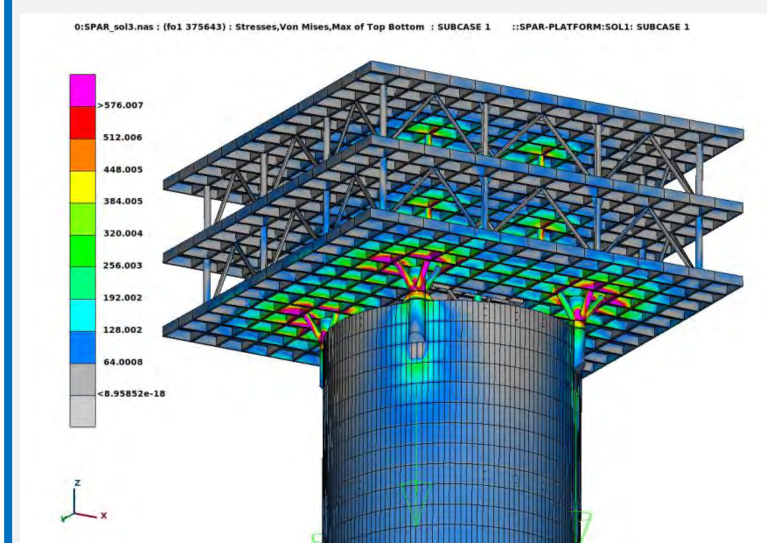
Semi Submersible Platform





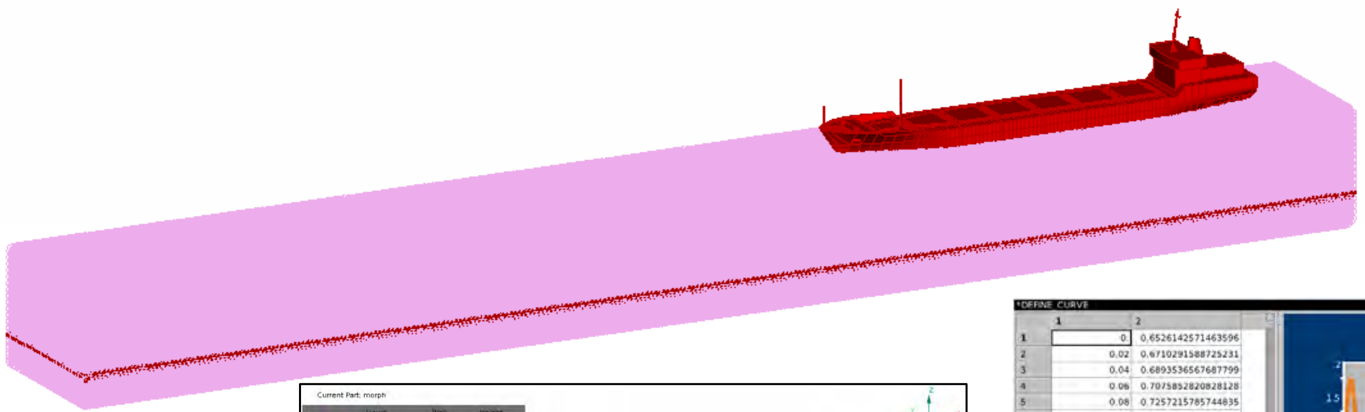
Spar Platform

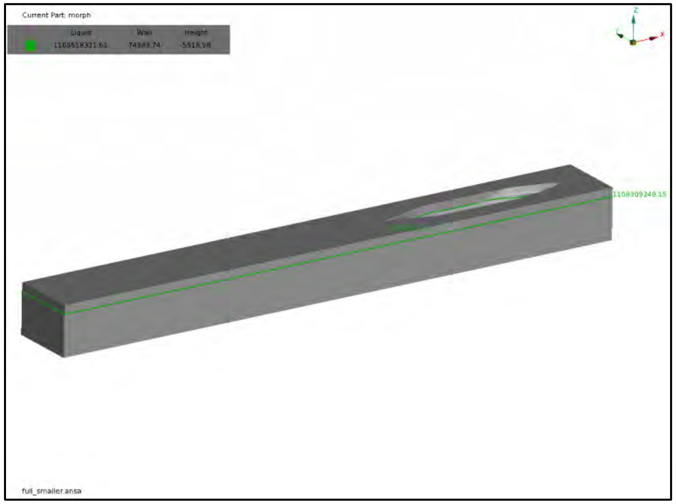


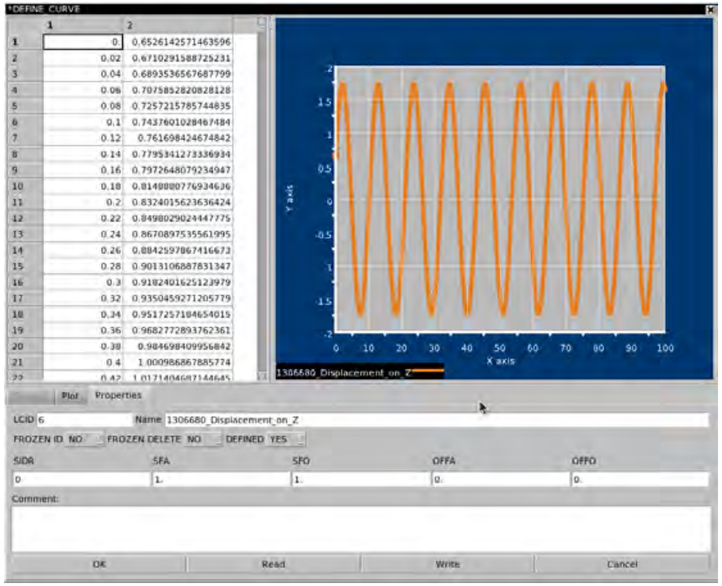


Wave on SPH case study

- Closed volume creation
- Automated SPH creation at user defined level using the Tank Tool
- Merging the rigid ship model
- Automated application of wave initial conditions using linear Airy wave theory

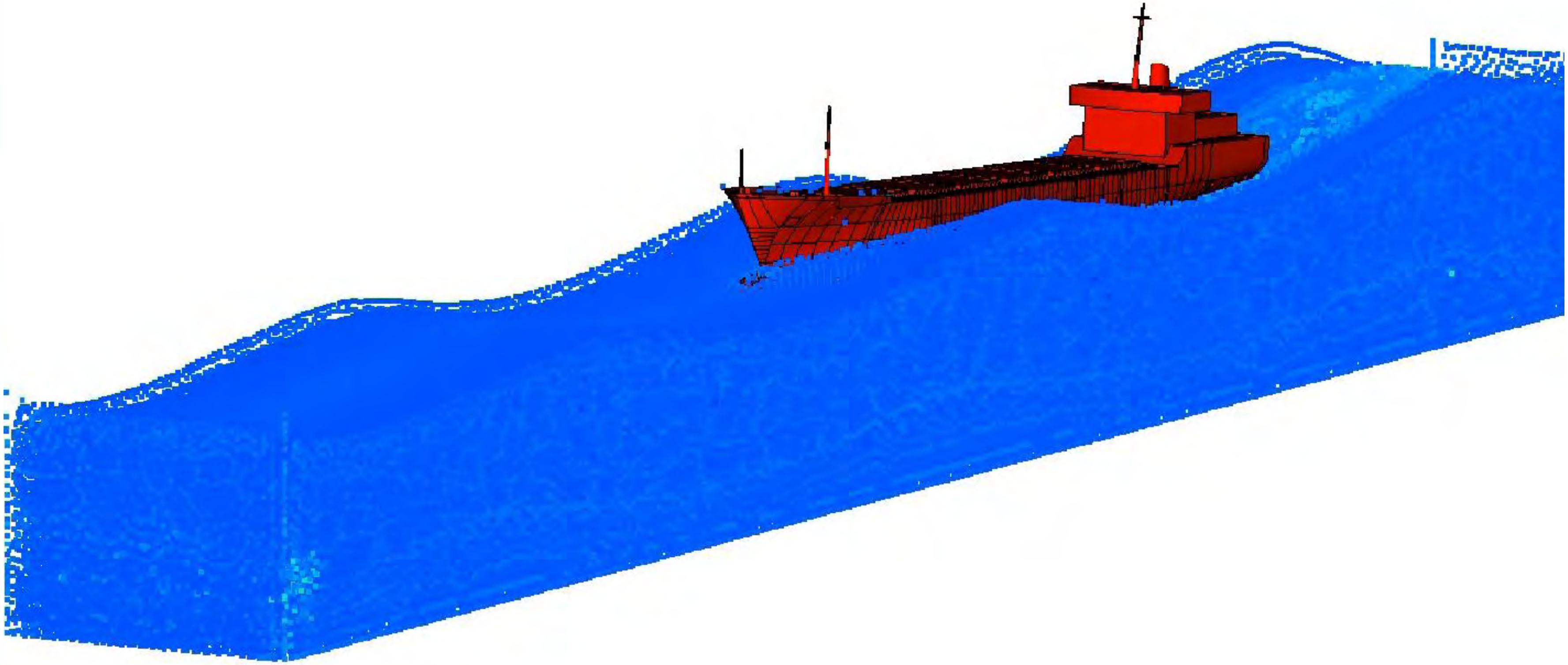


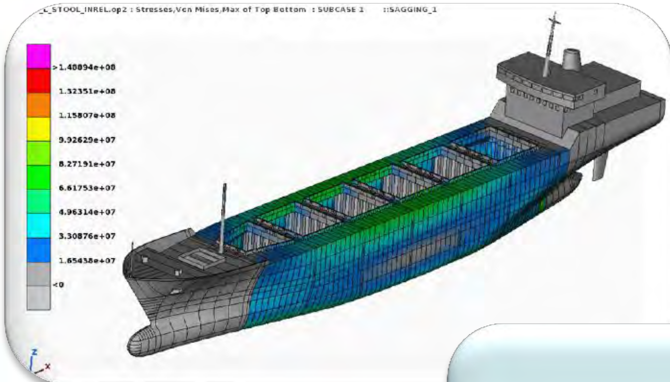




Wave on SPH case study

- Results in μETA




_L_STOOL_INREL.op2 : Stresses,Von Mises,Max of Top Bottom : SUBCASE 1 ::SAGGING_1
>1.48894e+08
1.32351e+08
1.15807e+08
9.92629e+07
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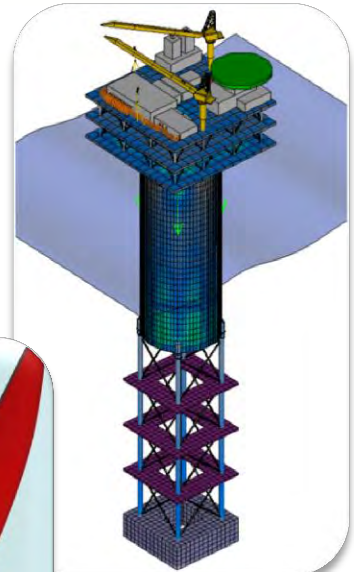
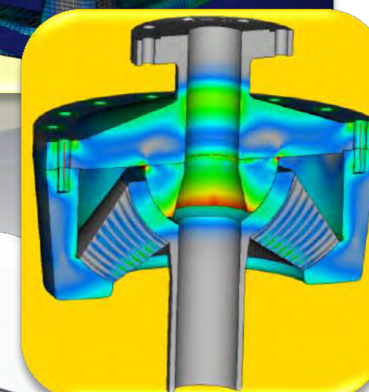
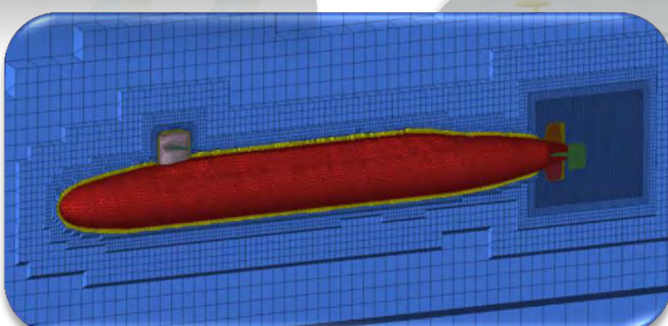
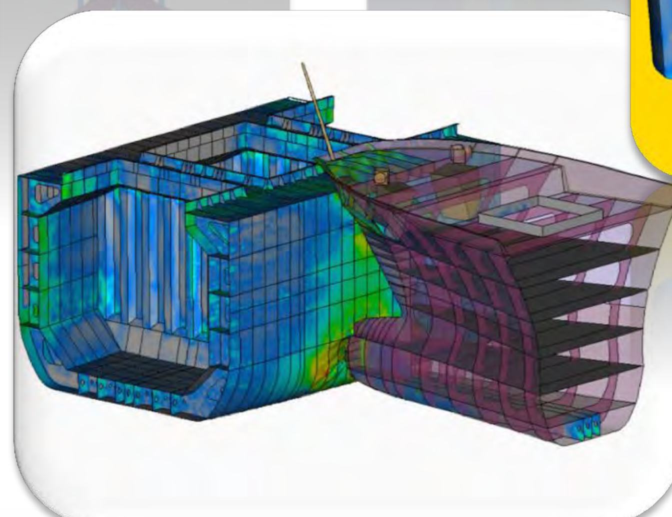
Z
X









Thank you!