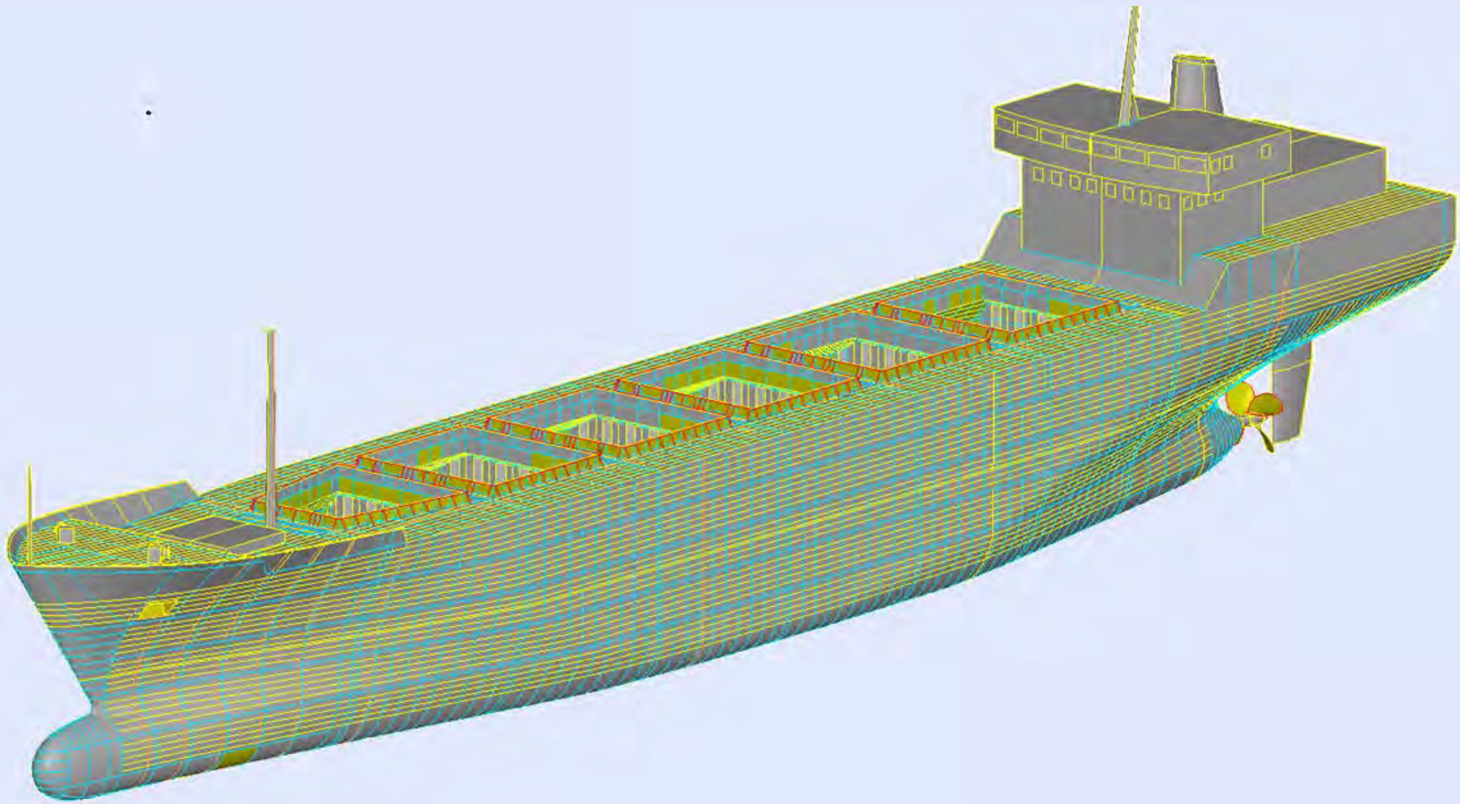
ANSA and META in Marine and Offshore structures analysis

physics on screen

BETA SIMULATION SOLUTIONS



INTERFACES

Interfaces

CAD & PDM data
- CATIA
- Pro/ENGINEER
- NX-Unigraphics
- IGES STEP …

Keyword files
- NASTRAN
- ABAQUS SESTRA
- LS-DYNA
- OPENFOAM …

Tessellated data
- STL
- VRML

Other (e.g. Medina)

ANSA pre-processor

Ready-to-run solver input files
- NASTRAN
- ABAQUS SESTRA
- LS-DYNA
- OPENFOAM …

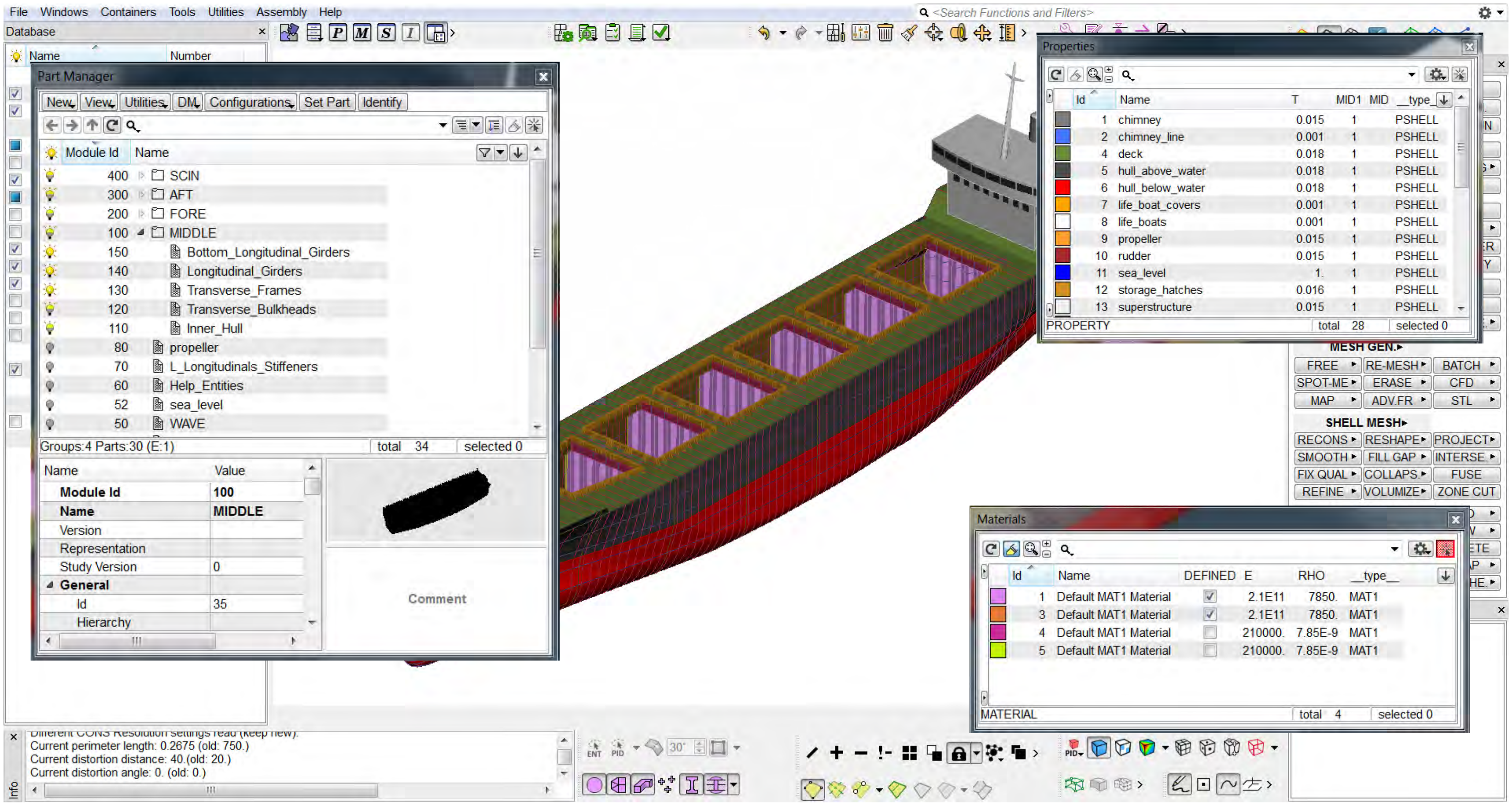
CAD files
- IGES
- STEP
- VDA-FS

Tessellated data
- STL
- VRML

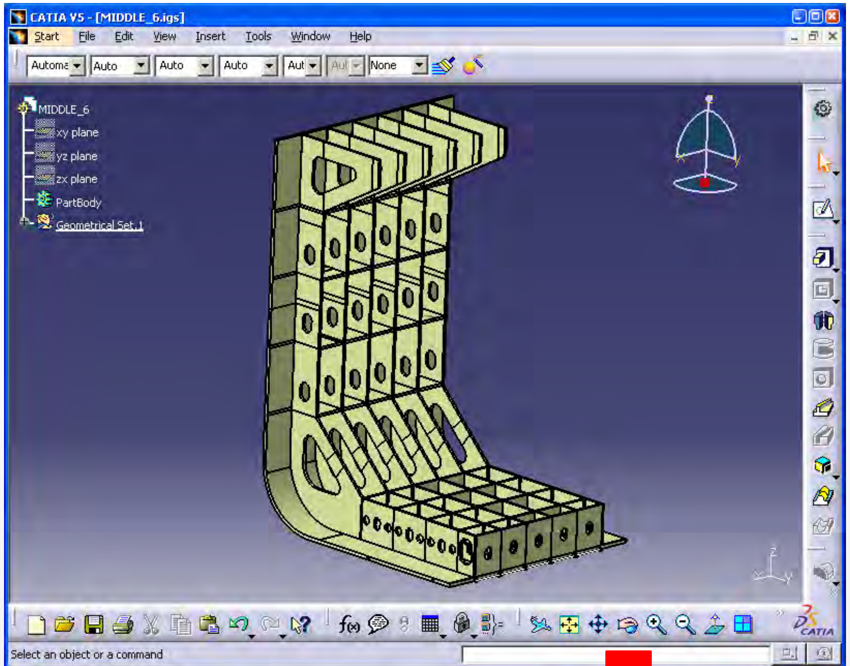
META Product Tree

Model management

Database browser, Model Browser, Properties / Materials lists, DM Browser



Native and Neutral CAD data input

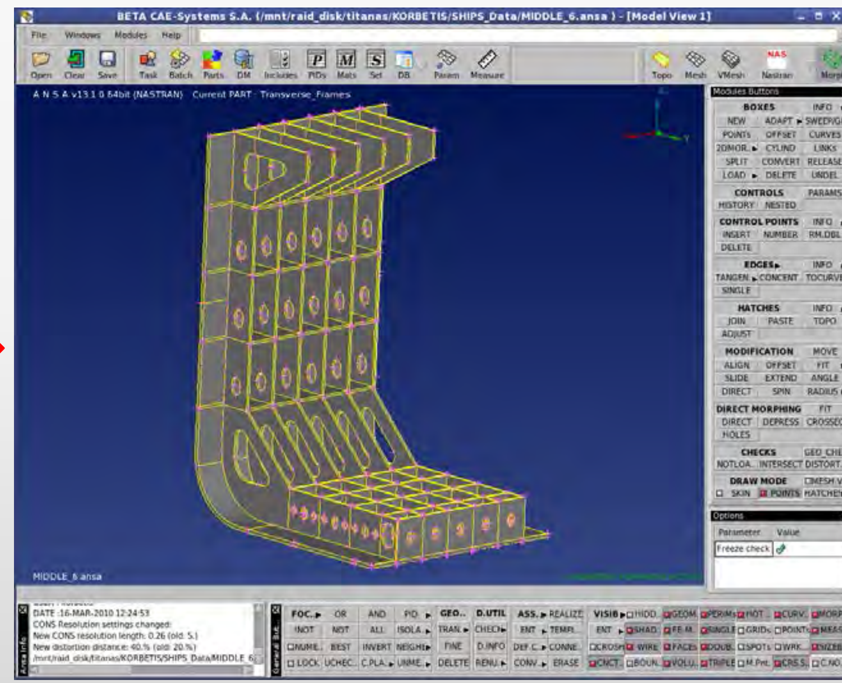


Native CAD data input:

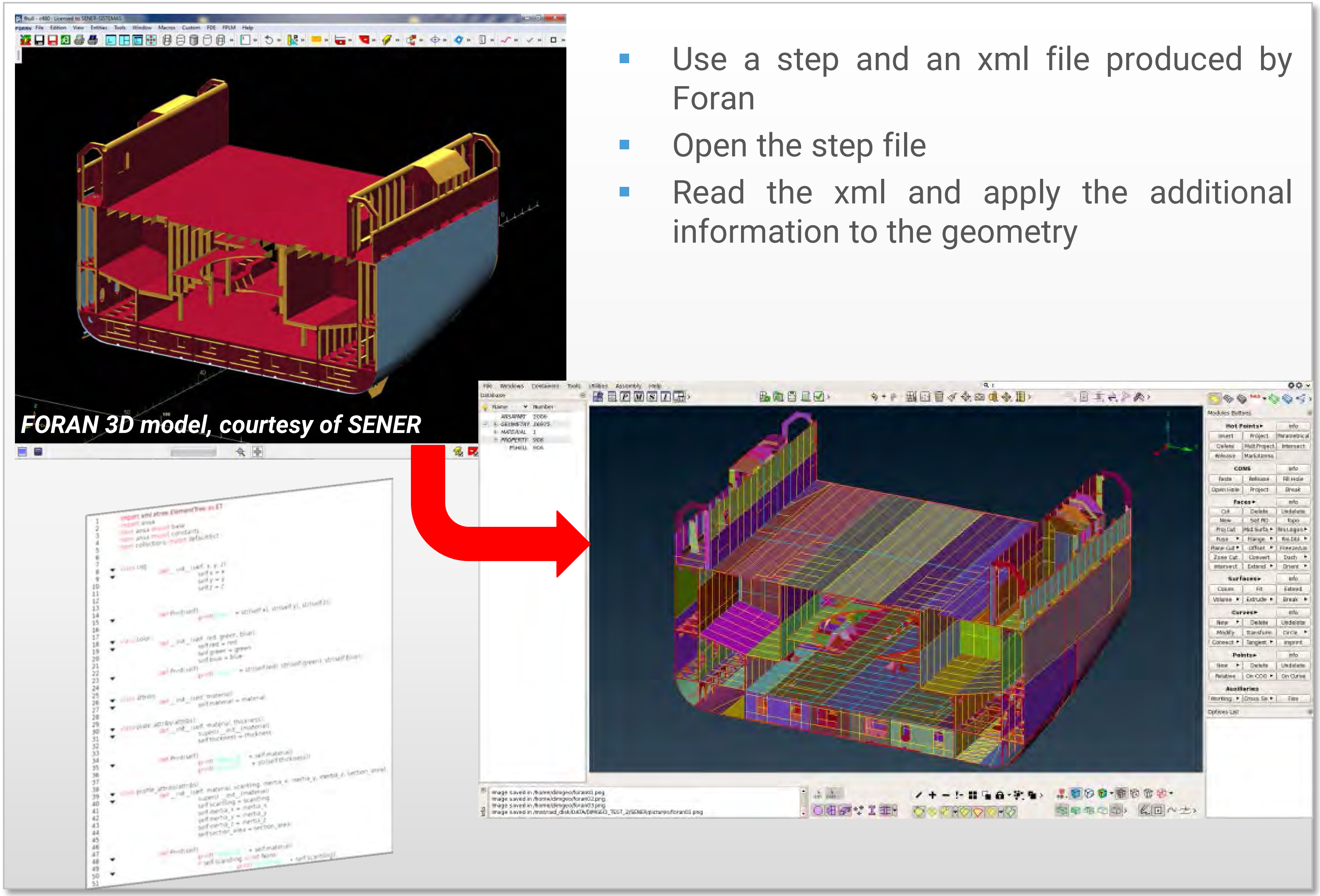
- CATIA, ProE, NX, JTOpen and more..

Direct Neutral File CAD data input:

- IGES, VDA-FS, STEP



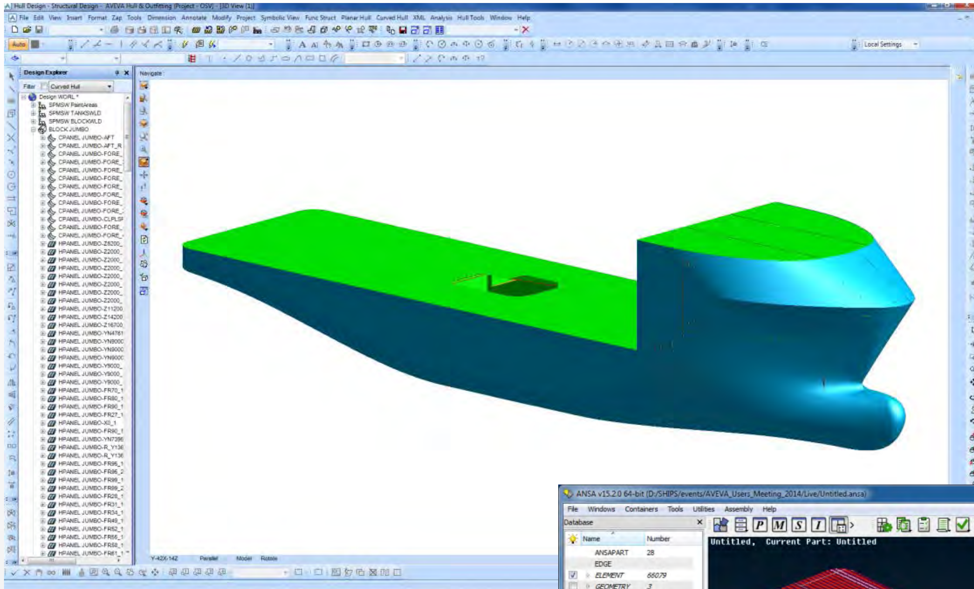
From FORAN to ANSA



- 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

From AVEVA Marine to ANSA

Additional information is read from an AVEVA xml file and applied on the model



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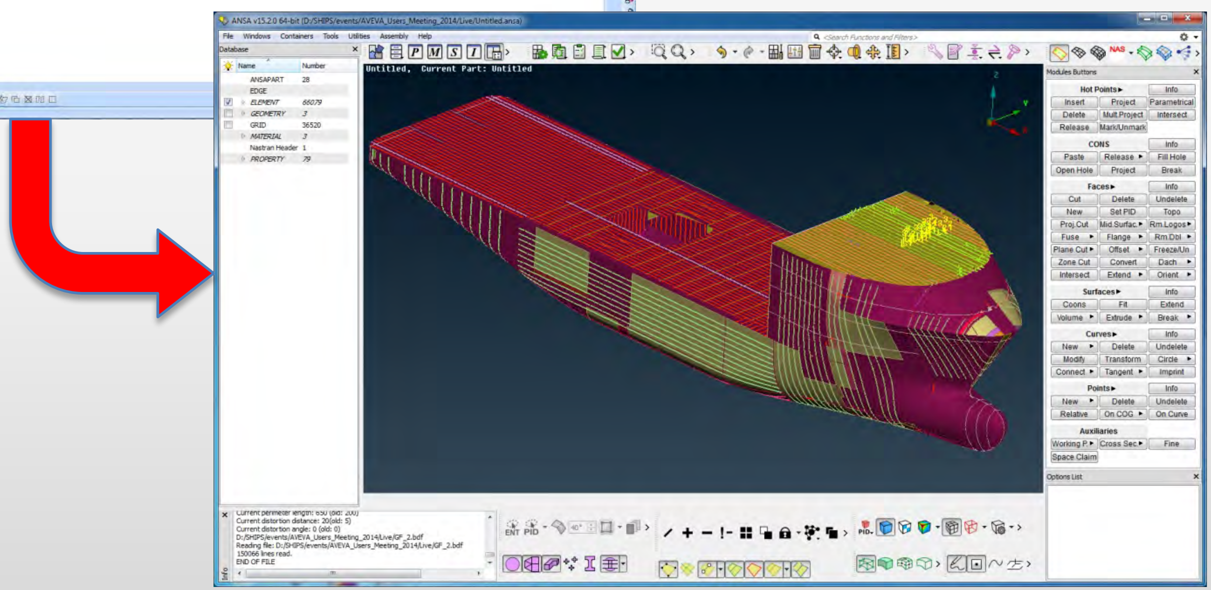
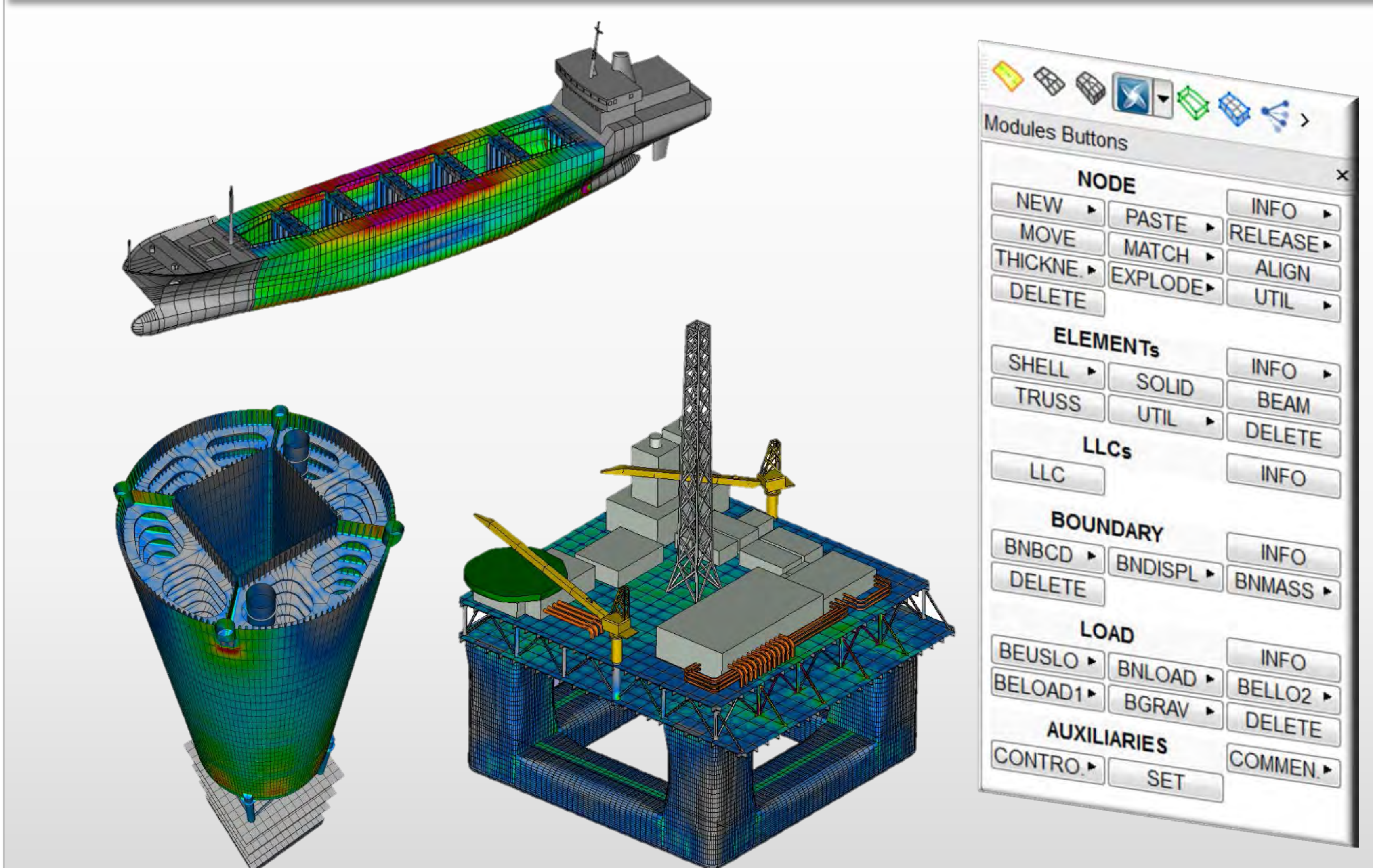


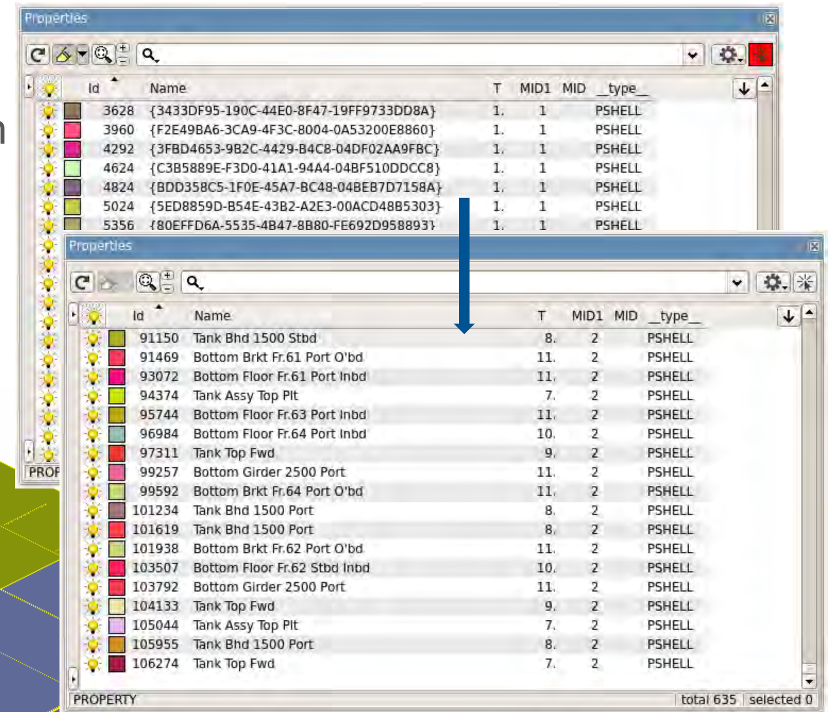
Interface for SESTRA

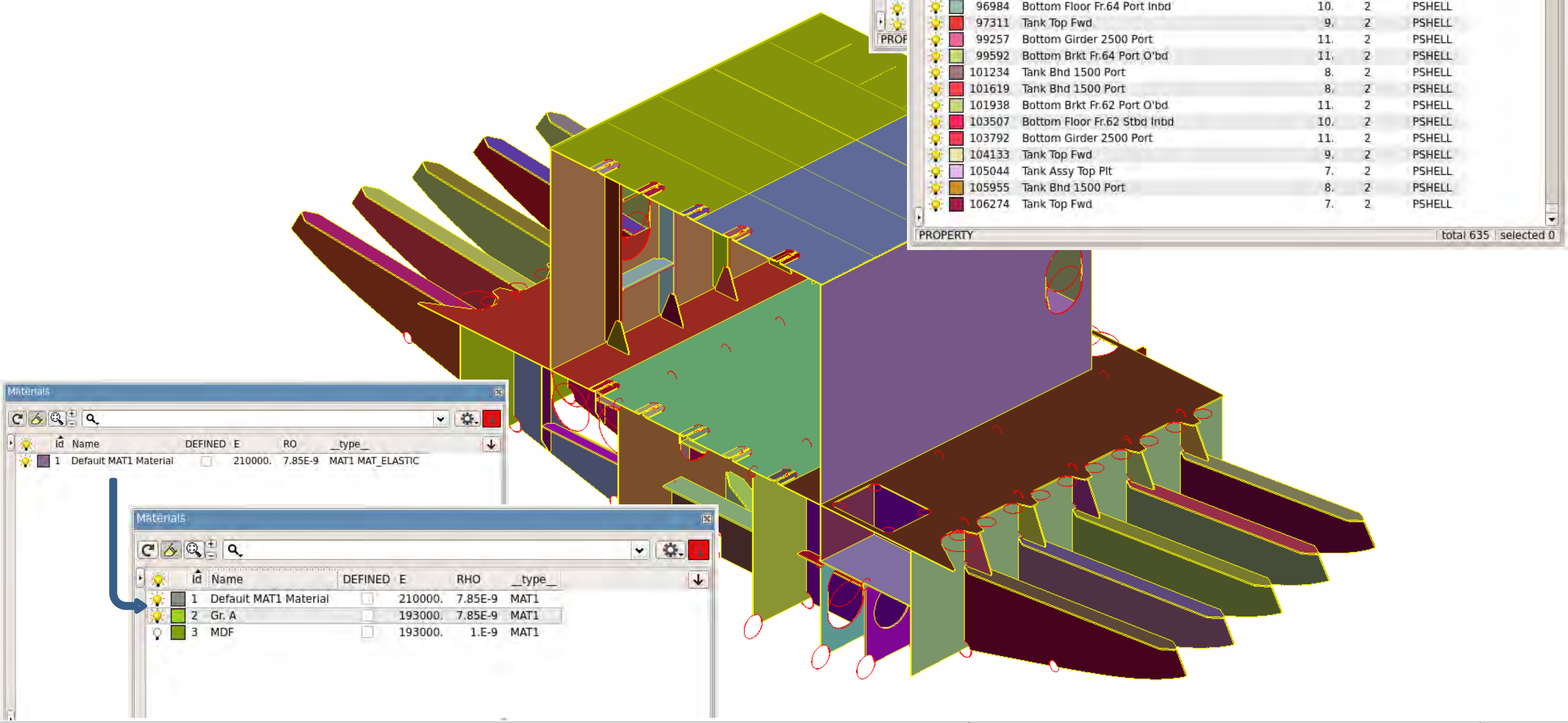
Input, output and new DECK for SESTRA



From Ship Constructor to ANSA

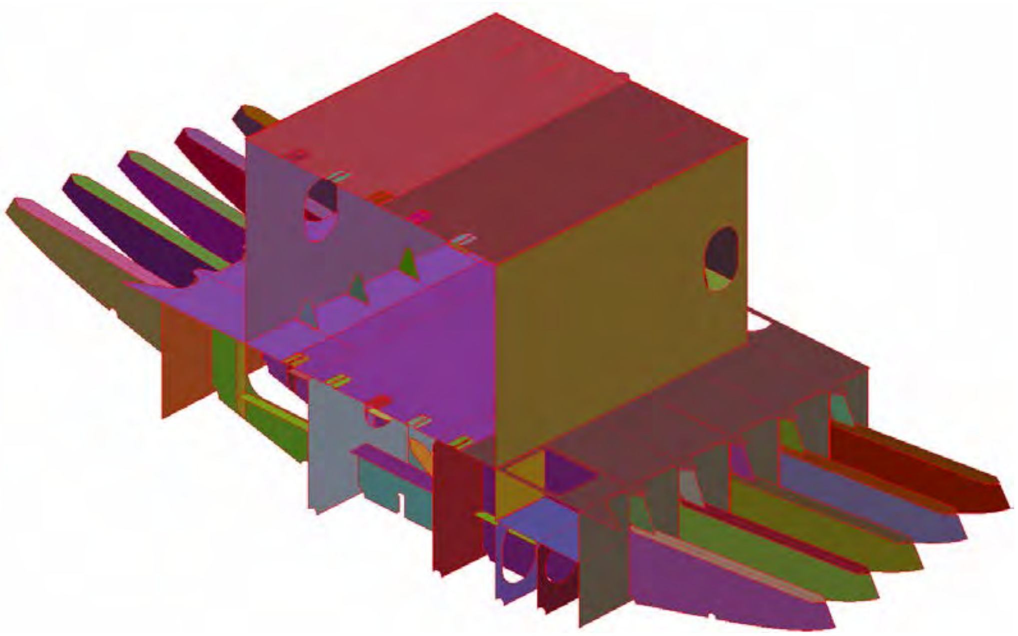
- Use of ship constructor data and solid description step file
- Import model data:
  - Property Thickness and
  - Material data

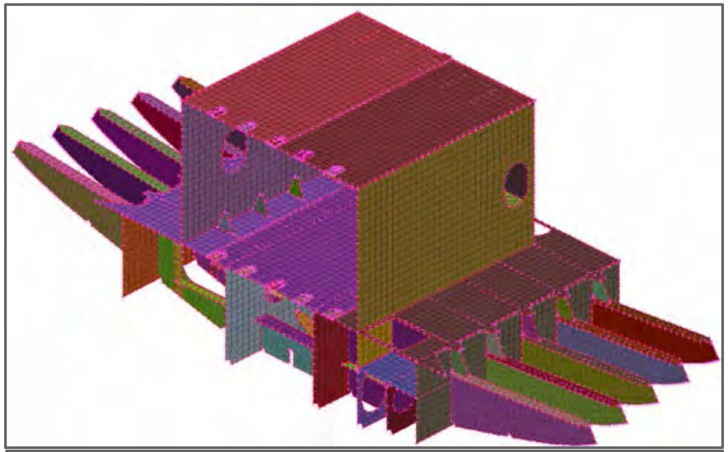


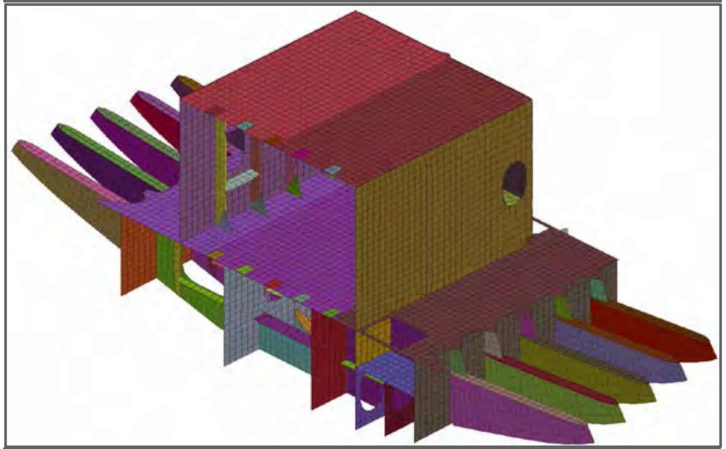


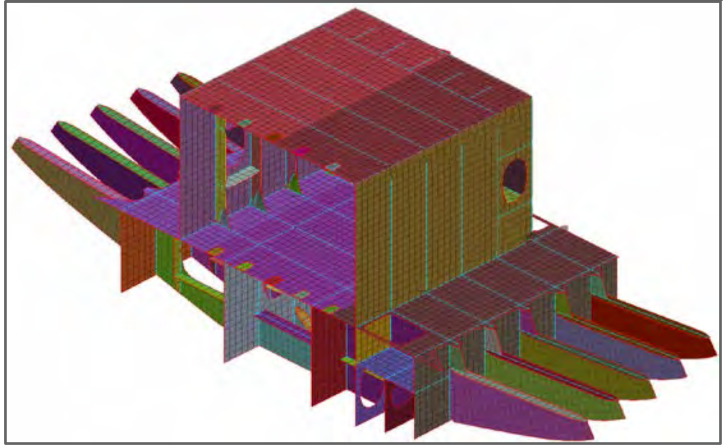
From Ship Constructor to ANSA

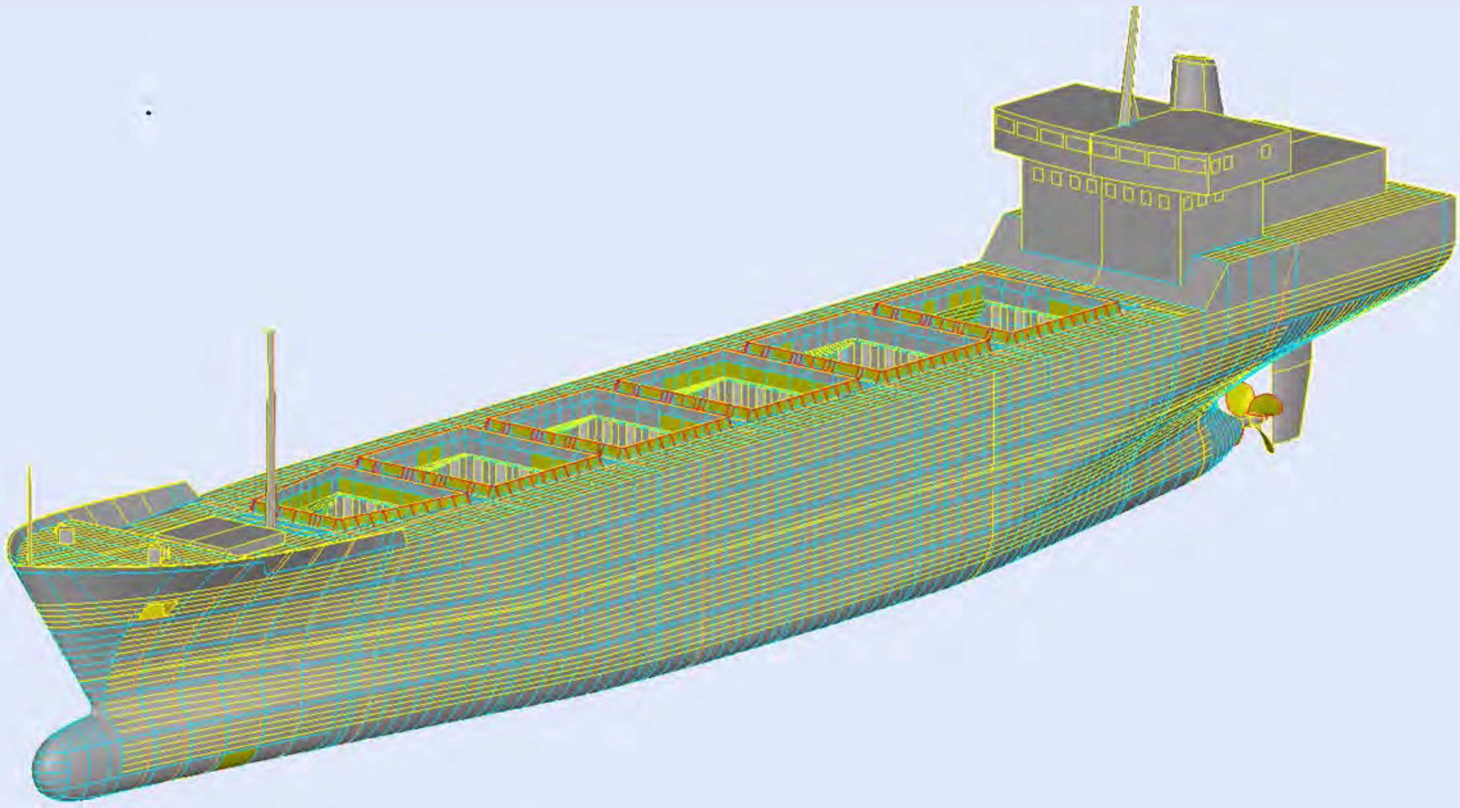
- Batch Middle skin extraction
- Auto mesh
- Reconstruct and auto connect
- Output as solver format







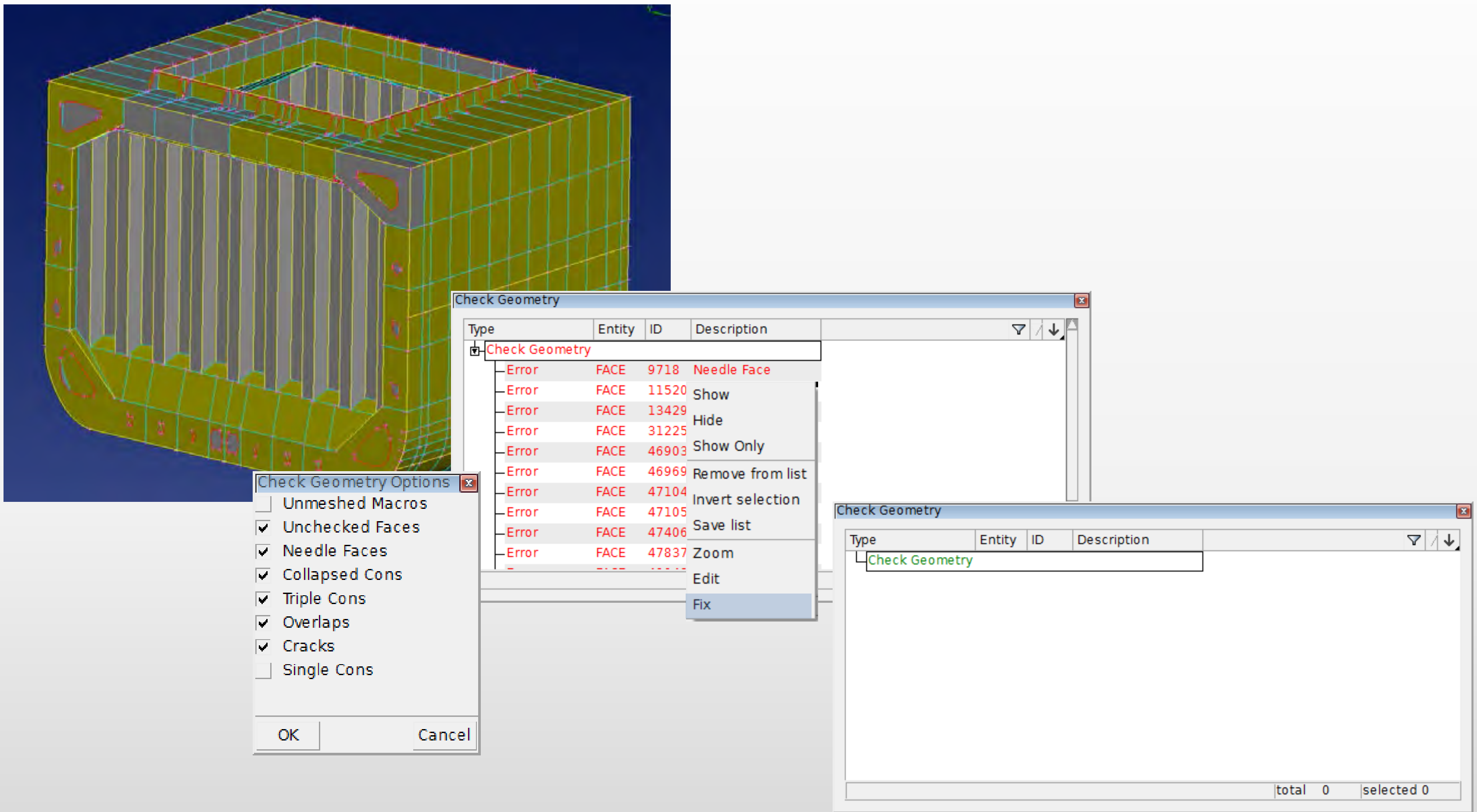




GEOMETRY

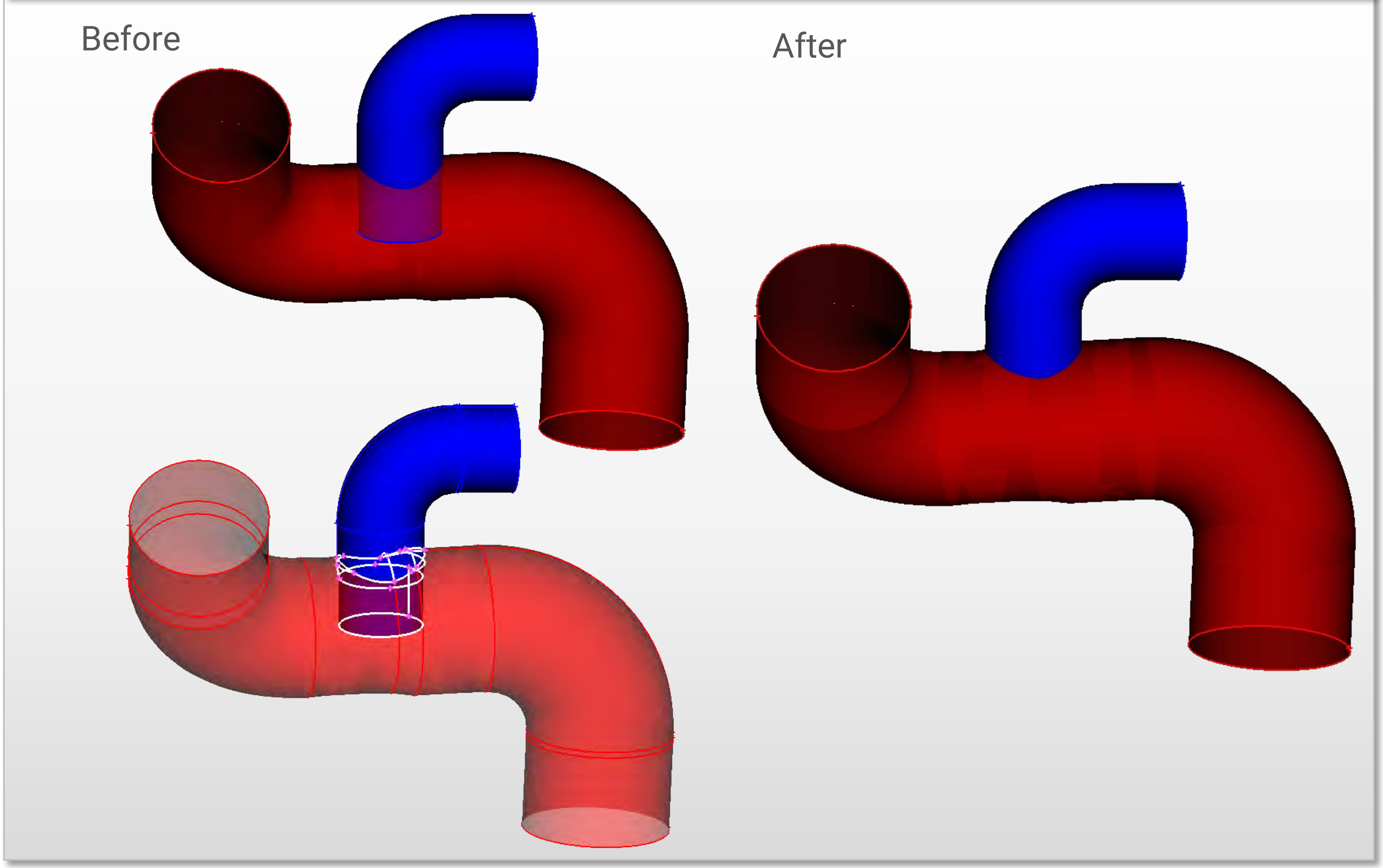
Geometry checks

Topological errors identification and fix



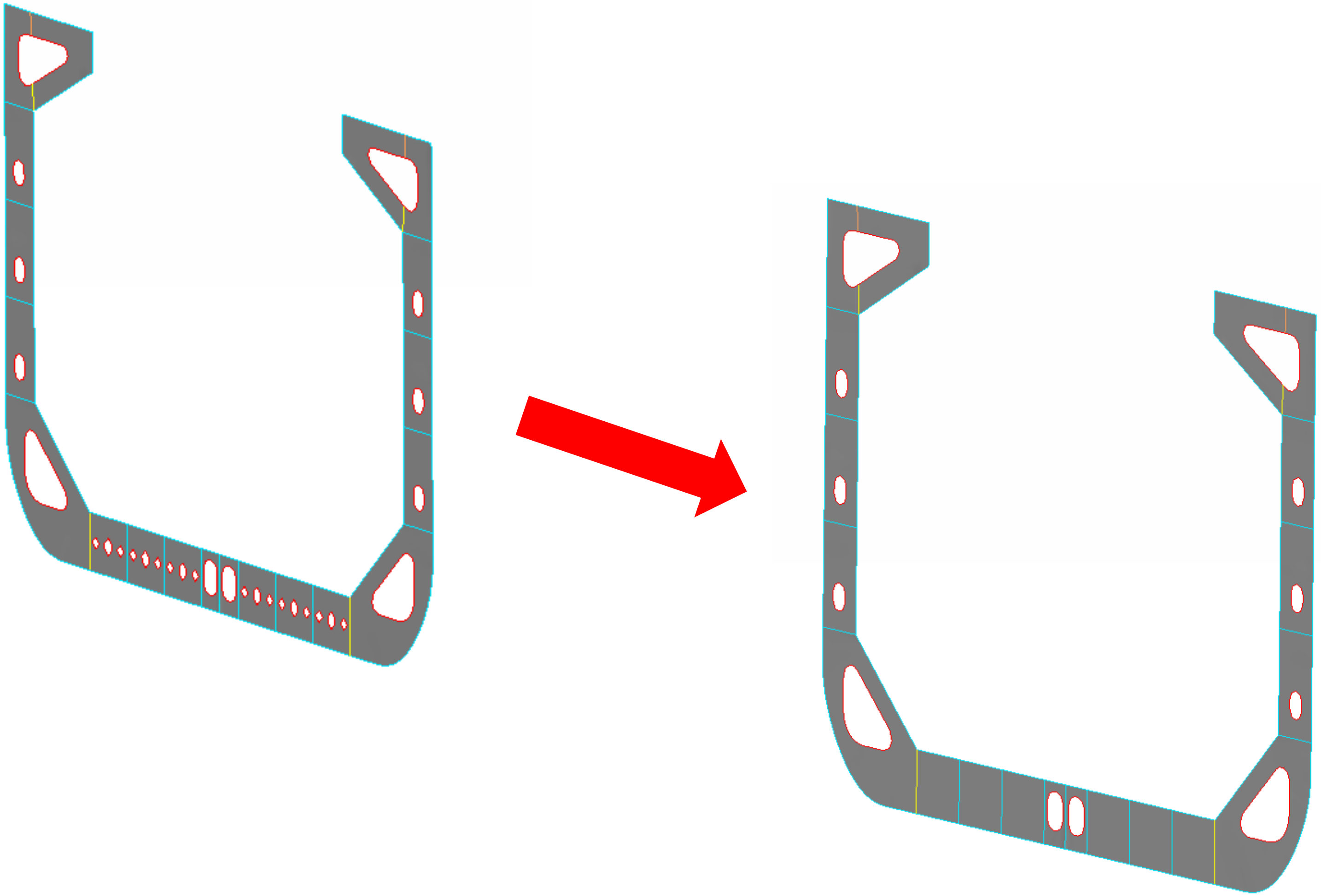
Intersections

Geometry trimming



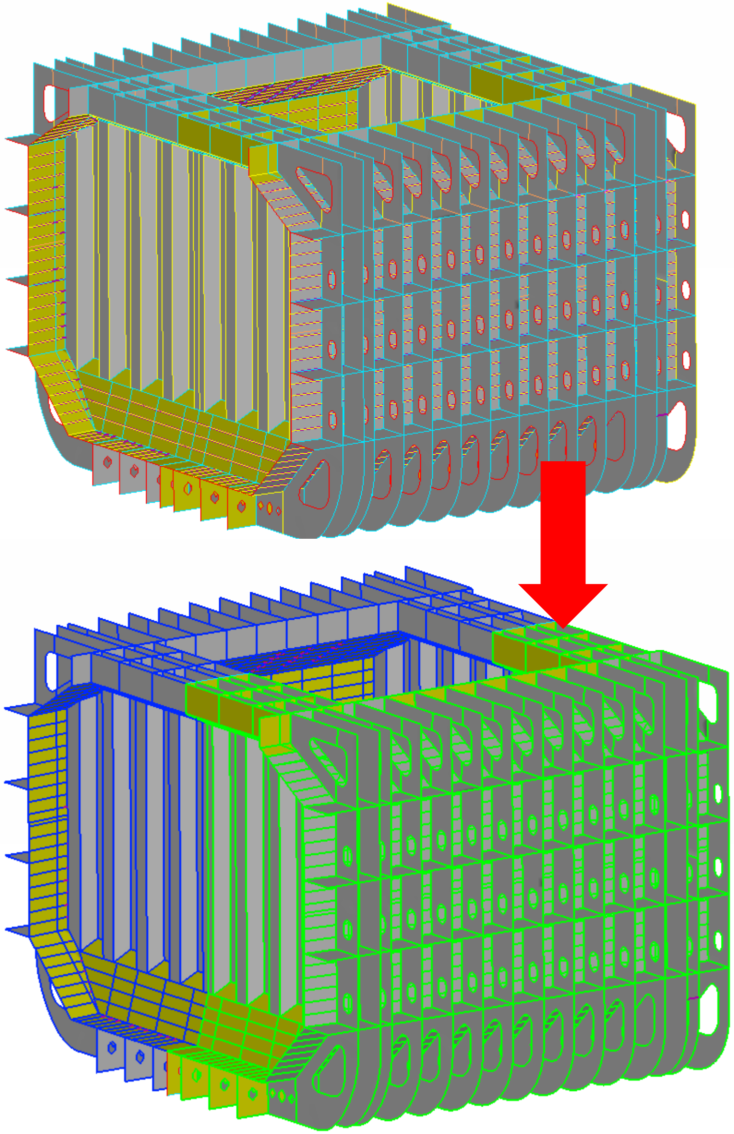
Model simplification

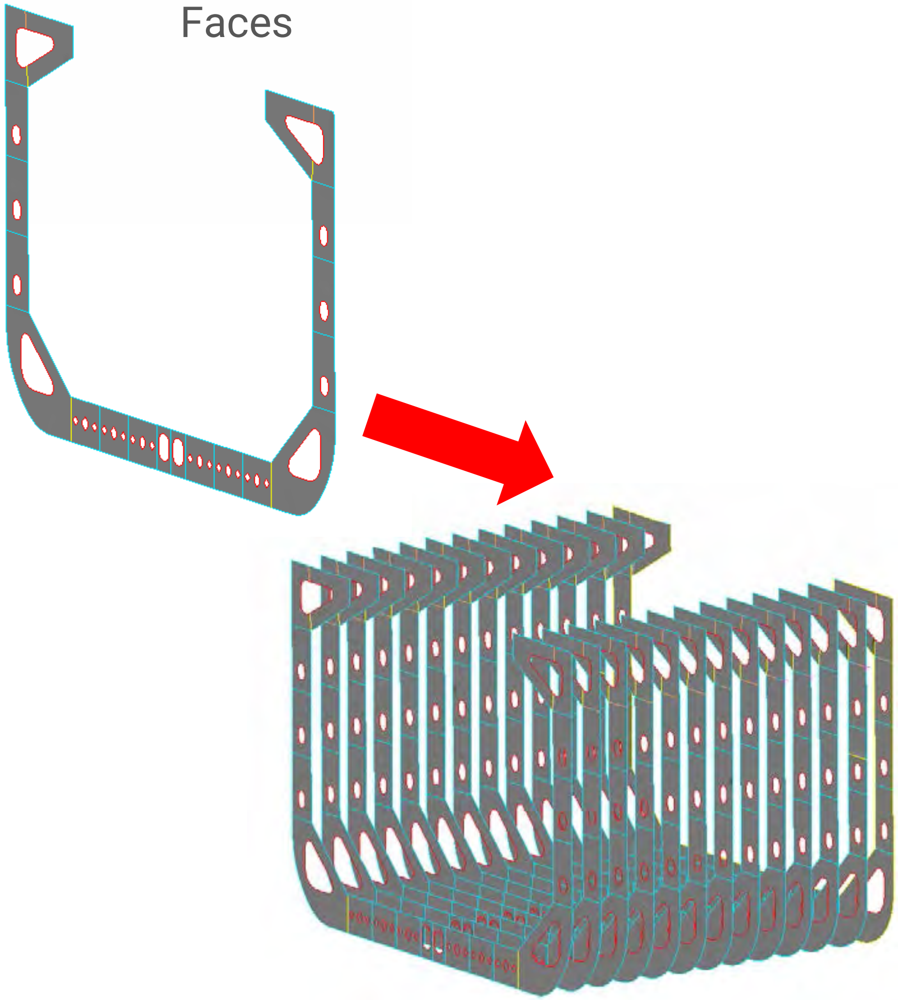
- Identifying unchecked faces, needle faces, collapsed CONS, triple bounds, overlaps, cracks
- Treatment of holes, fillets, chamfers, features



Handling pattern-wise faces & parts

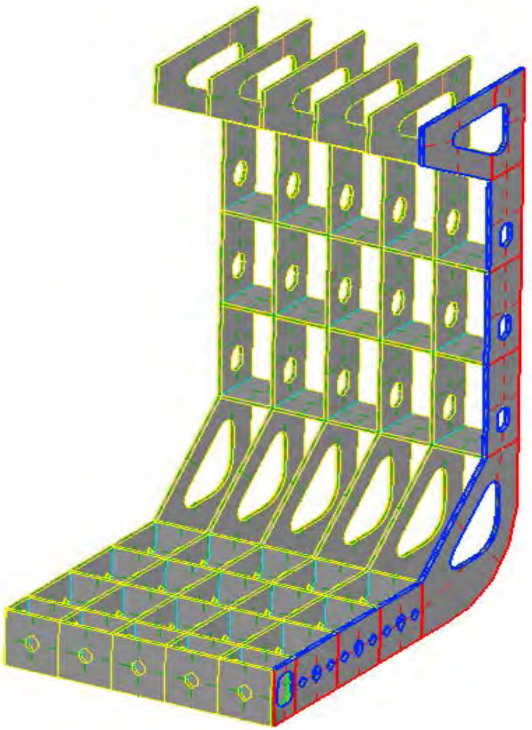
- Substitute geometry with Linked Faces
- Create symmetry, mirror or translation Faces

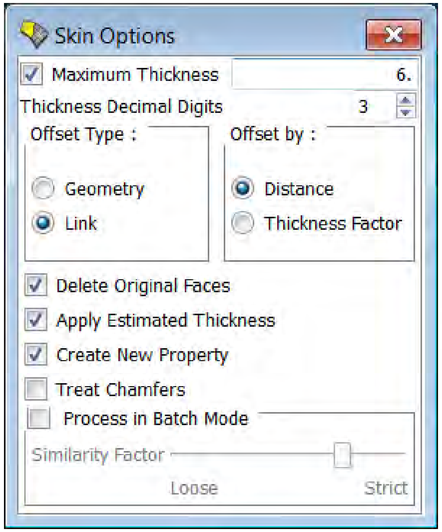


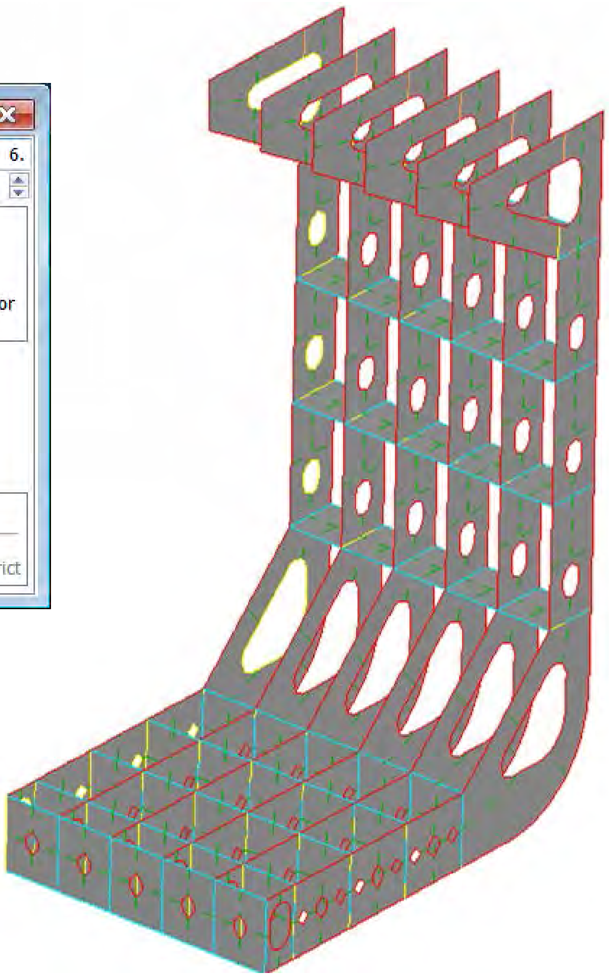


Middle skin extraction

Special tool for middle skin extraction creates new geometry

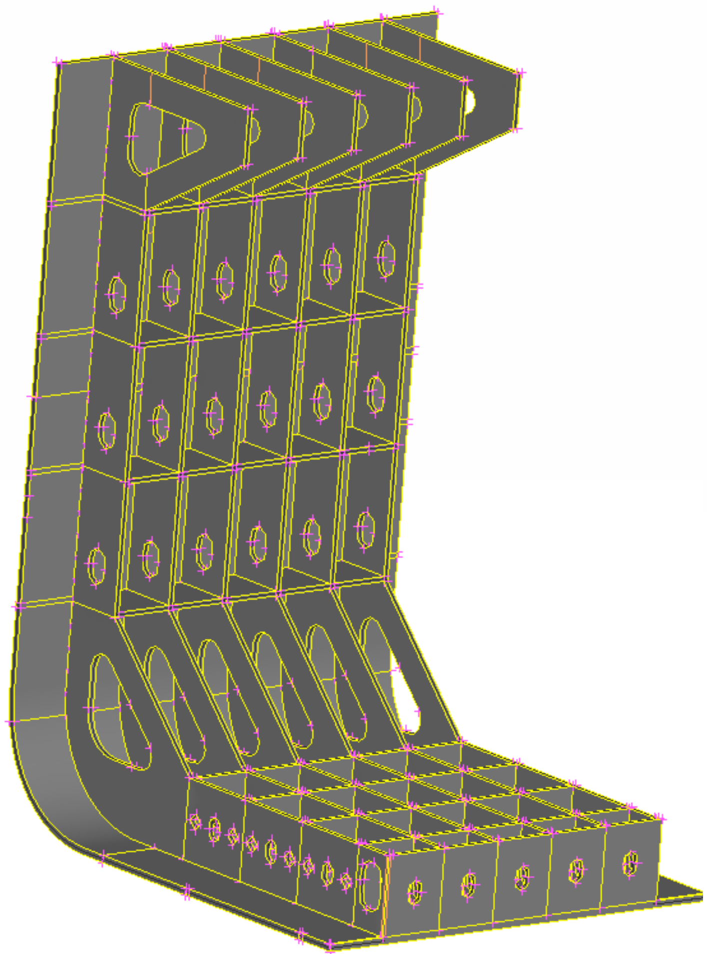


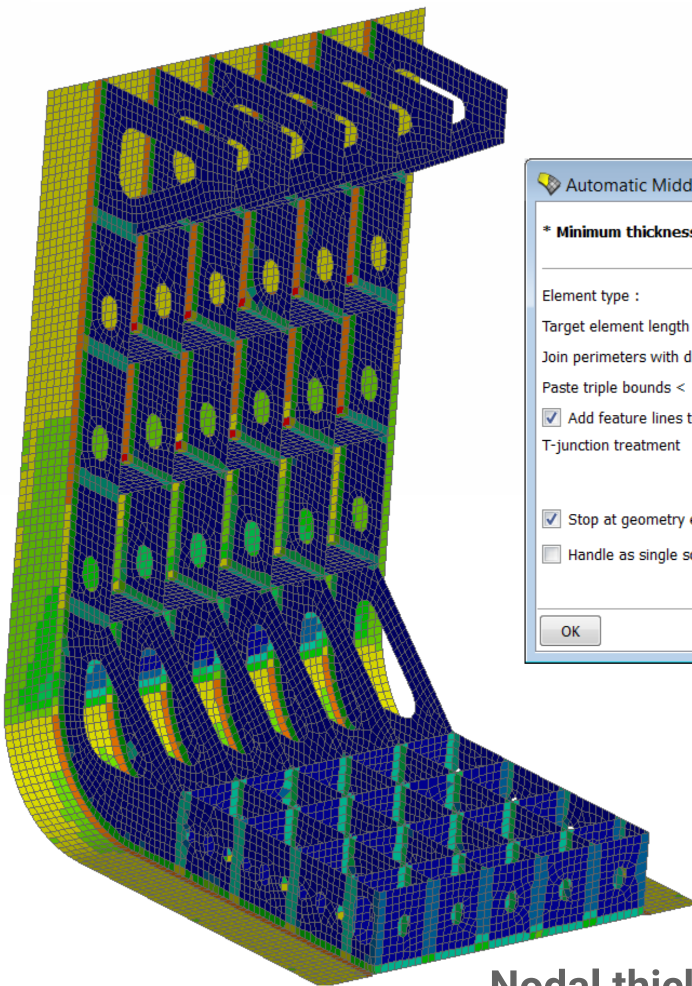


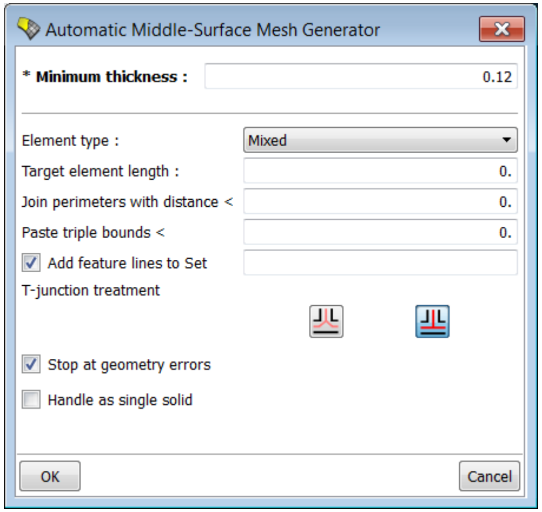


Middle skin extraction

Fully automatic middle surface extraction creates FE Model



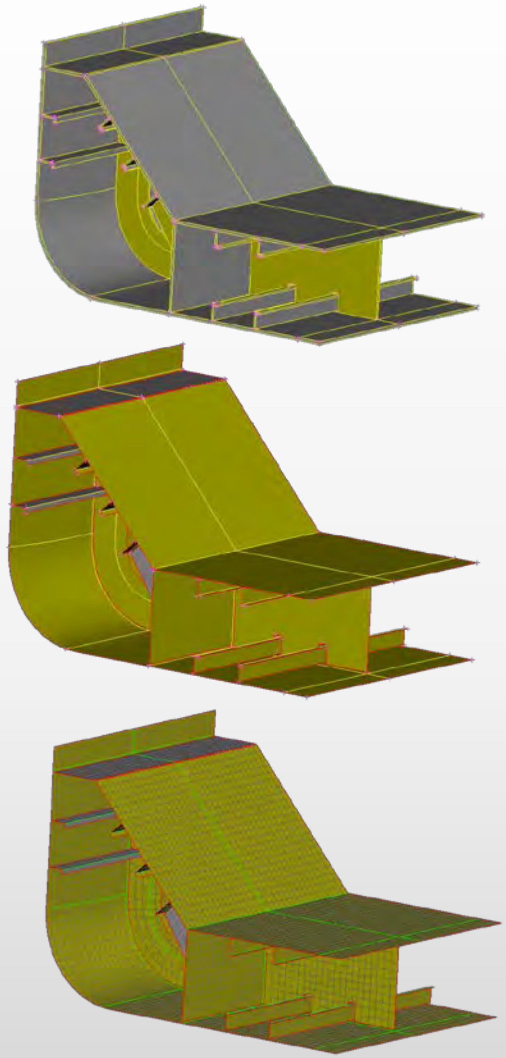




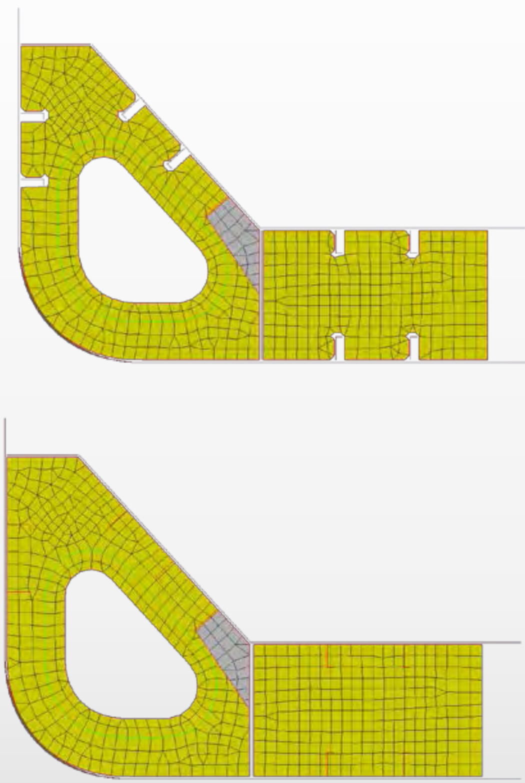
Nodal thickness assignment

Automatic middle skin extraction and assembly

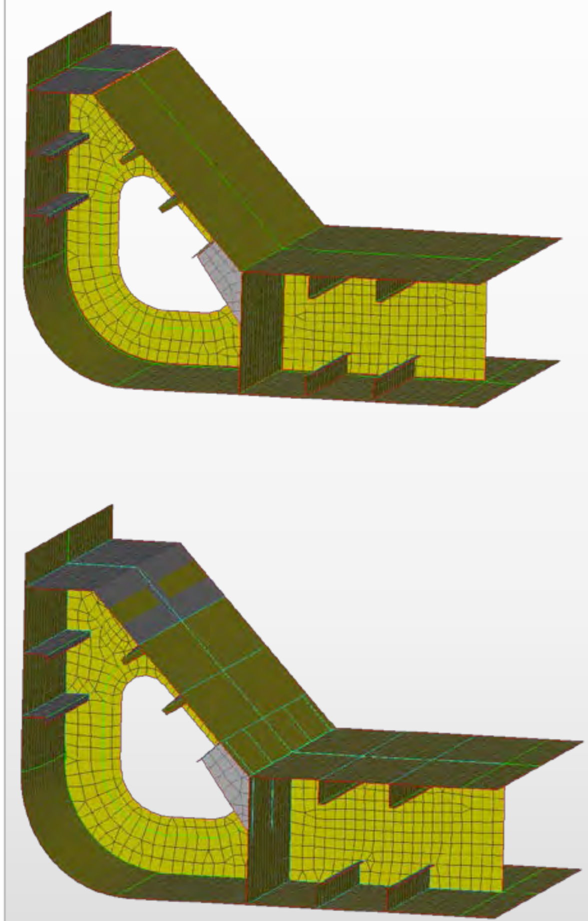
Create the middle skin

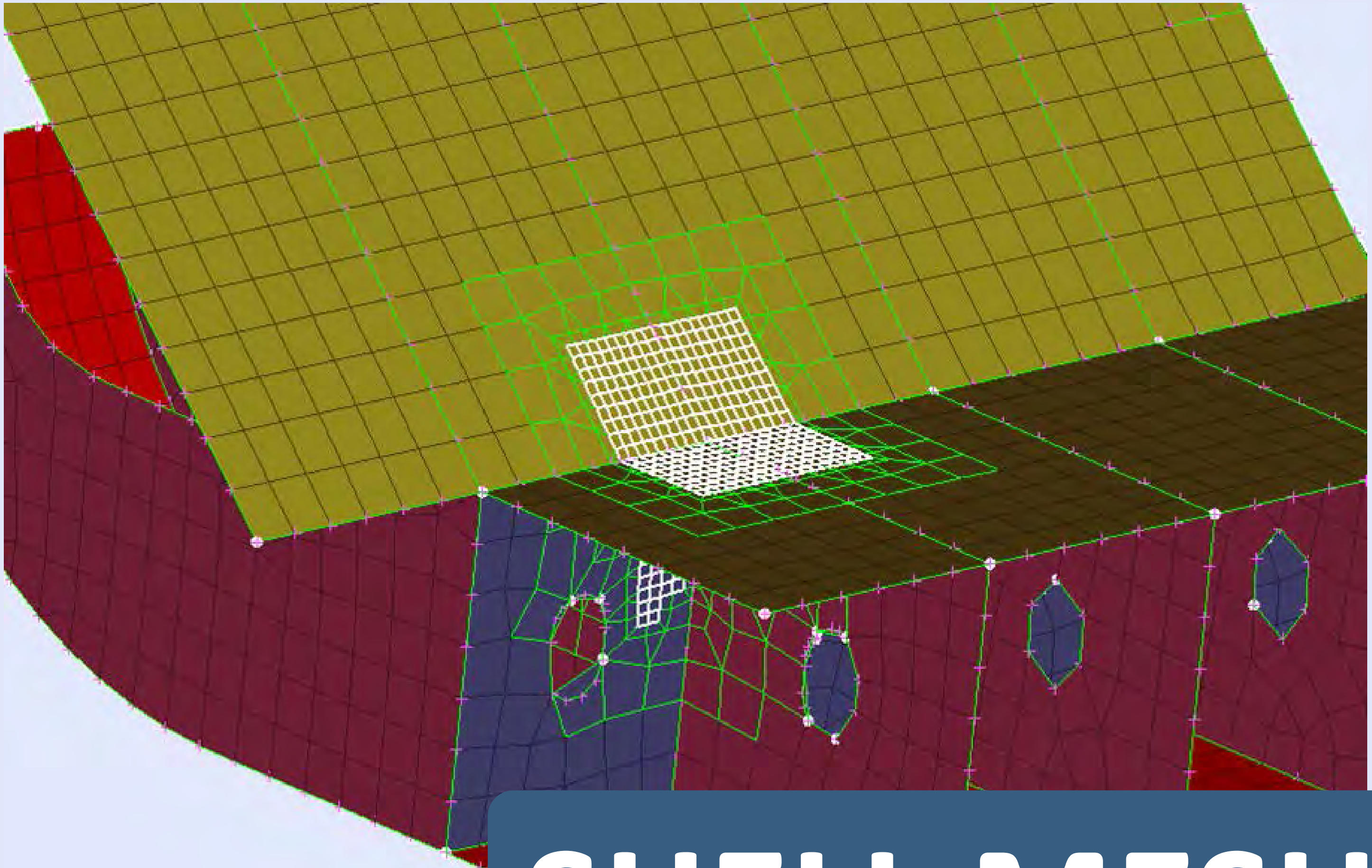


Fill unwanted openings



Connect the parts

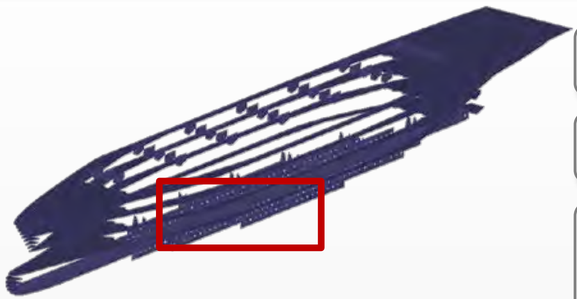


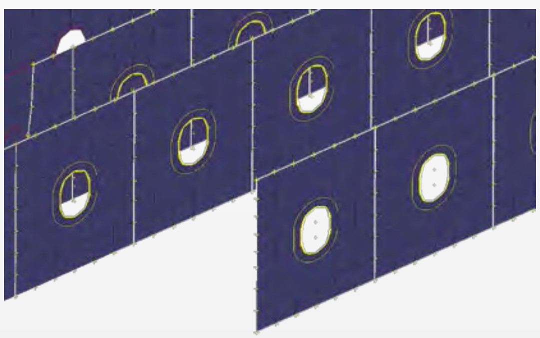


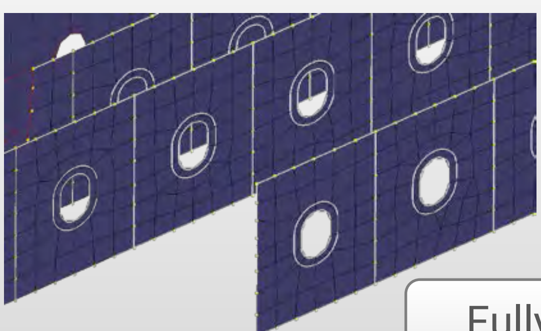
SHELL MESH

Shell Meshing

Mesh for Structural Applications: Sheet-metal components





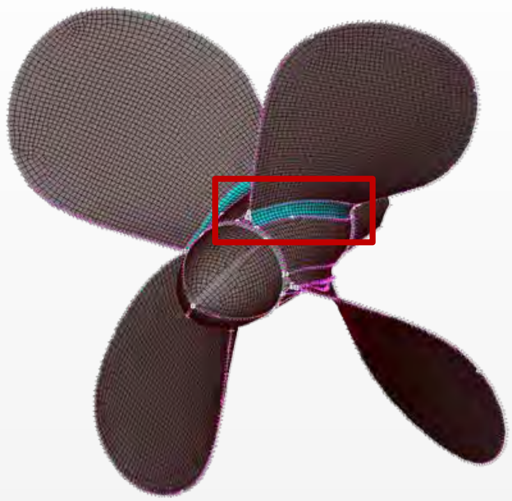


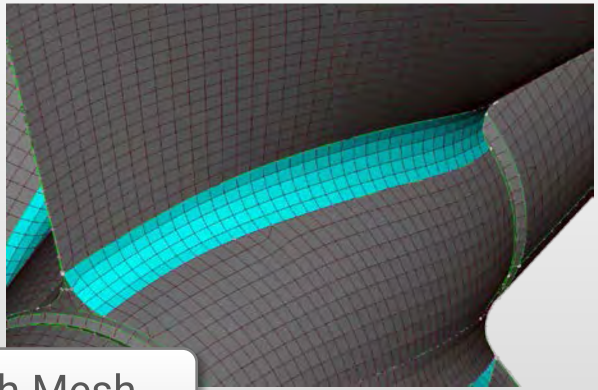
Automatic defeaturing

Mesh quality control

Feature treatment

- Holes
- Fillets
- Flanges

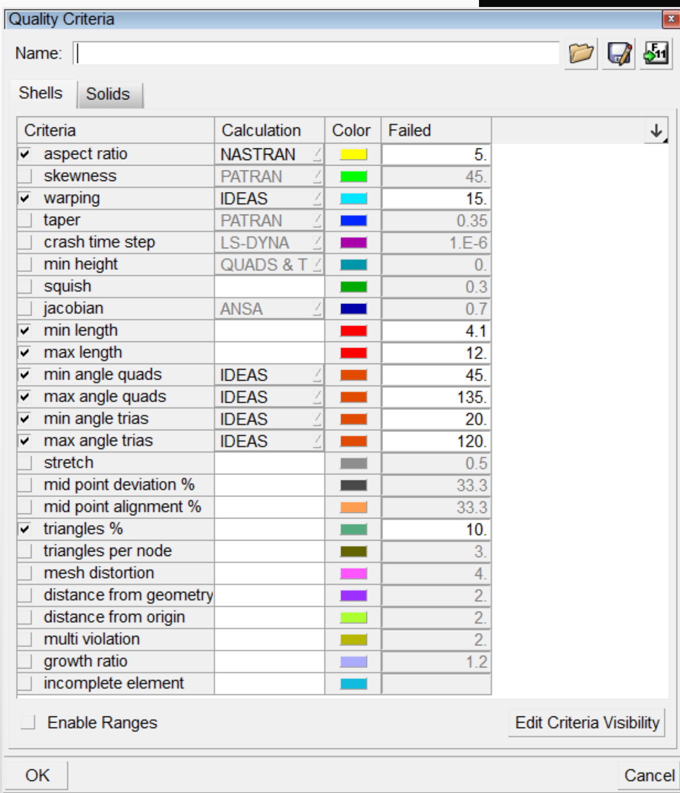




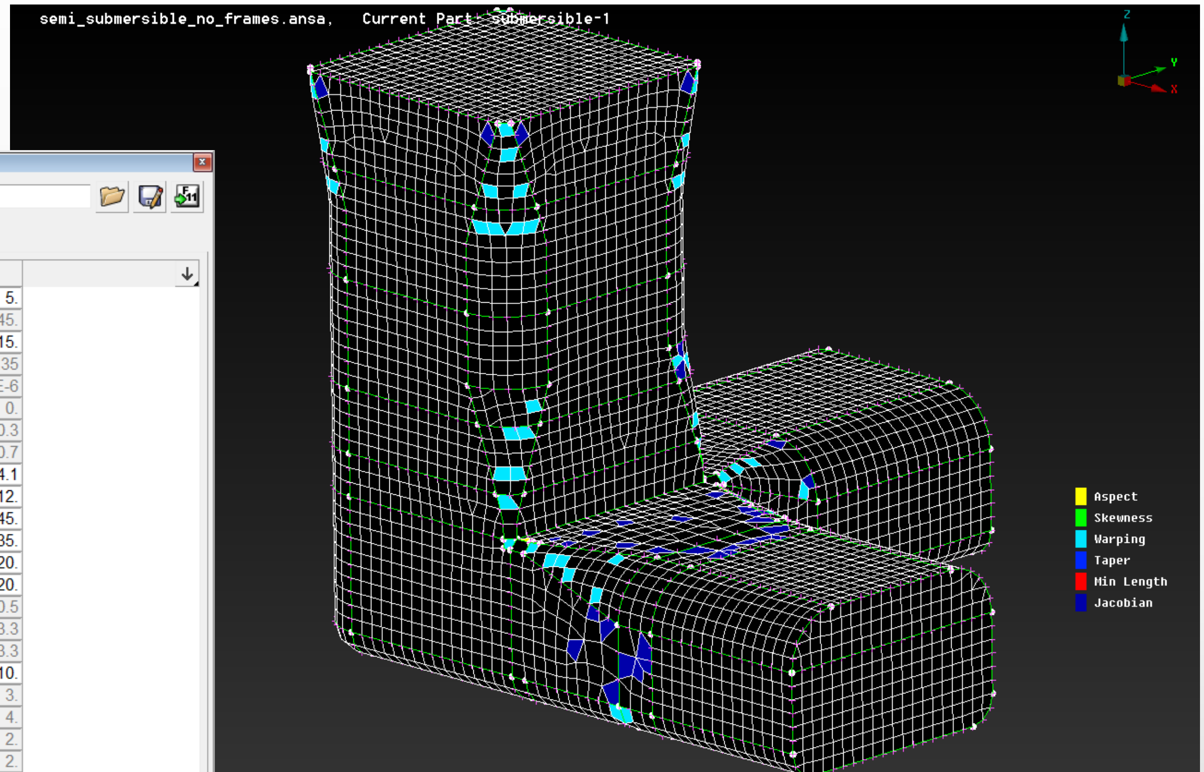
Fully automated through Batch Mesh

Shell Meshing

Numerous quality criteria



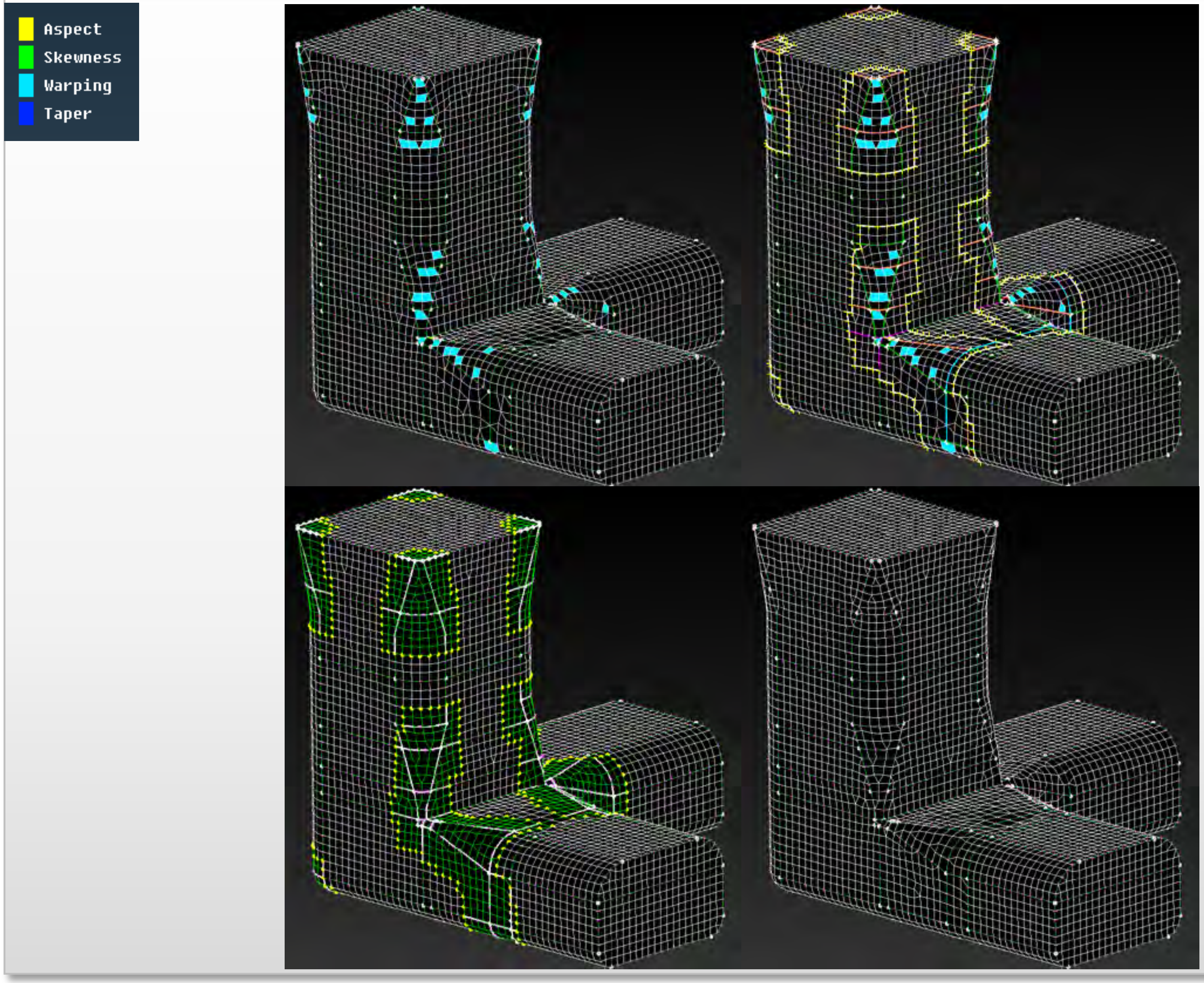
Criteria	Calculation	Color	Failed
☑ aspect ratio	NASTRAN		5.
☐ skewness	PATRAN		45.
☑ warping	IDEAS		15.
☐ taper	PATRAN		0.35
☐ crash time step	LS-DYNA		1.E-6
☐ min height	QUADS & T		0.
☐ squish			0.3
☐ jacobian	ANSA		0.7
☑ min length			4.1
☑ max length			12.
☑ min angle quads	IDEAS		45.
☑ max angle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



Color-coding of violations

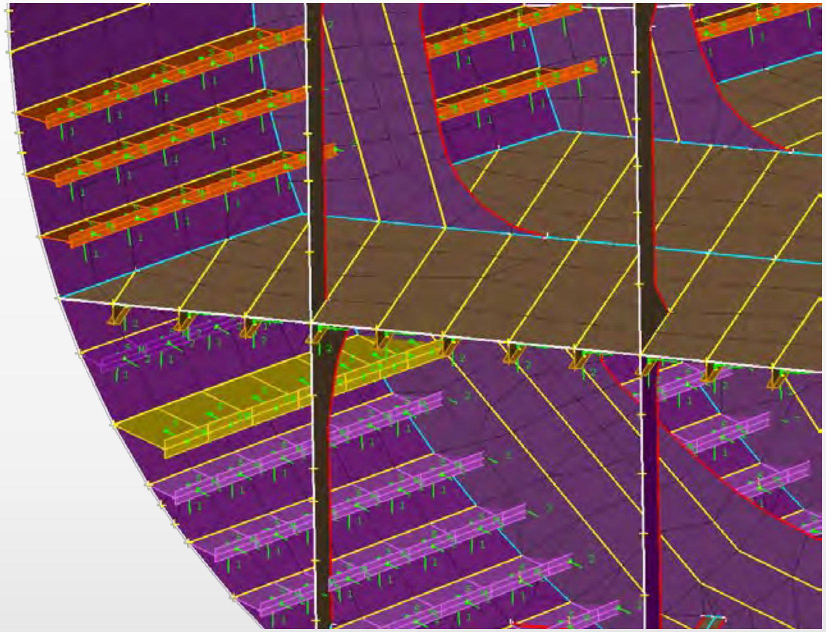
Shell Meshing

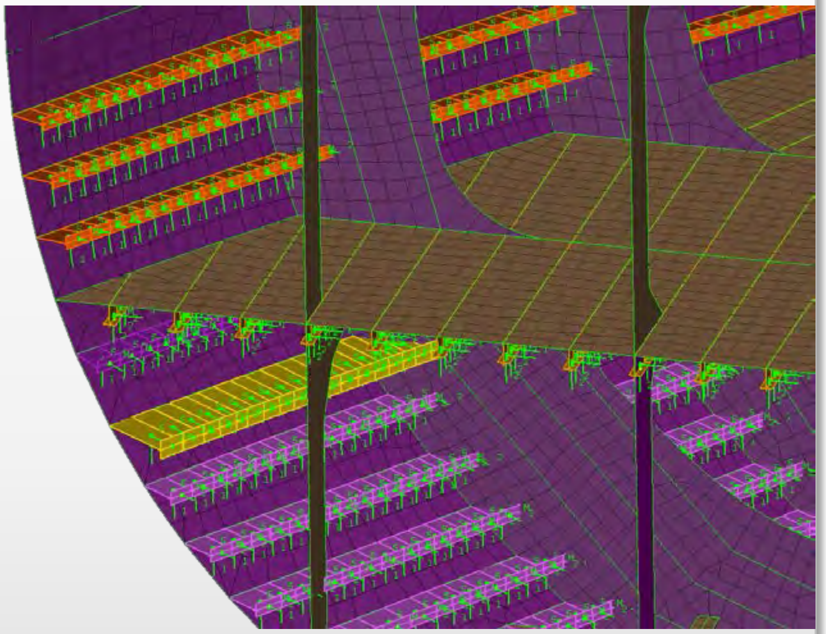
Automatic fix of quality violations



Reconstruct shells and beams

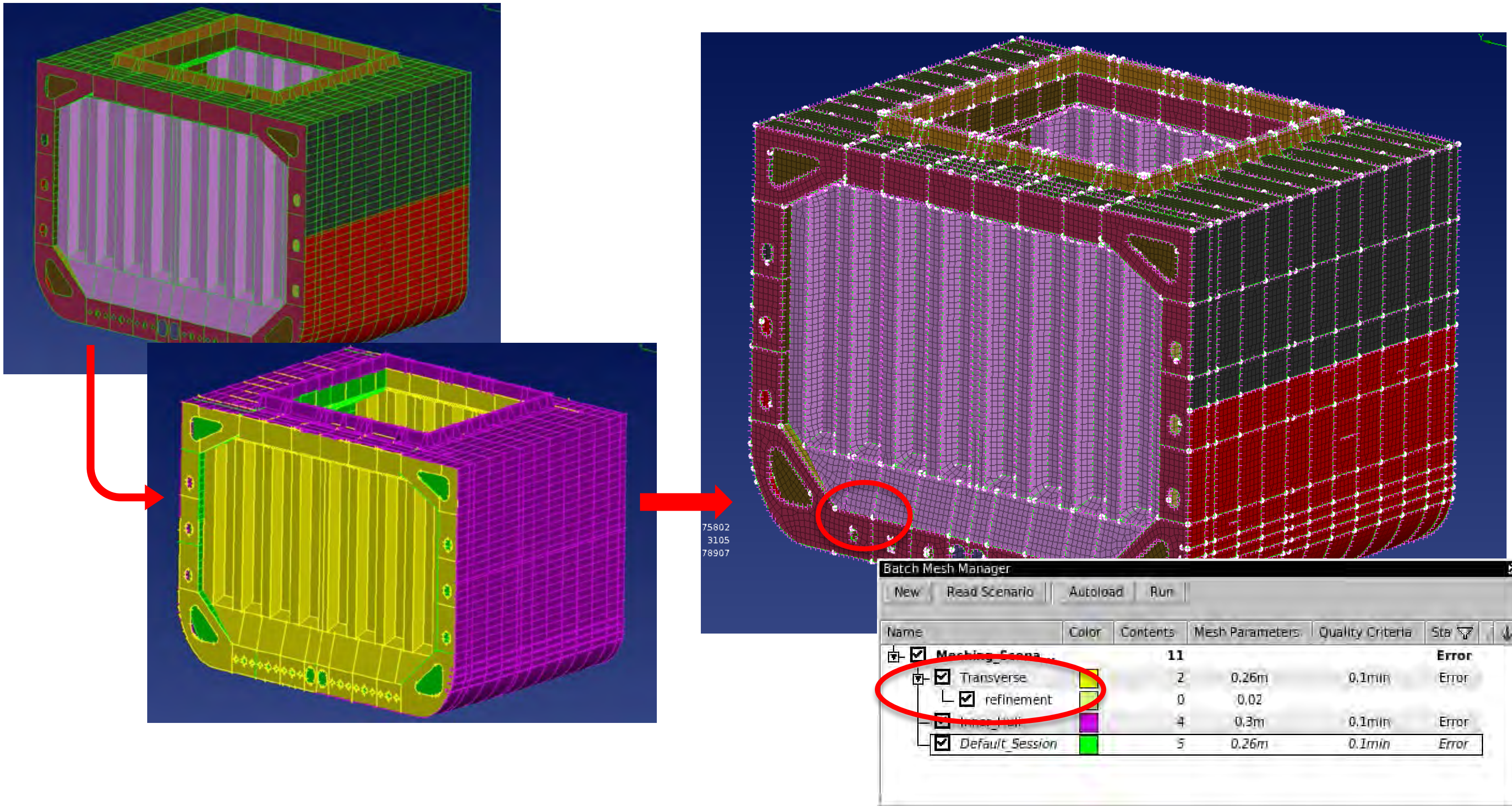
Reconstruct shells and the attached beams at the same time





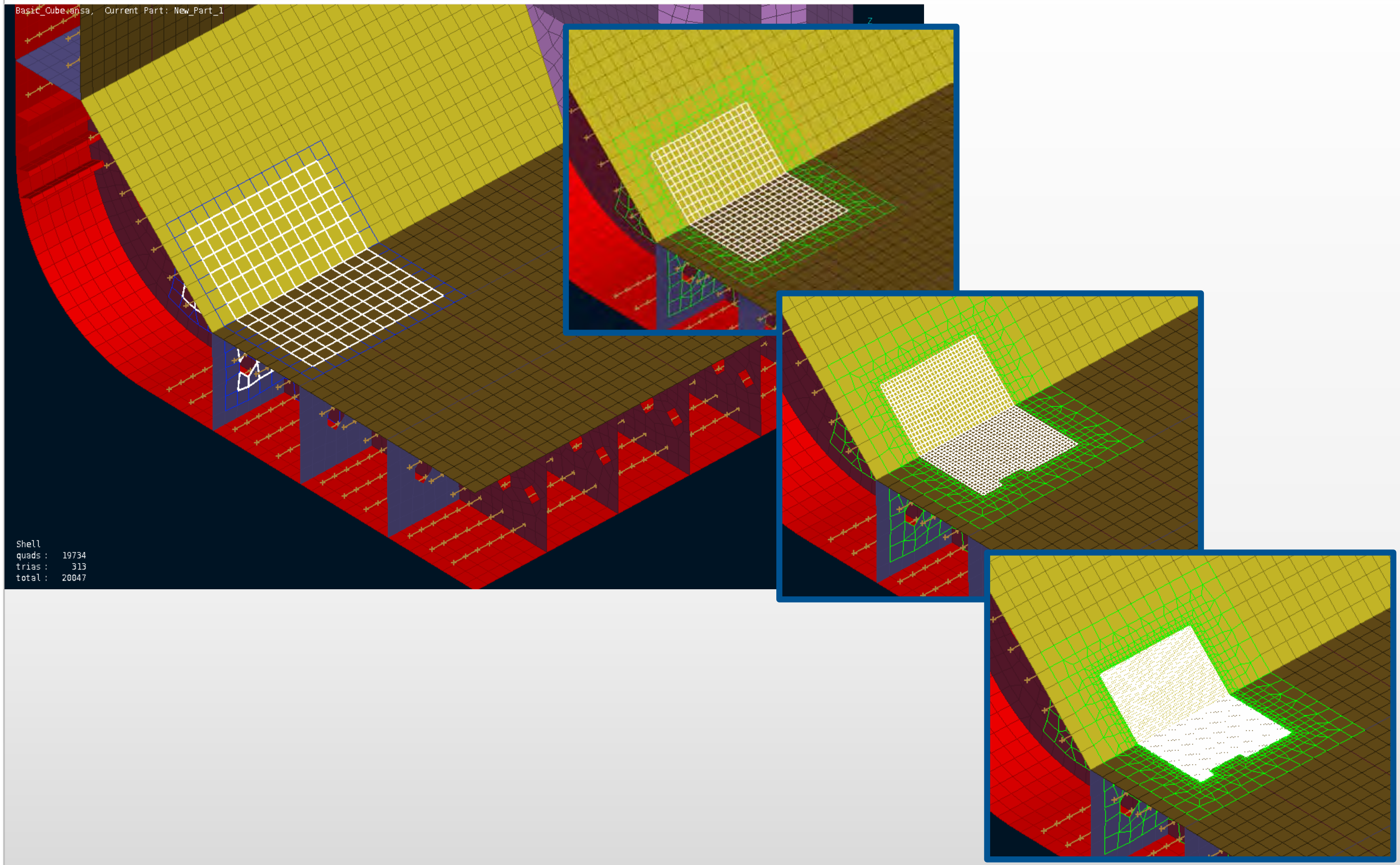
Batch meshing

- Definition of meshing parameters and quality criteria
- Features treatment and model simplification
- Automatic meshing and quality improvement

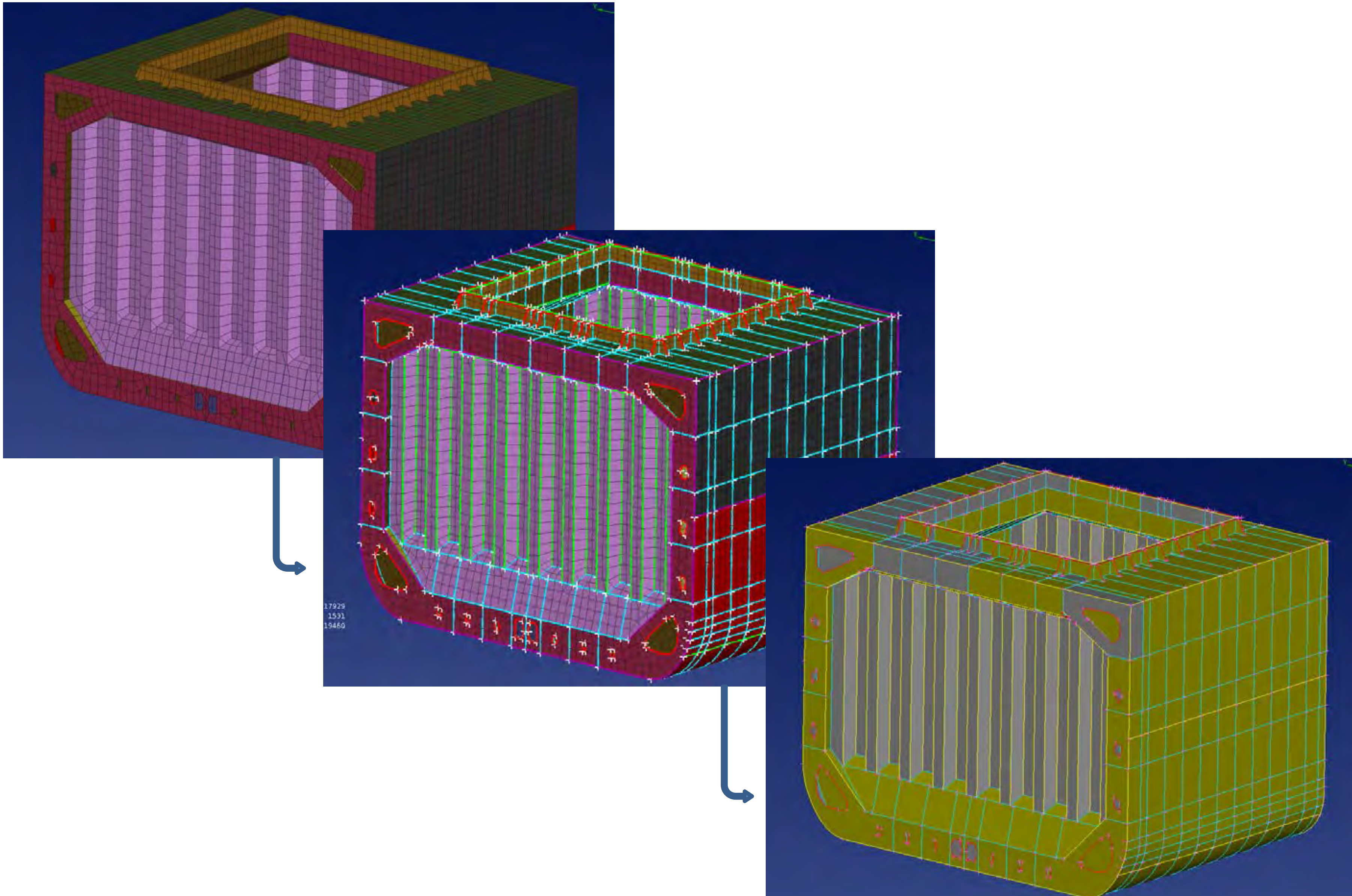


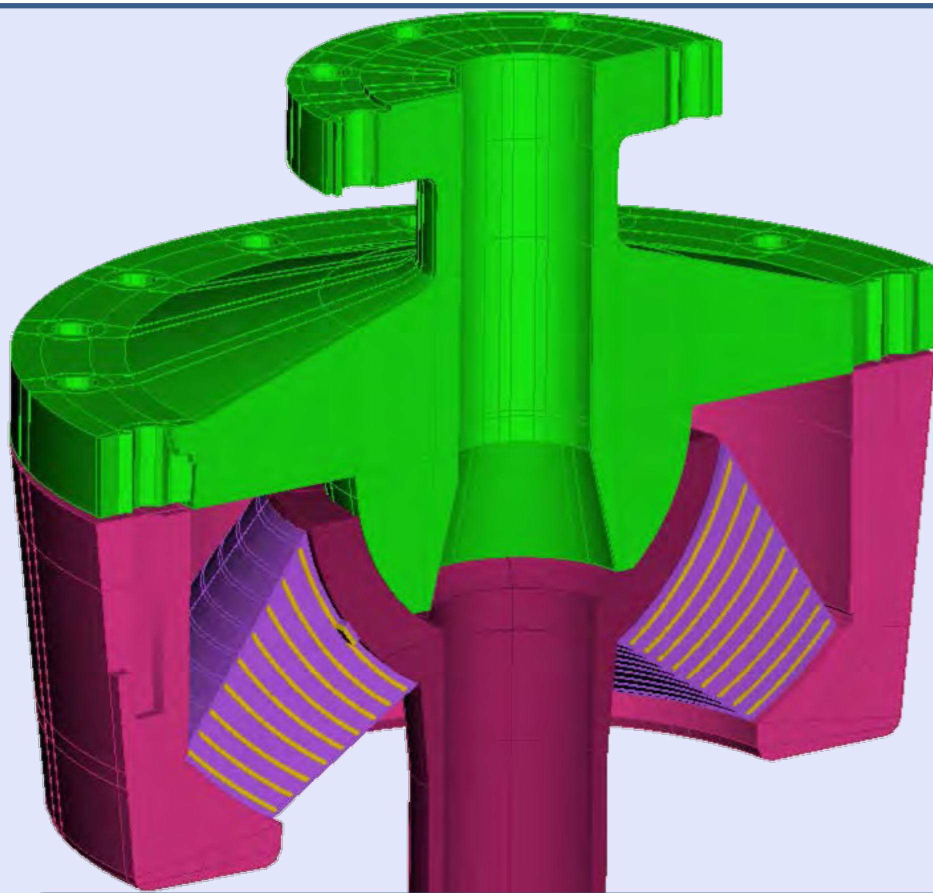
Local refinement

Local mesh refinement of geometry mesh and FE



Automatic definition of geometry from FE model

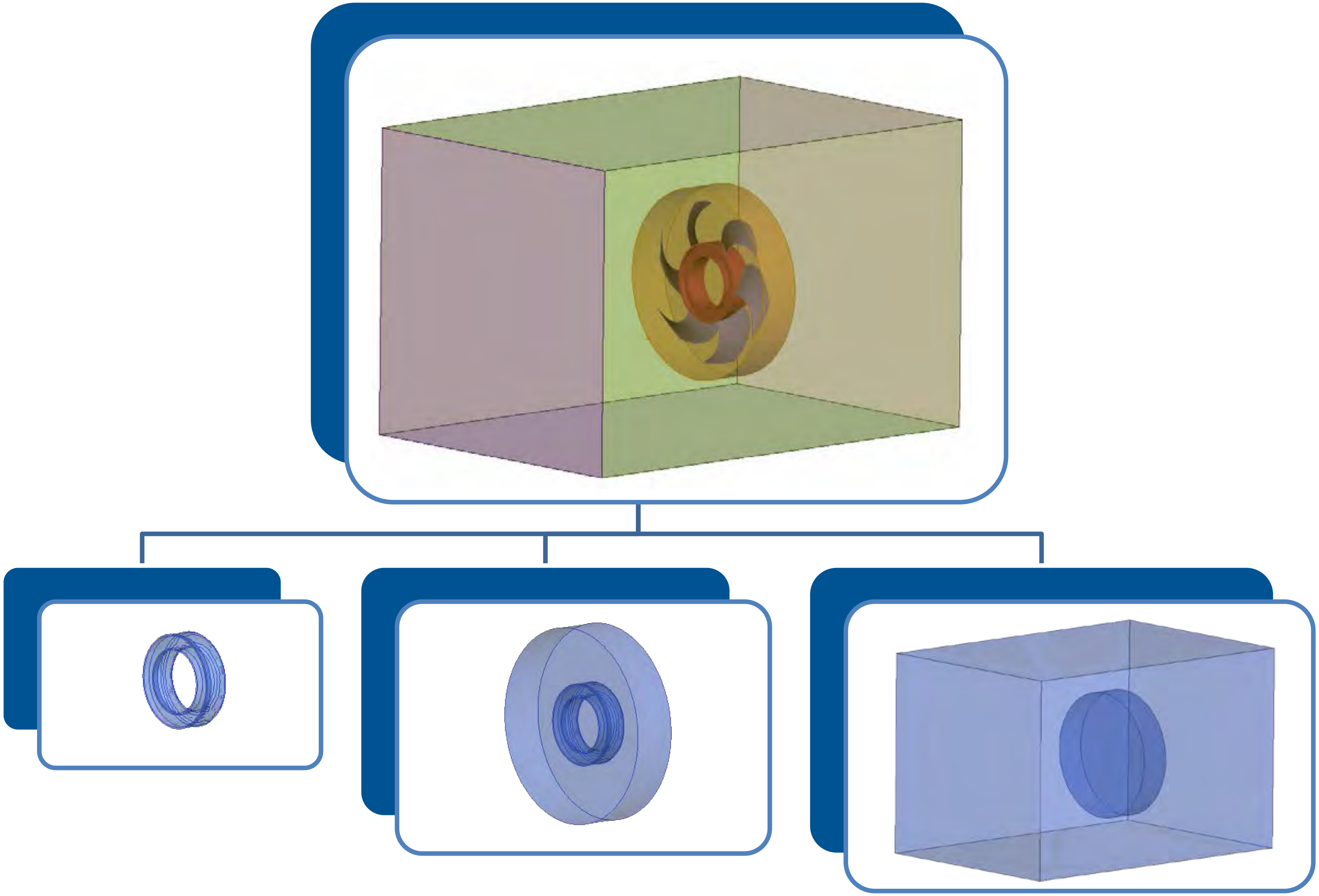




VOLUME MESH

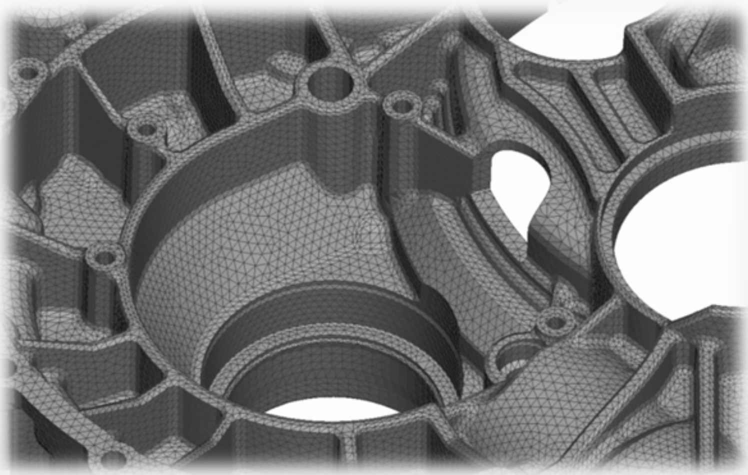
Volume Meshing

Automatic detection of all valid volumes and sub volumes

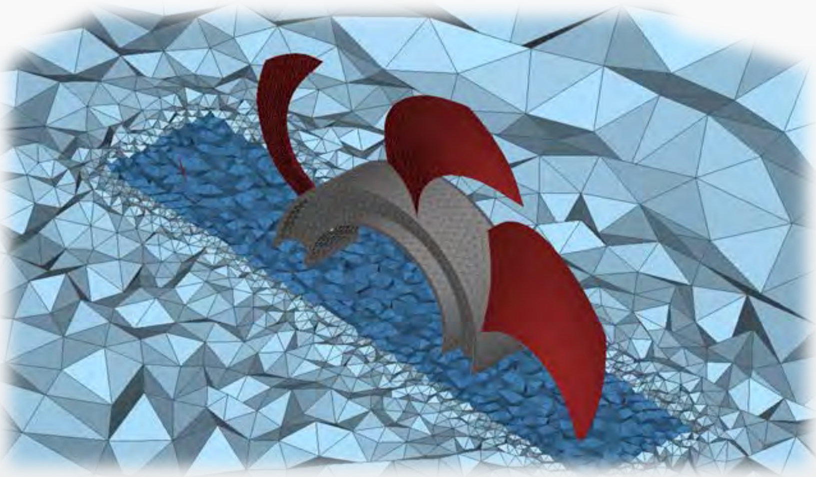


Volume Meshing

Tetrahedral Mesh



..for structural

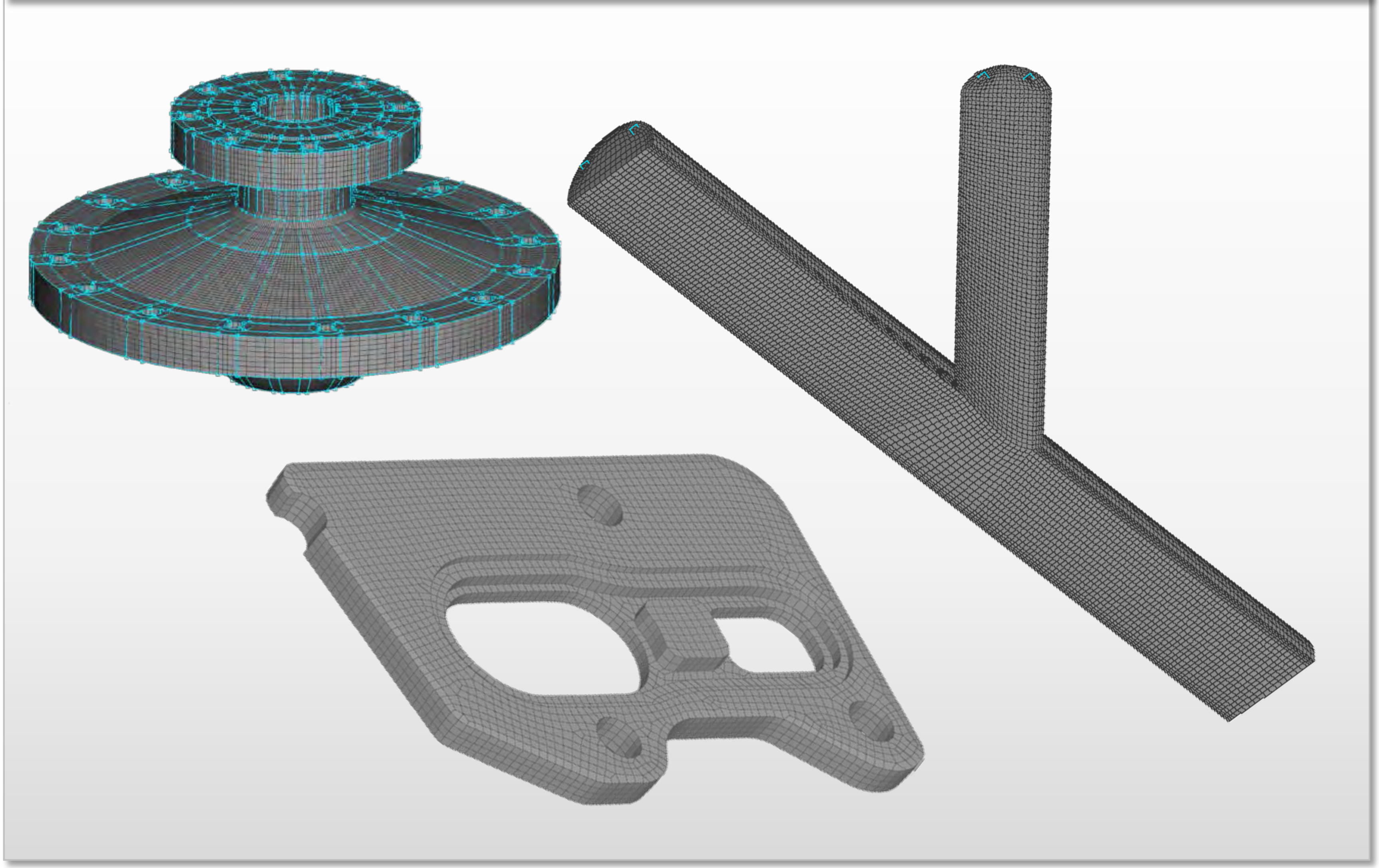


..for CFD

Fully automated through Batch Mesh

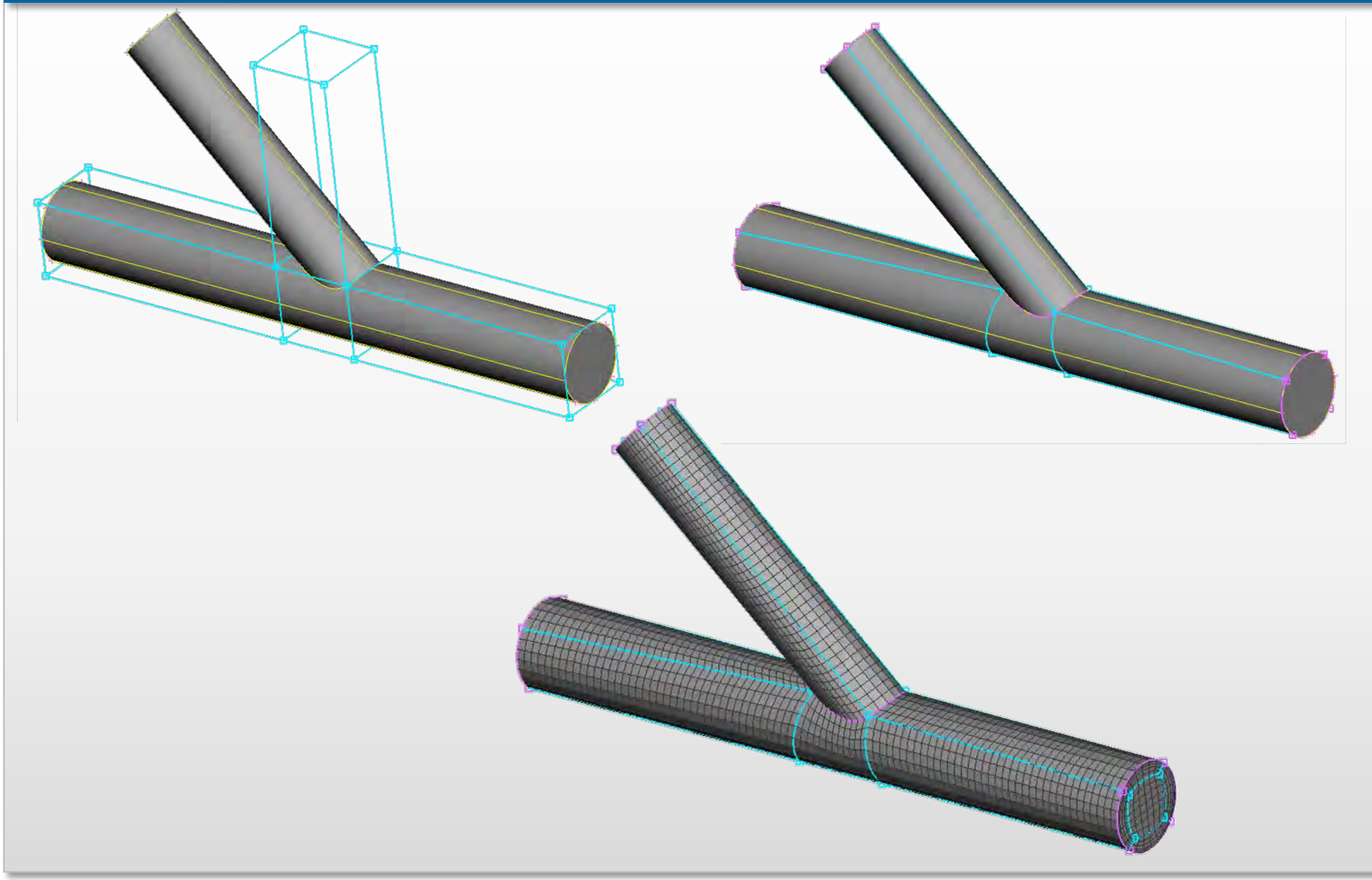
Volume Meshing

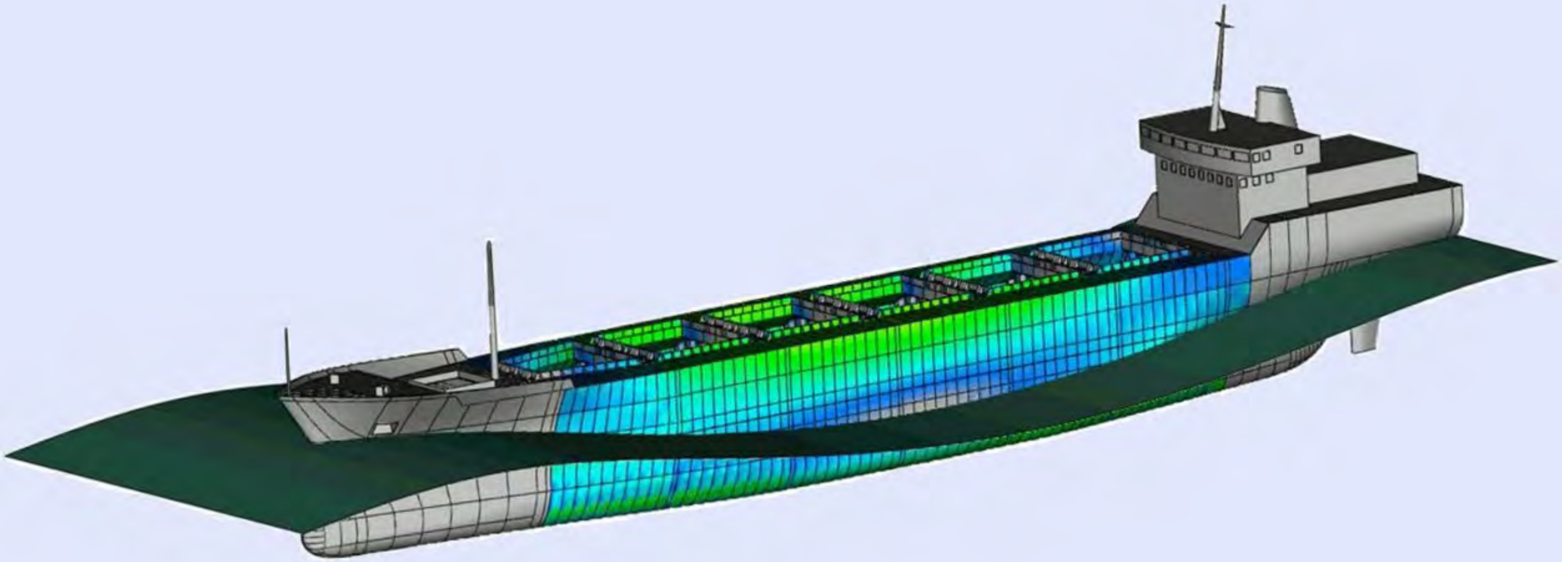
Hexa Meshing



HexaBlock meshing

Hexa meshing based on block structures associated to the model

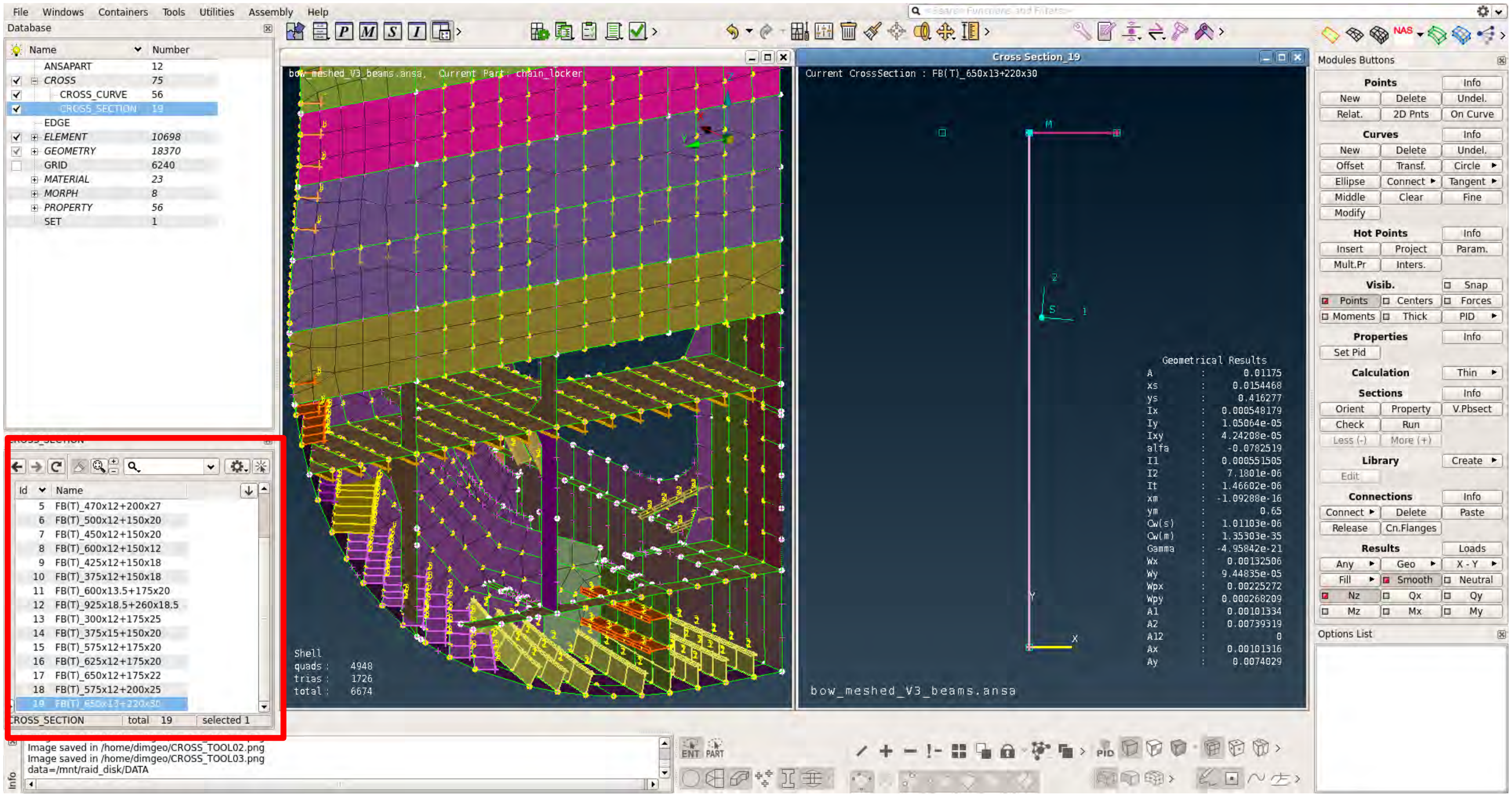




ANALYSIS TOOLS

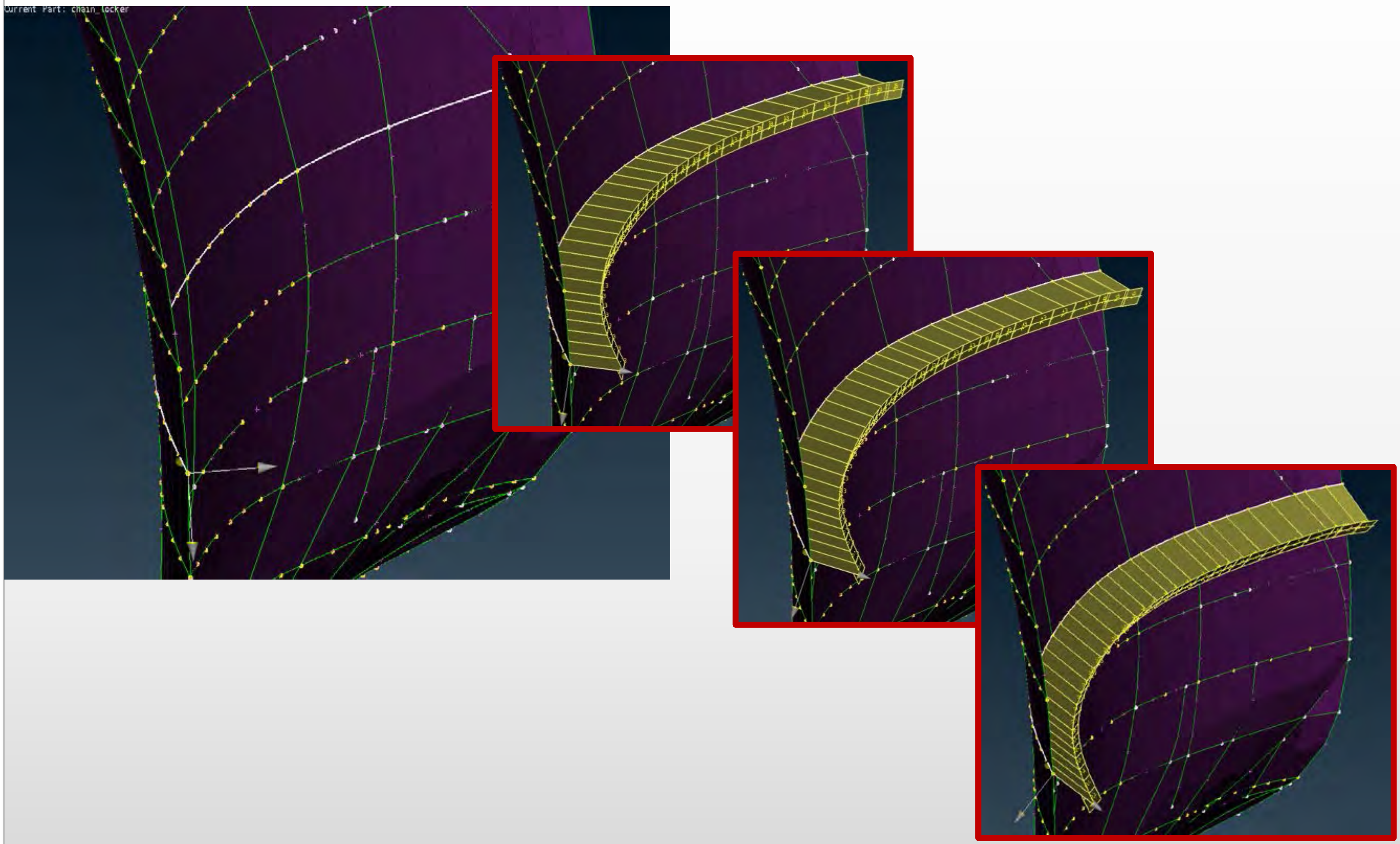
Stiffeners creation using beams

Creating database of cross sections of any shape



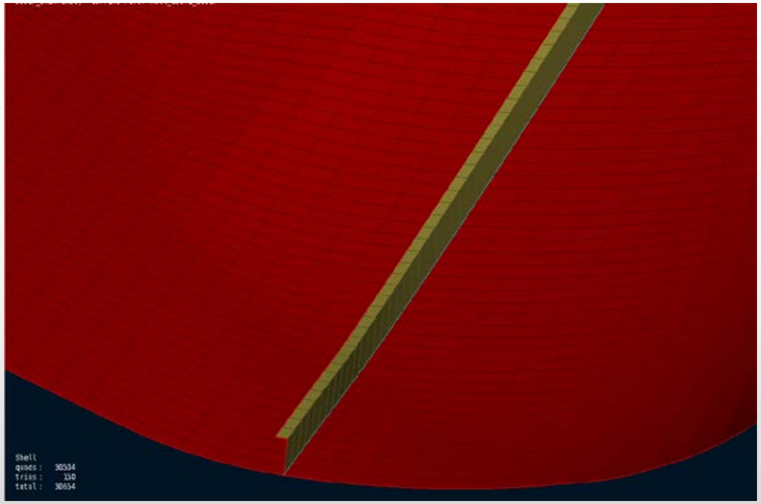
Stiffeners creation using beams

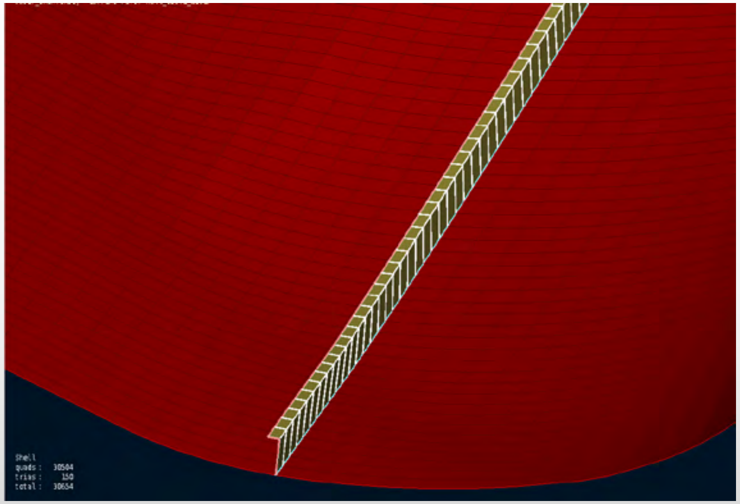
Creating stiffeners using beams with a selected cross section

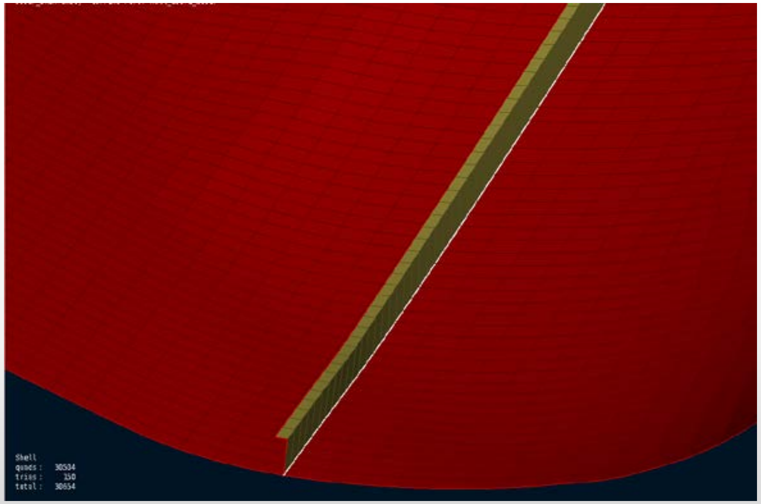


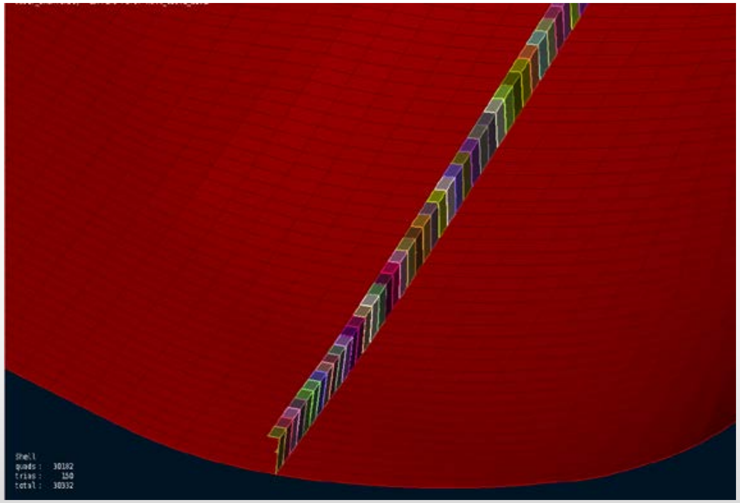
Stiffeners replacement with beams

Replacement of standard cross section reinforcements with beams



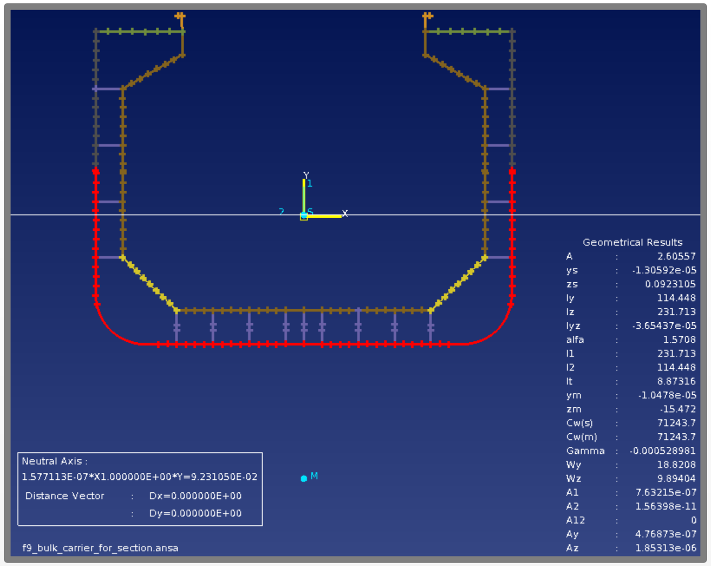


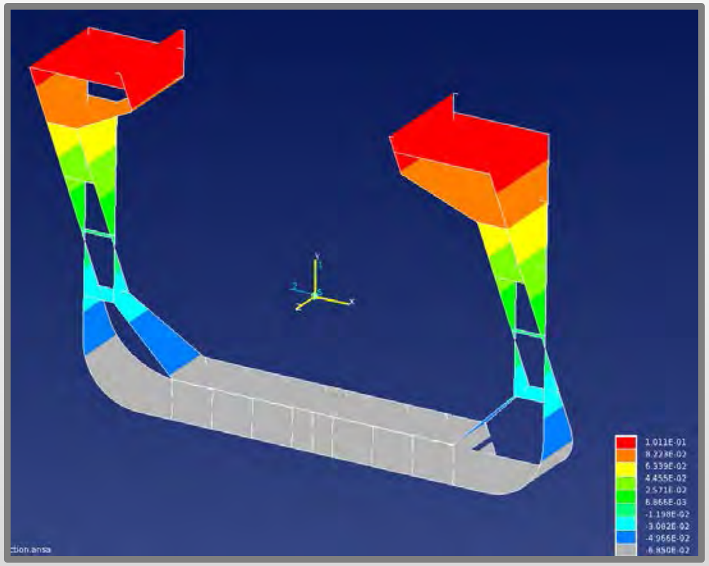


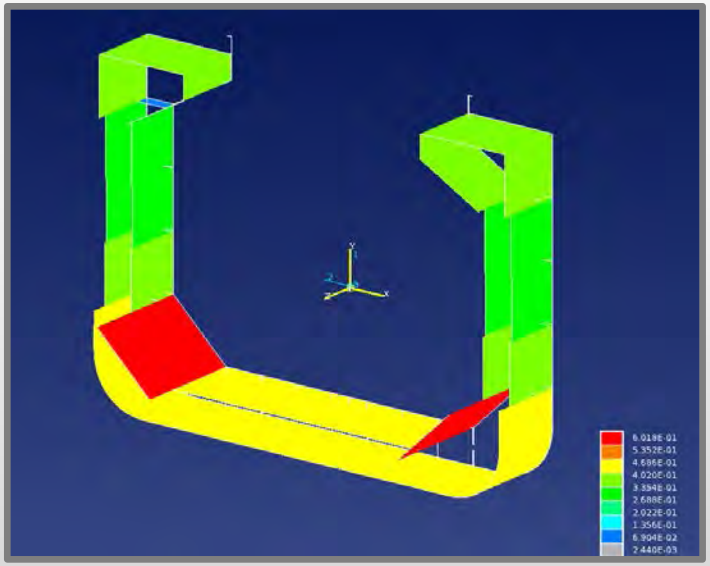


Calculating Cross Sections

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

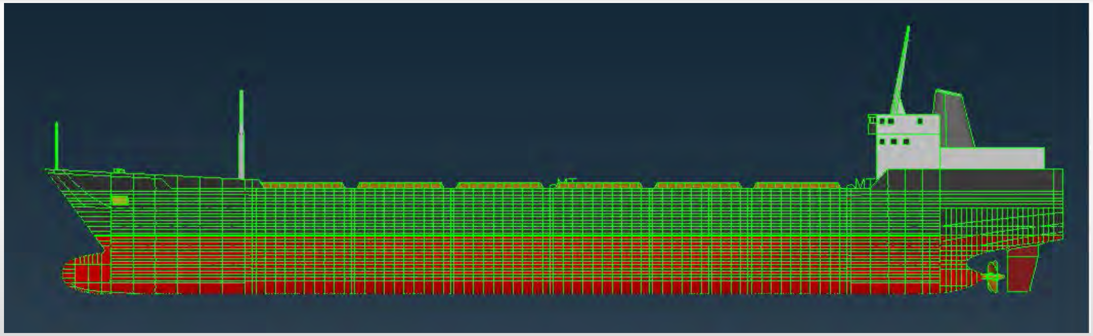


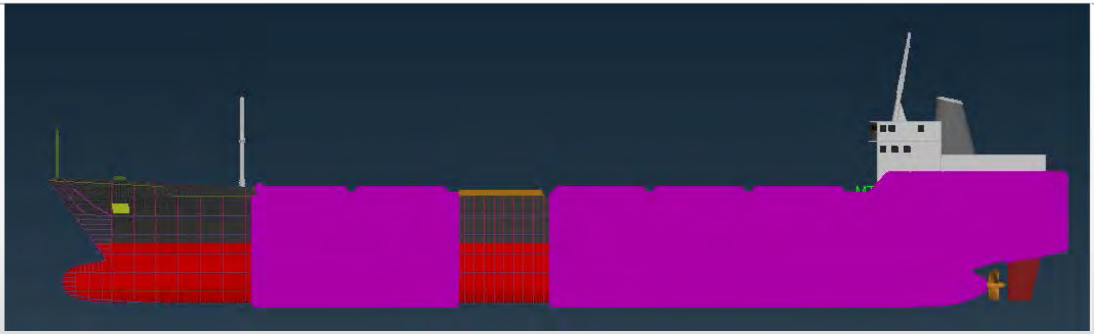


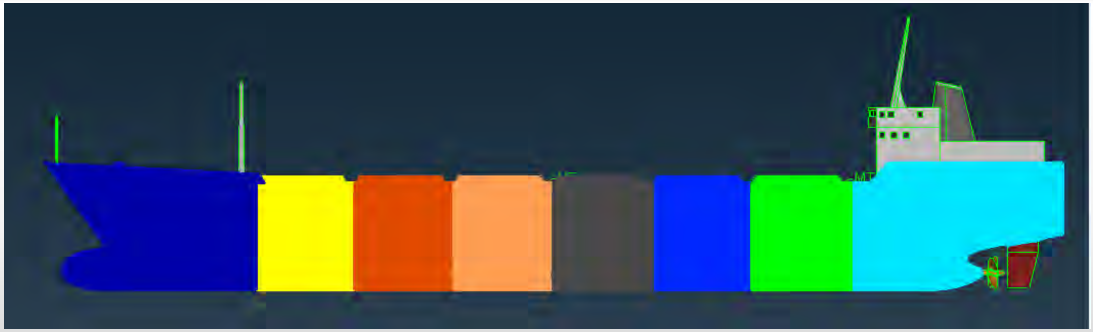


Mass distribution

Applying additional mass to model by fulfilling balance criteria

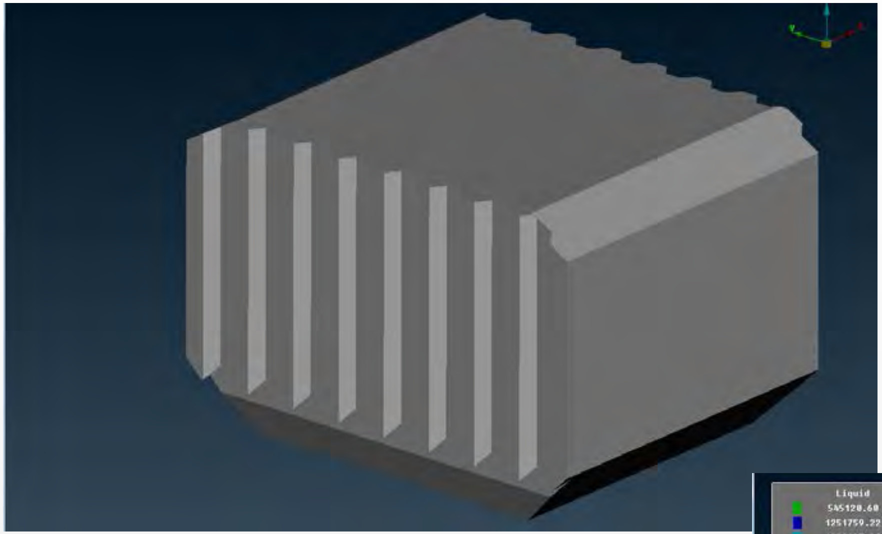


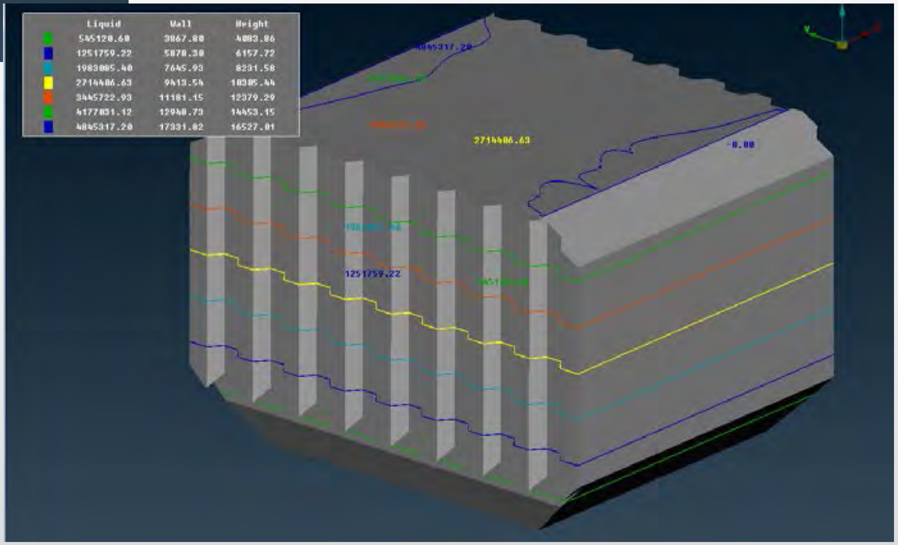




Tank Tool

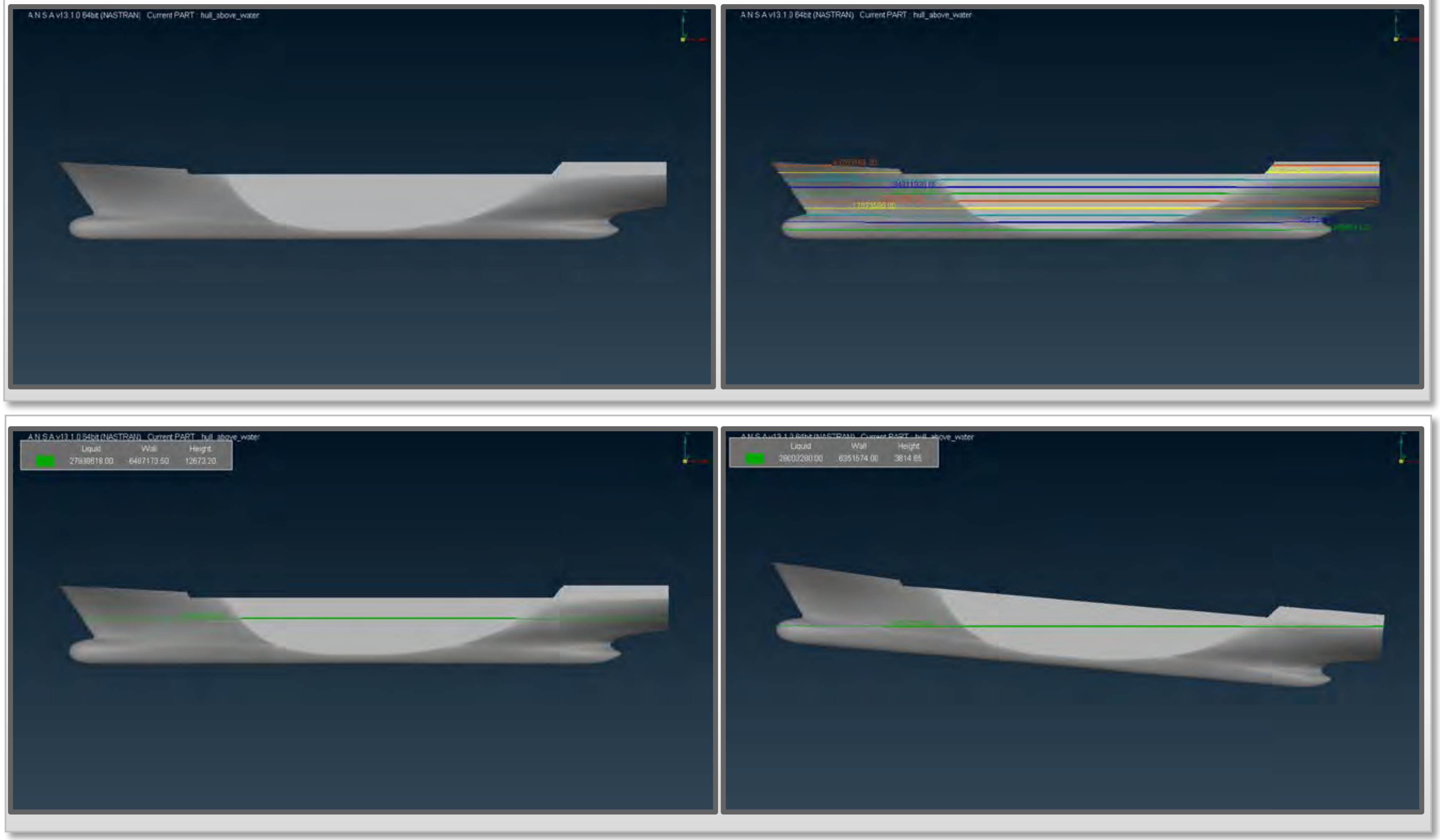
Calculating the level of cargo in a tank





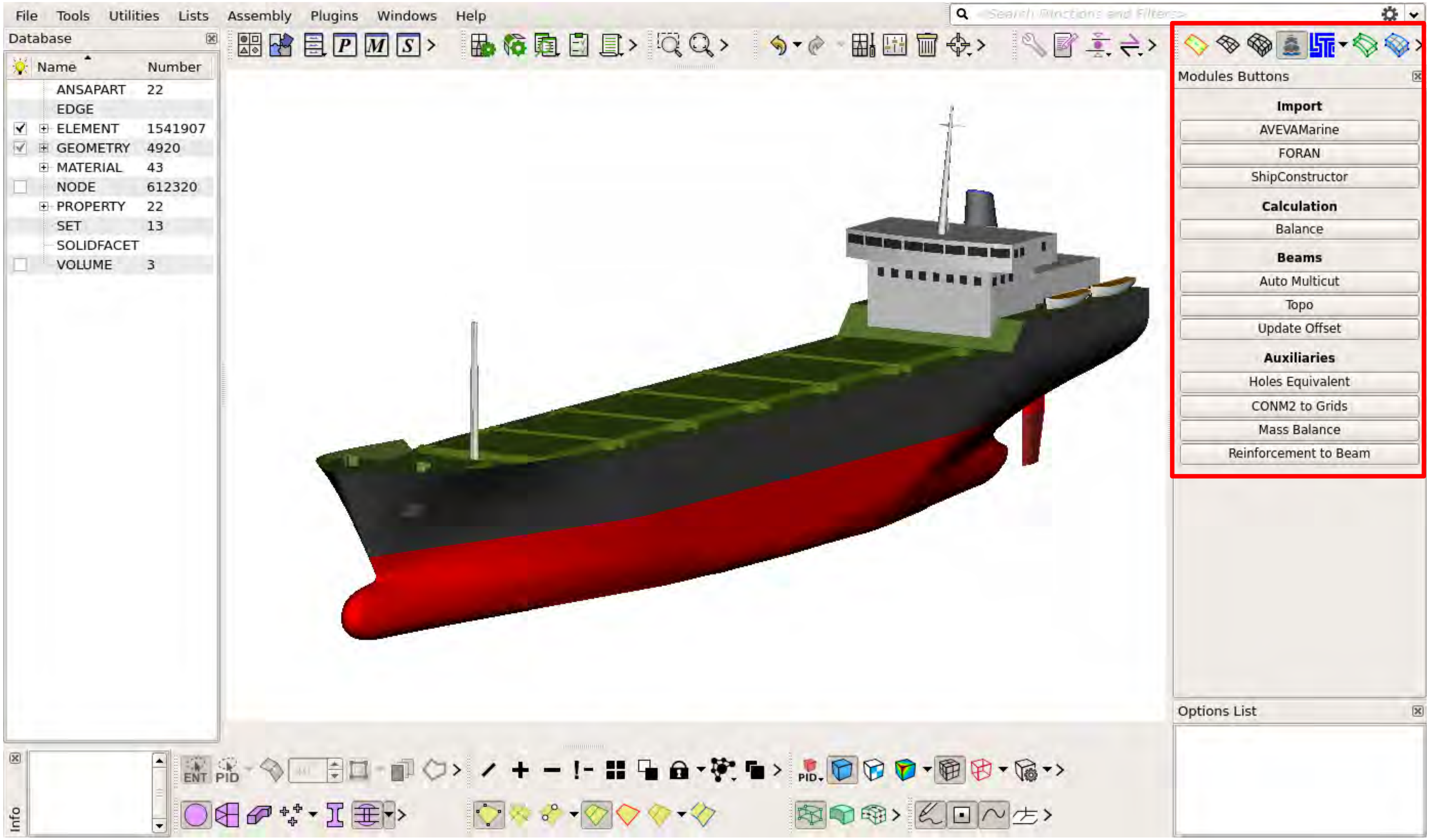
Waterline calculation

Calculating the waterline for variable ship loading



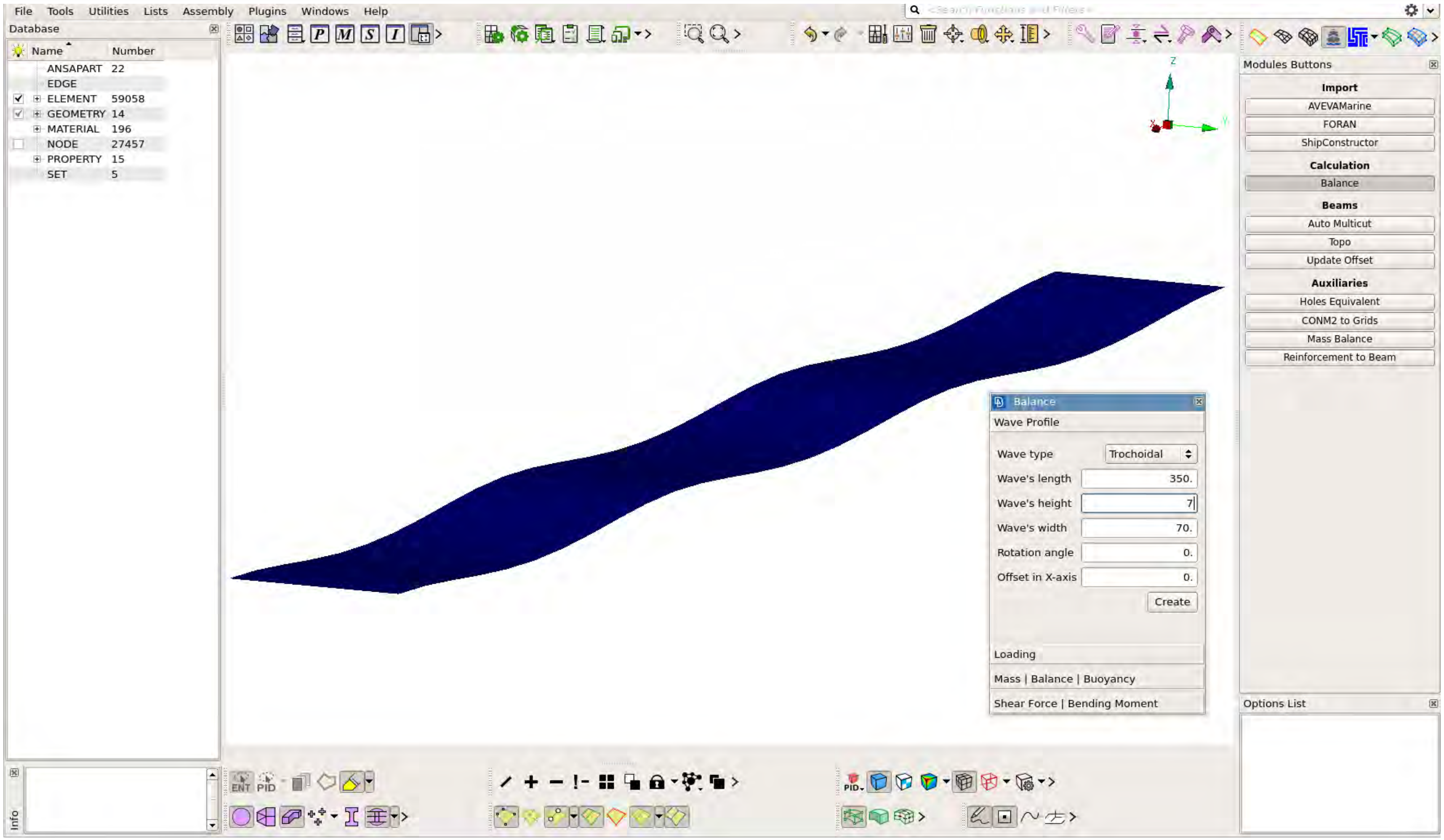
Marine & Offshore Tool

Dedicated tools for Marine & Offshore applications



Marine & Offshore Tool

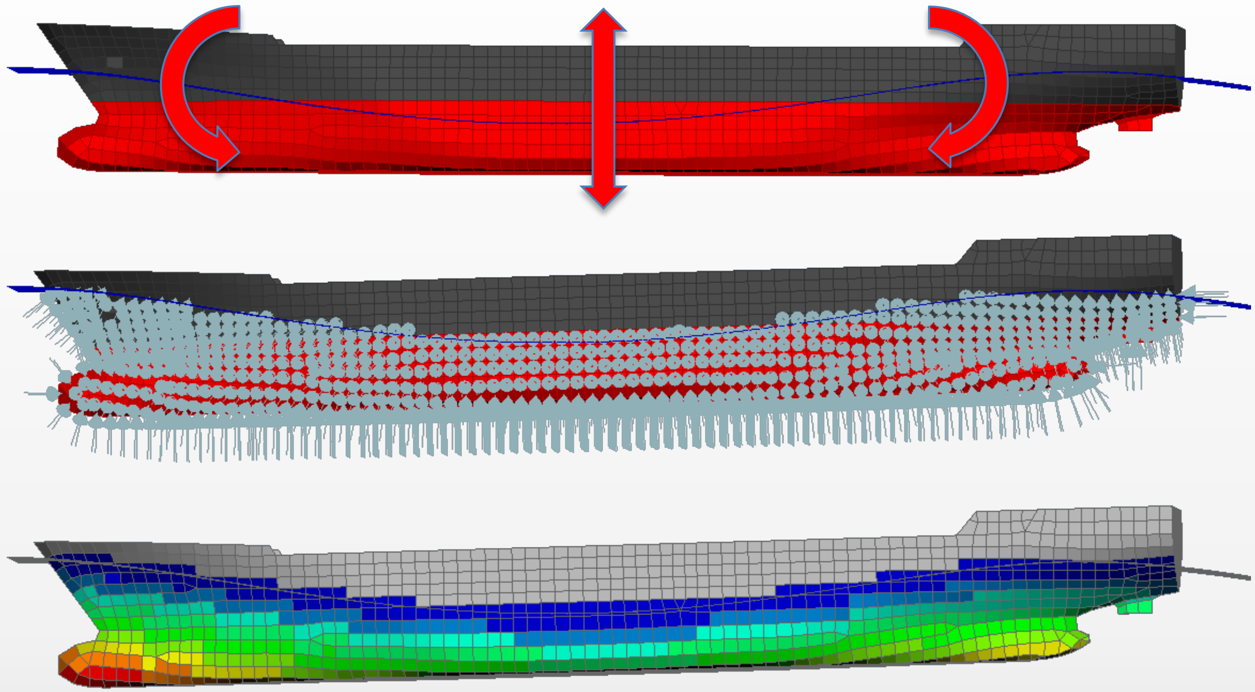
Wave profile creation



- ✓ Sinusoidal
- ✓ Trochoidal

Marine & Offshore Tool

Ship balance calculation

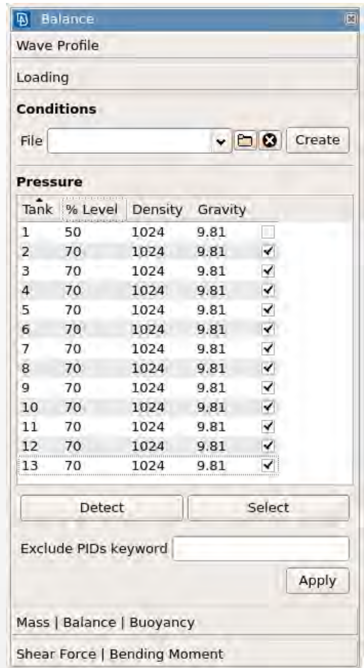


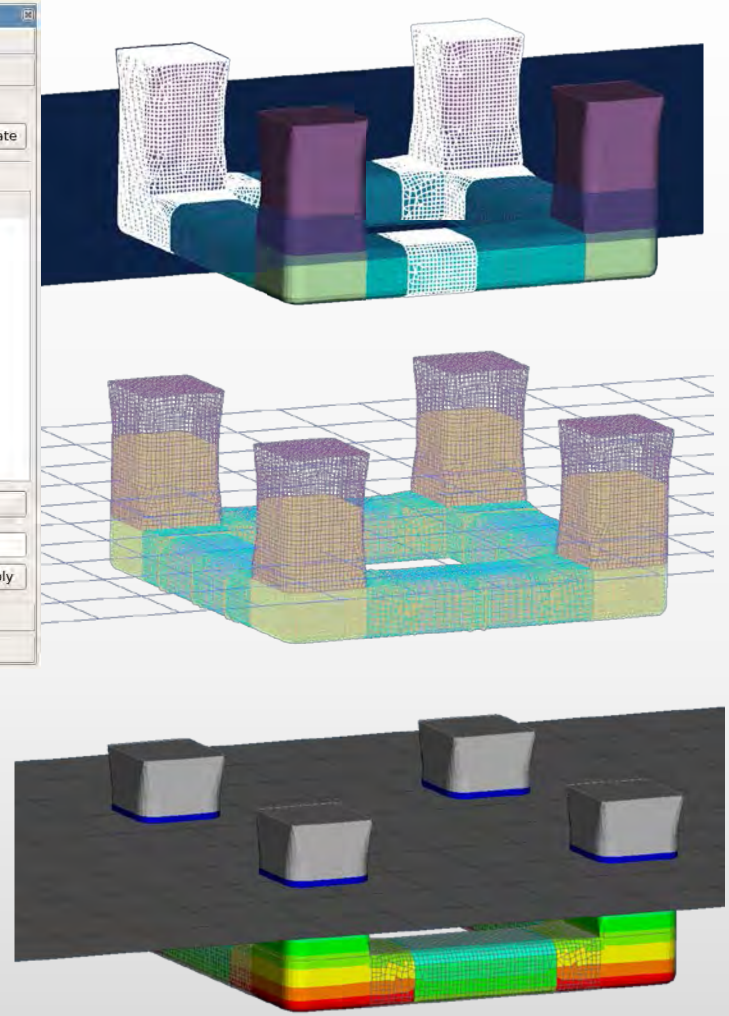
- **Balance through**
  - Heave
  - Pitch
  - Roll
- **Convergence criteria**
  - Weight – Buoyancy difference
  - C.O.G – C.O.B distance
- **Buoyancy assignment**

Marine & Offshore Tool

Pressure loads application

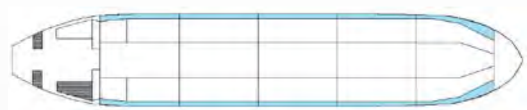
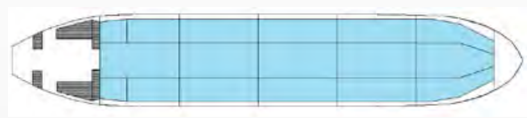
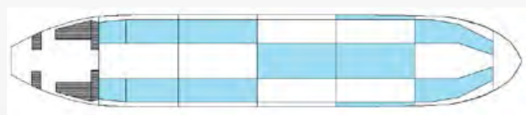
- Automatic recognition of tanks
- Definition of load properties
- Exclusion of areas from pressure application
- Pressure application on selected tanks

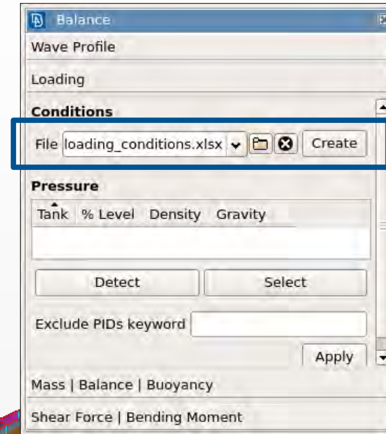


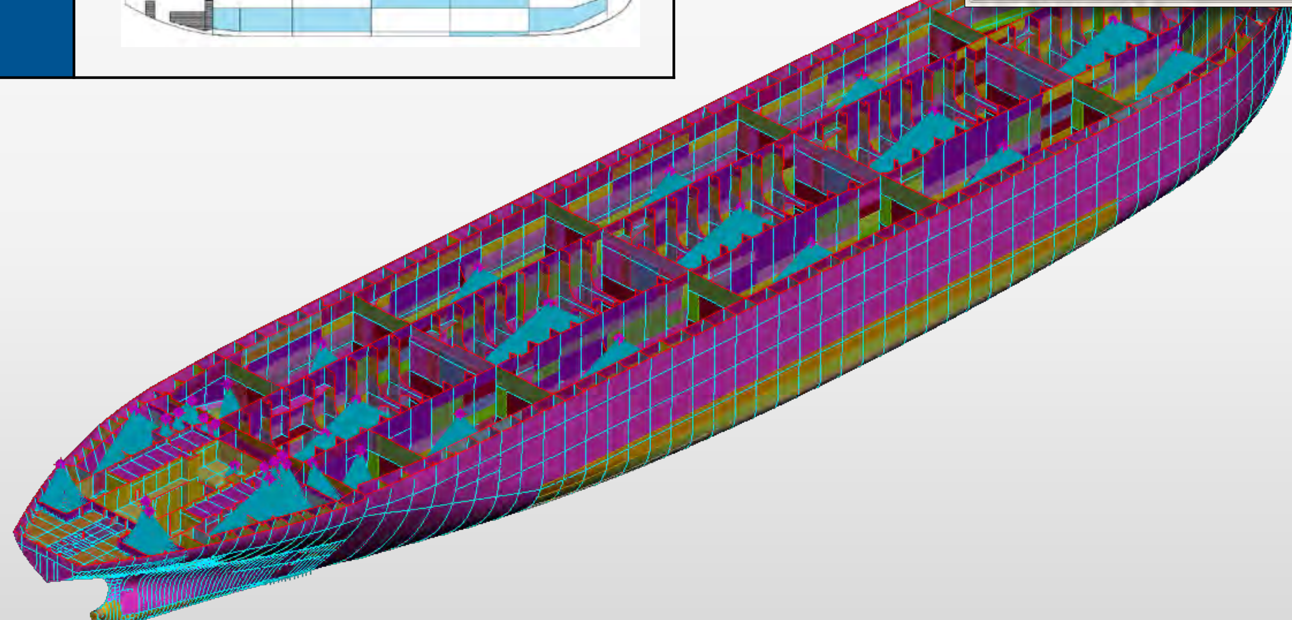


Marine & Offshore Tool

Loads application through mass

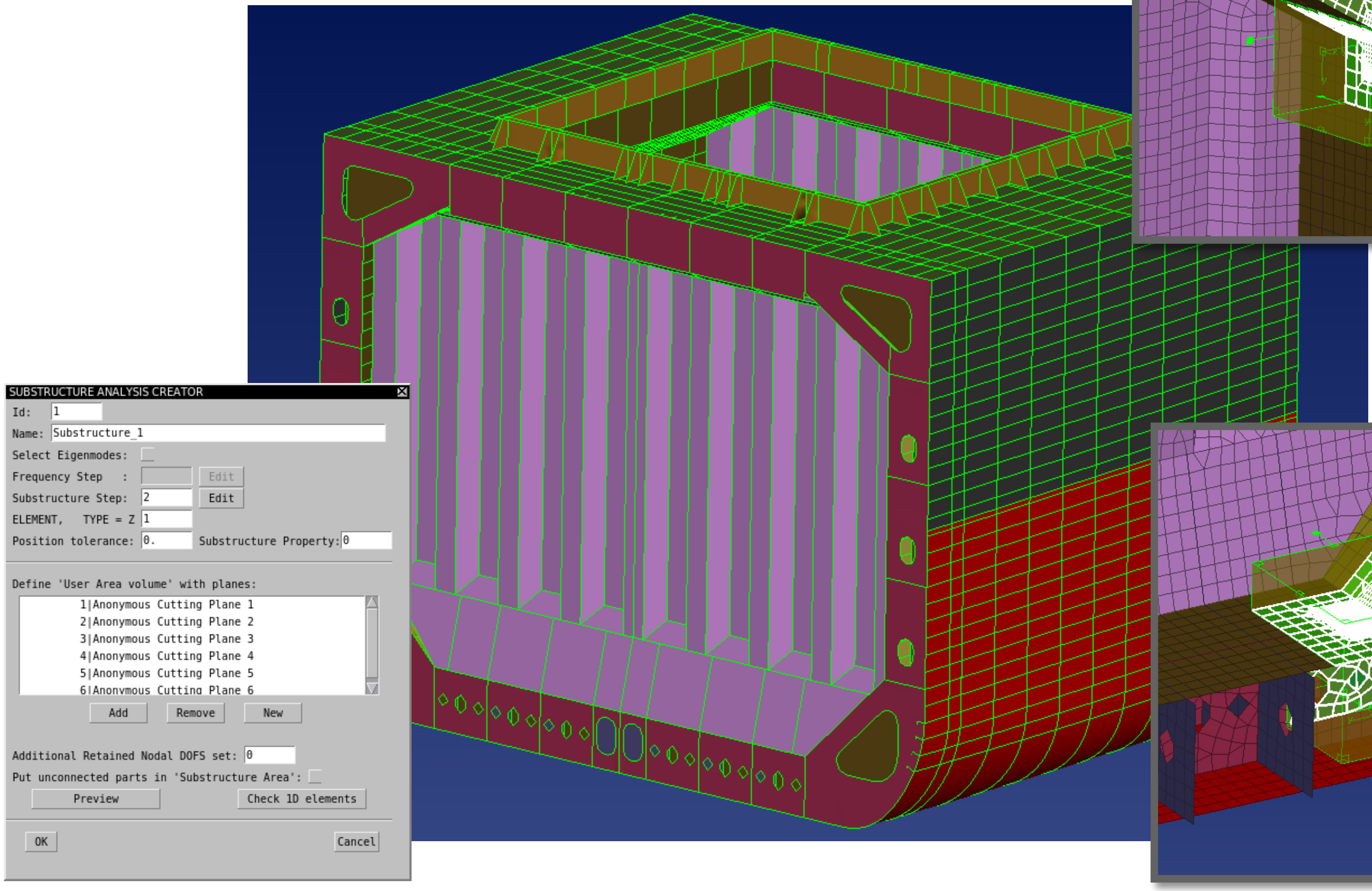
Ballast arrival condition (L.C. 1) **Displacement: 145647 tones** **Draft: 9.69 m** **Trim: 2.12 m**	
Full-load departure condition (L.C. 2) **Displacement: 364074 tones** **Draft: 22.52 m** **Trim: 0.11 m**	
Departure with partial load (L.C. 3) **Displacement: 229276 tones** **Draft: 14.78 m** **Trim: 3.05 m**	

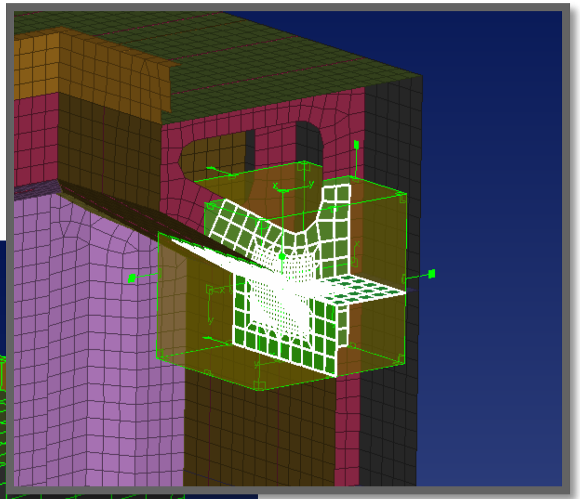


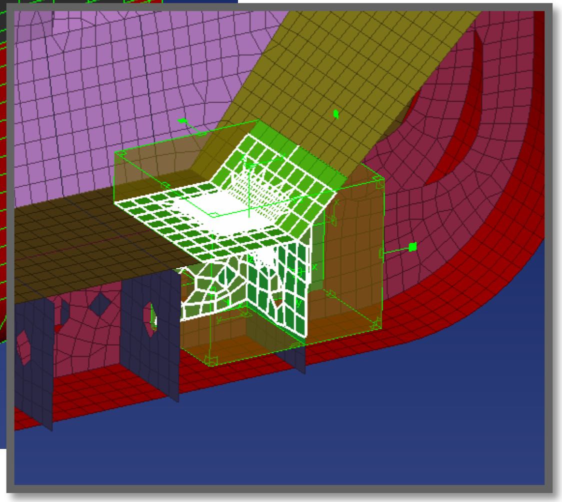


Sub-structuring and Sub-modeling

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

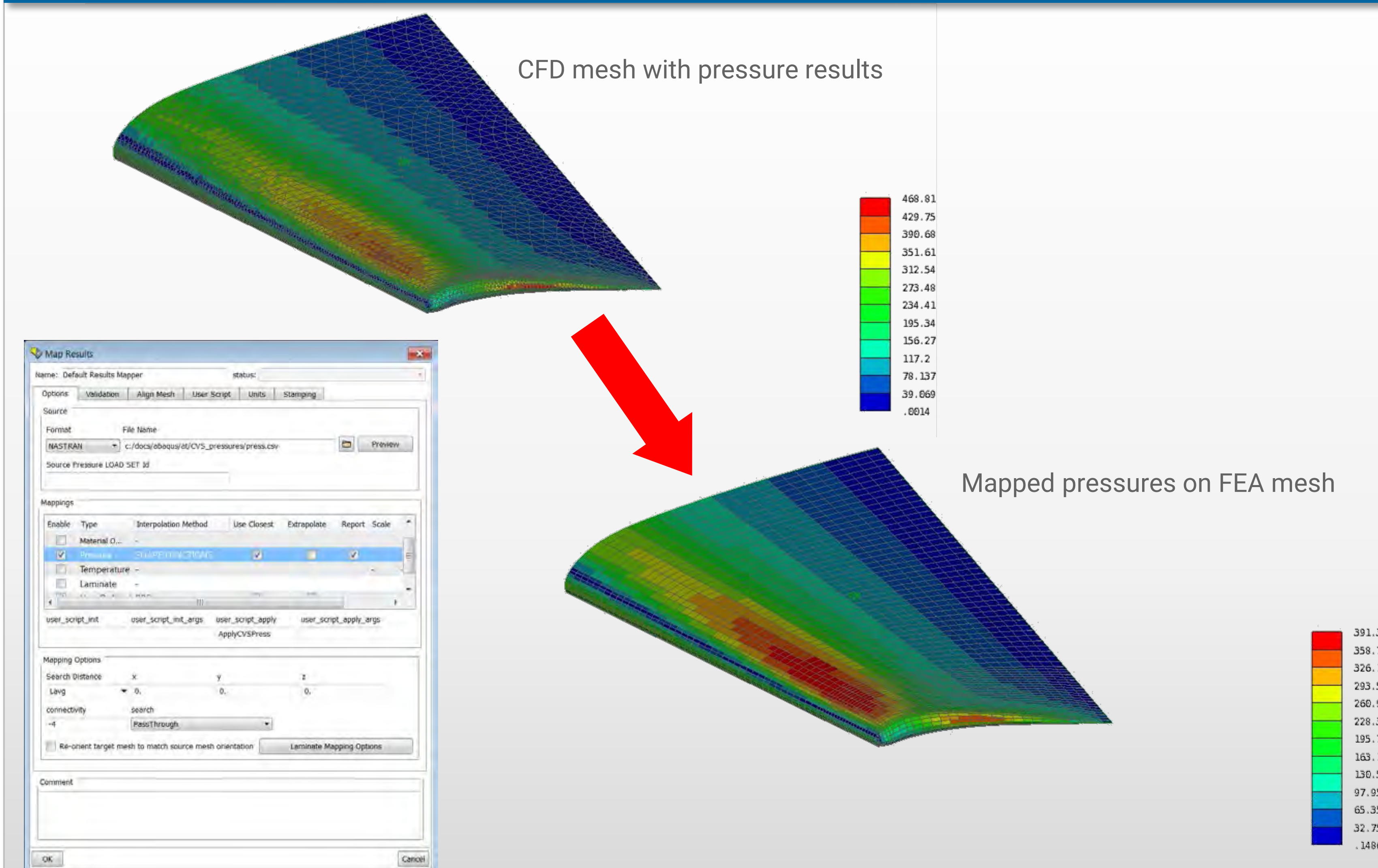


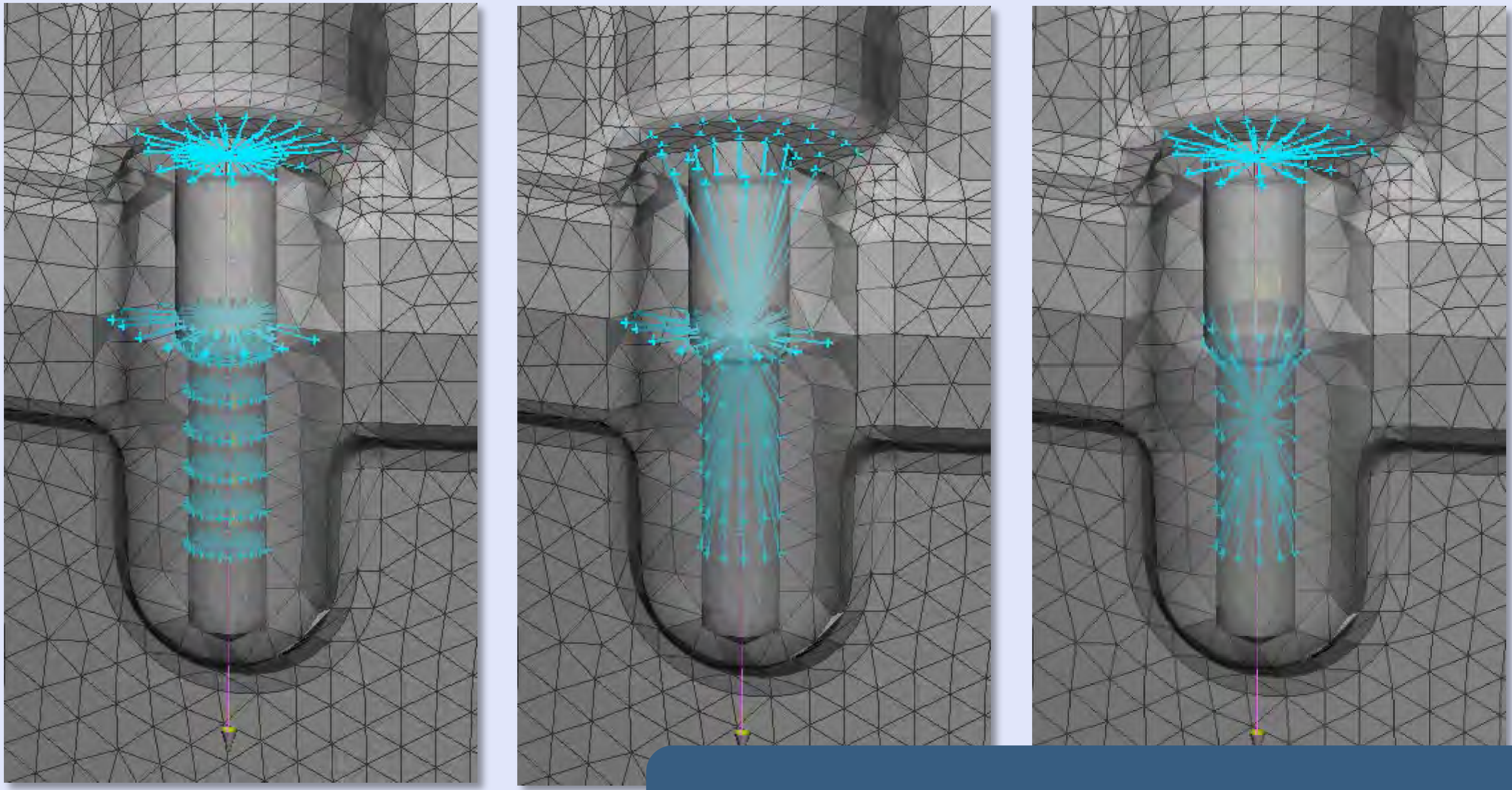




Mapping CFD results to FEA models

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

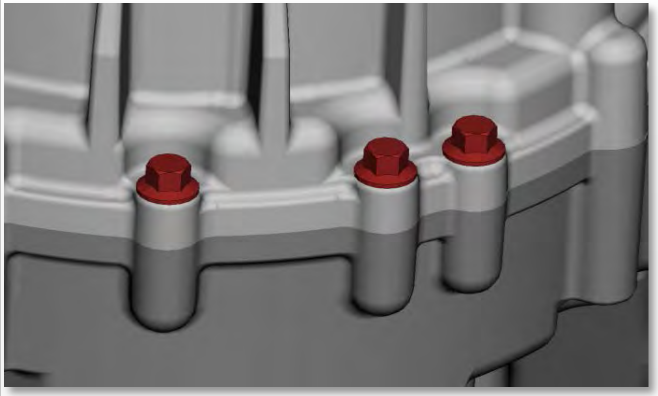


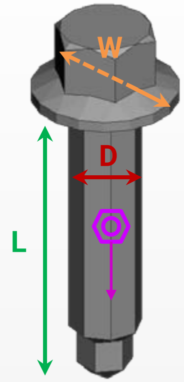


ASSEMBLY

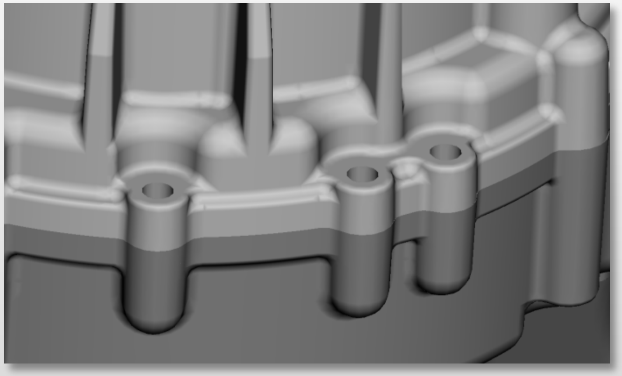
Connection Manager: Bolts

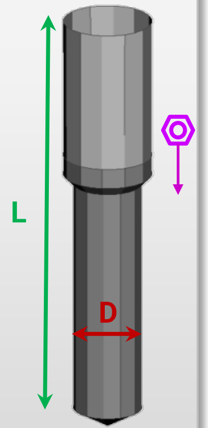
From bolt geometry



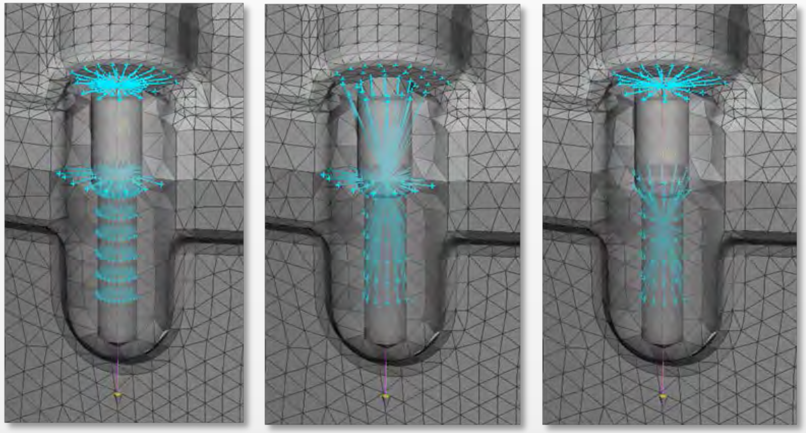


From tubes



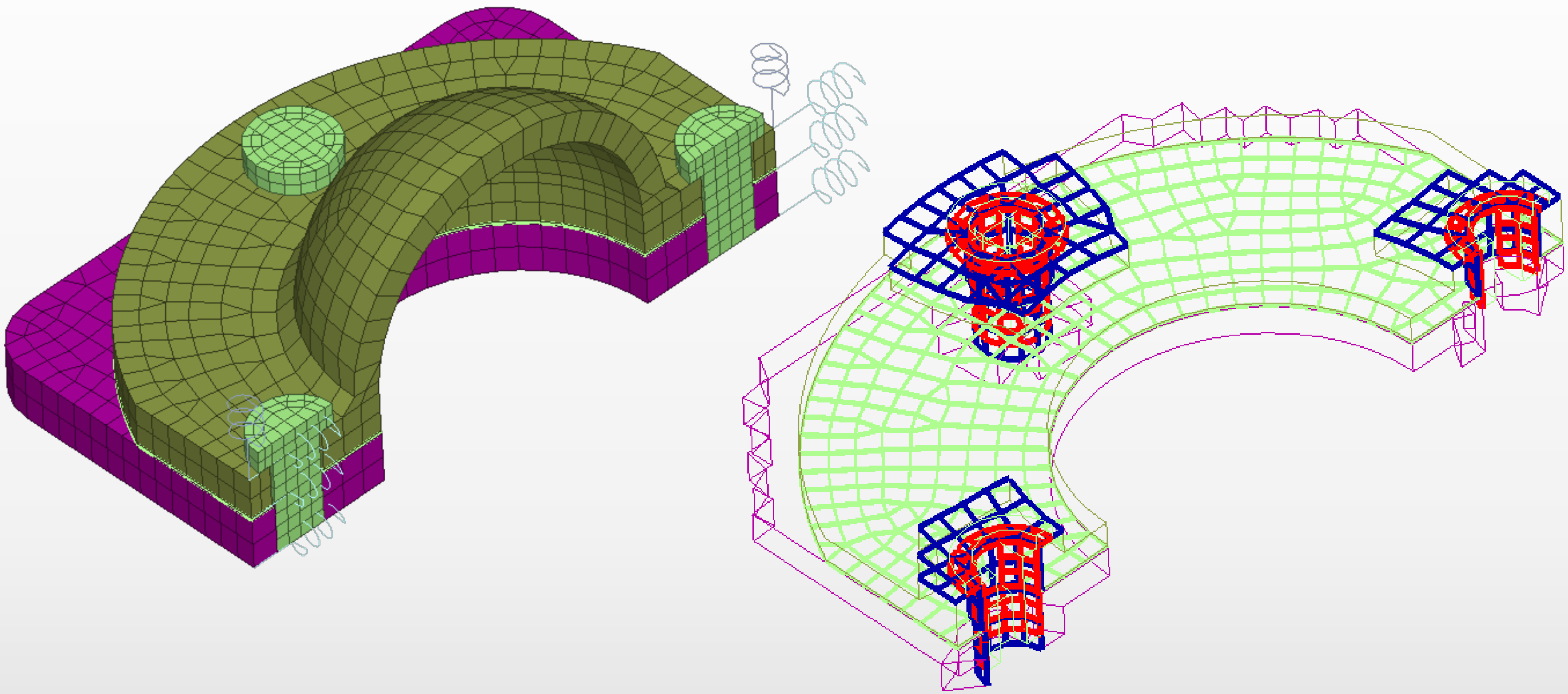


Numerous realization patterns



Automated Contact definition

Contact interfaces



Automatic detection of contact pairs based on proximity

Analysis Set-up

Material database

- **Loaded automatically during start-up**
- **Can load one MatDB per deck**
- **Materials update from MatDB:**
  - By material name
  - By material id

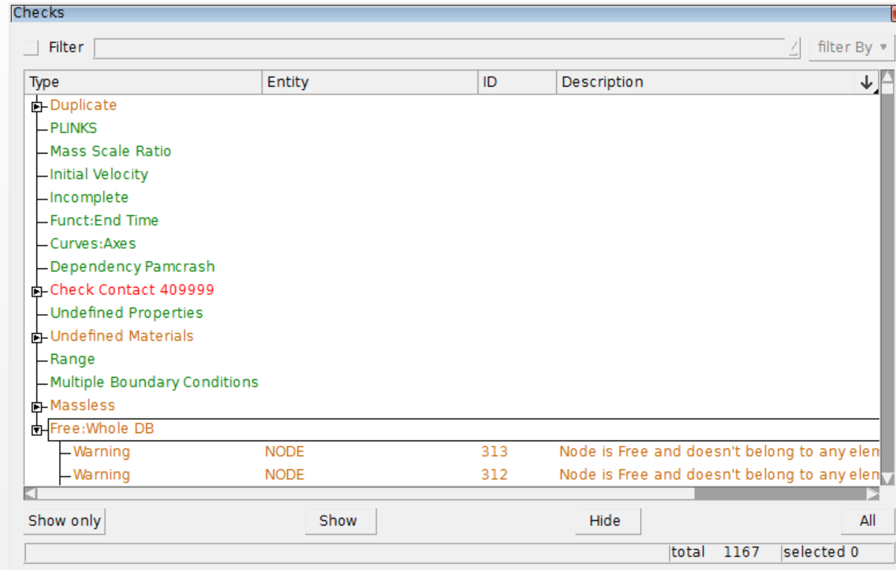
Material mapping

Automatic transfer of curves and tables between frequently used materials

Analysis Set-up

Model validation through build in Checks

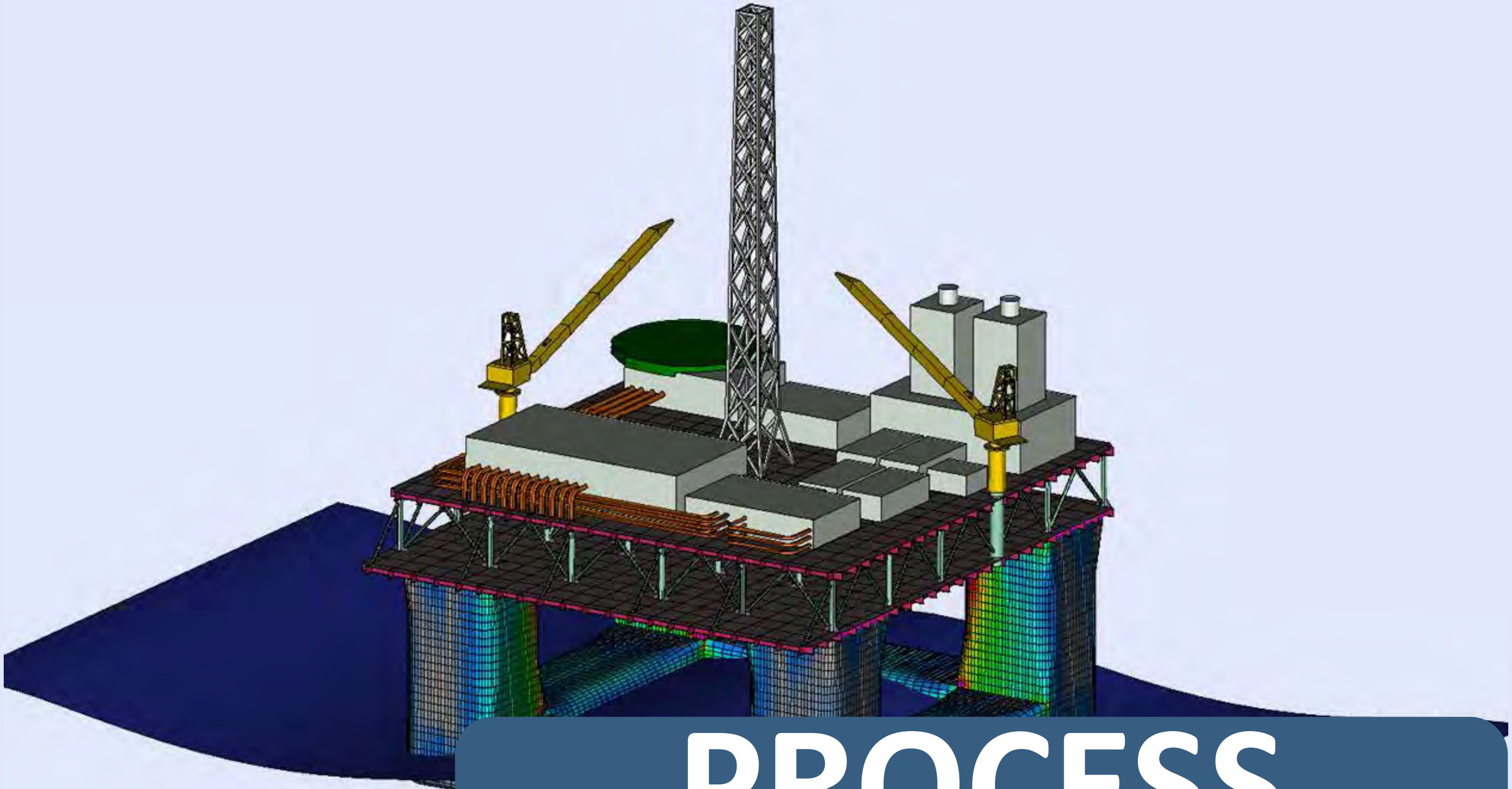
- Hundreds of model checks
- General and solver checks
- Automatic fix functions
- Custom checks through script
- Check templates
- Color coding of results



Errors

Warnings

OK



PROCESS AUTOMATION

Process Automation

Python Scripting Language | Task Manager

Scripting Capabilities using Python

Entities Handling

- Create
- Delete
- Modify
- Acquire Info

ASCII files I/O

- Read lists
- Write XML files
- Create lists
- Read XML files

Custom GUI

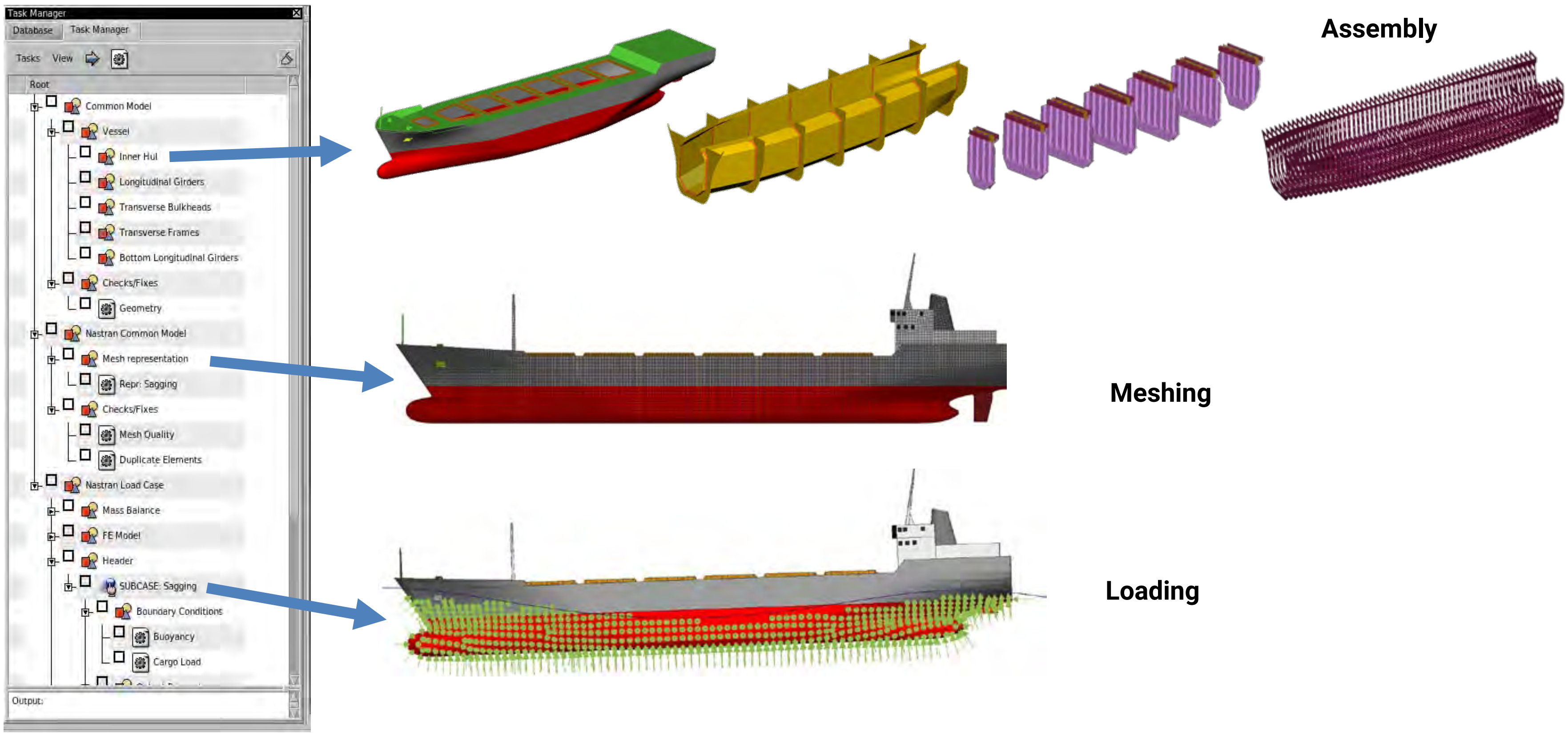
- Line edits
- Buttons
- List boxes
- Check buttons
- Radio groups
- Tables

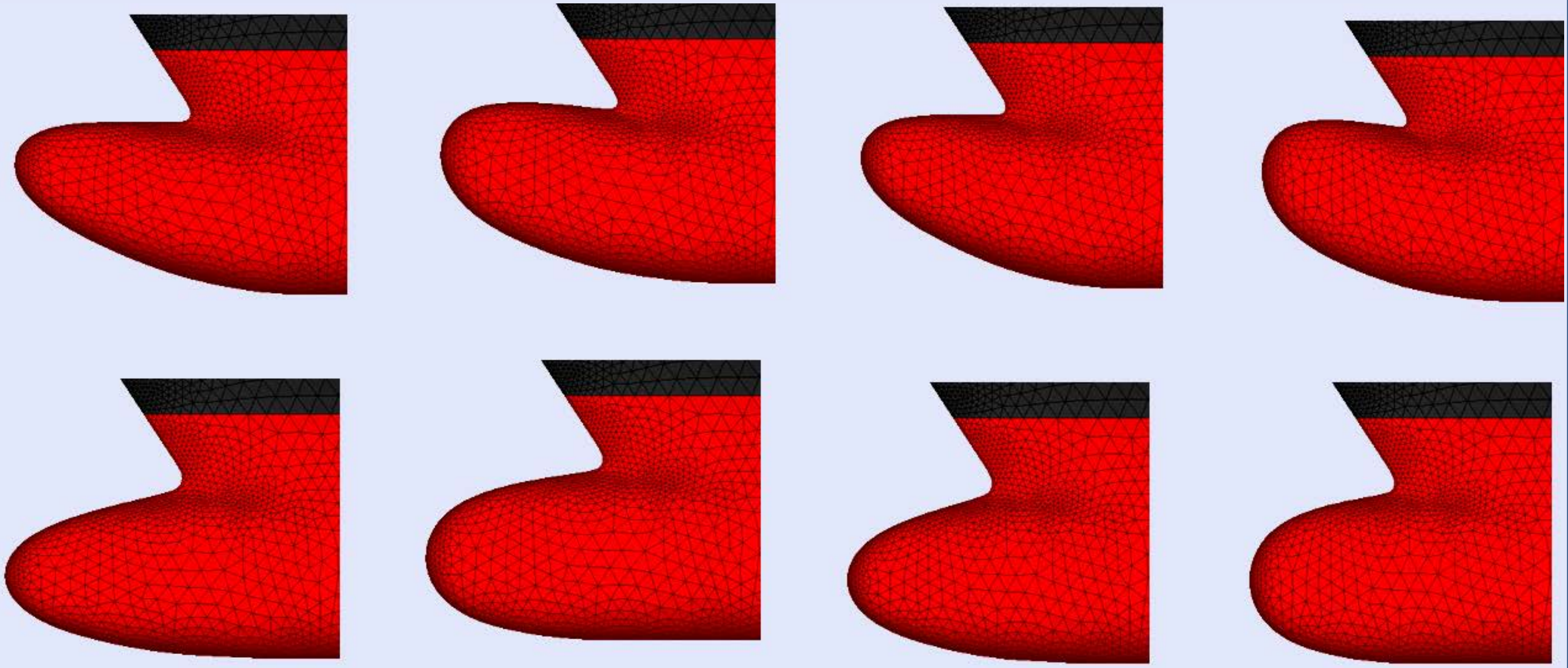
ANSA core functionality in batch

- CAD files translation
- Geometry checks
- Batch Mesh
- Middle skin extraction

Process Automation

Python Scripting Language → Task Manager

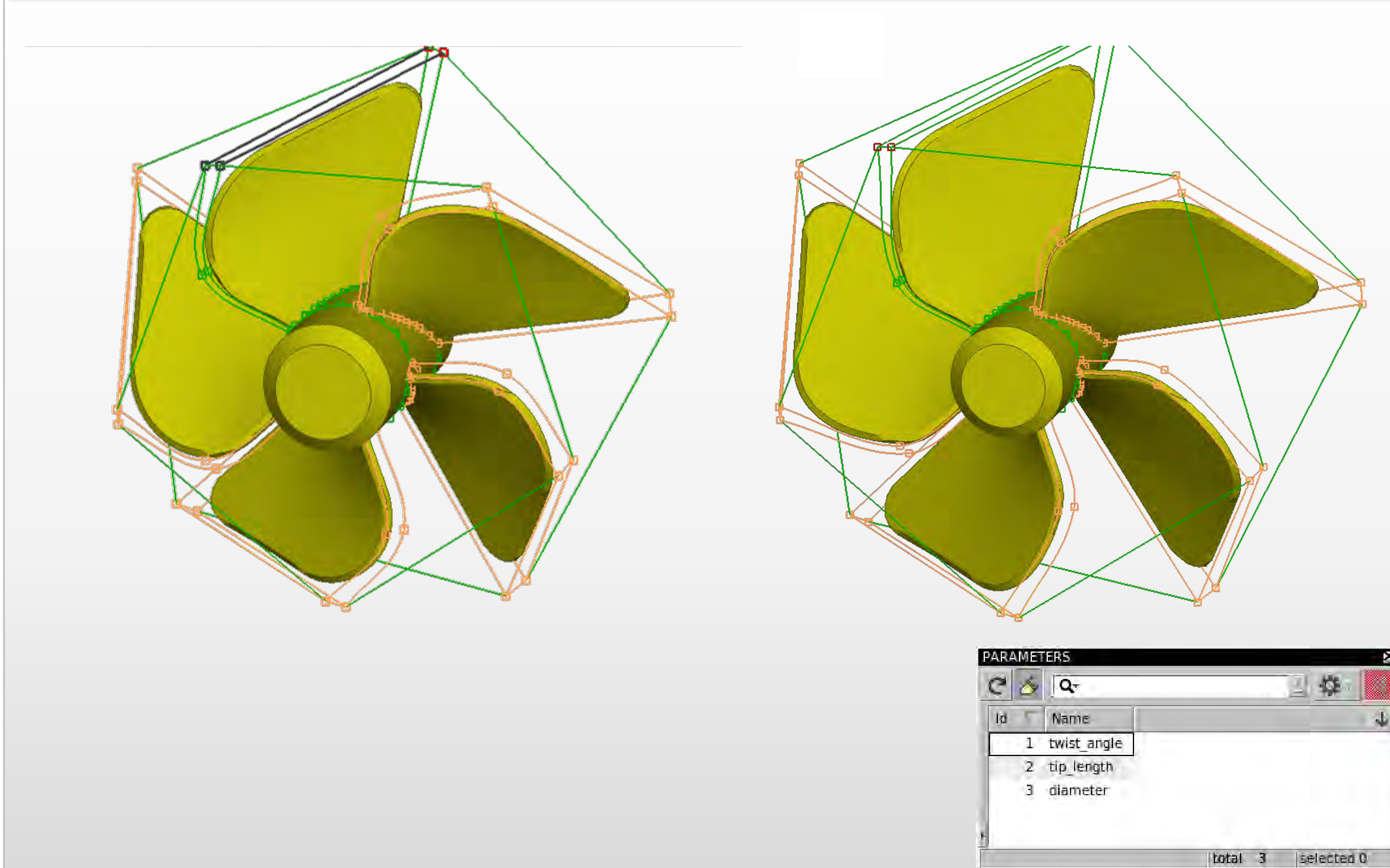




MORPHING - OPTIMIZATION

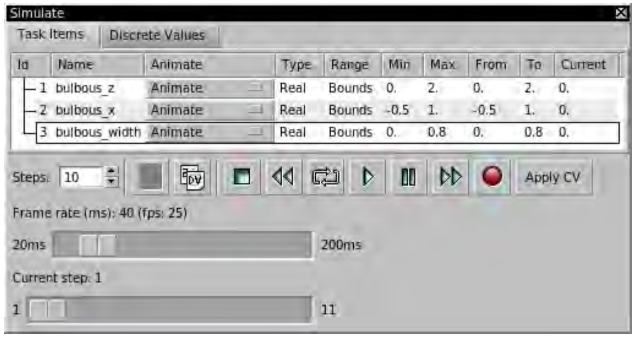
Shape optimization using the Morphing Tool

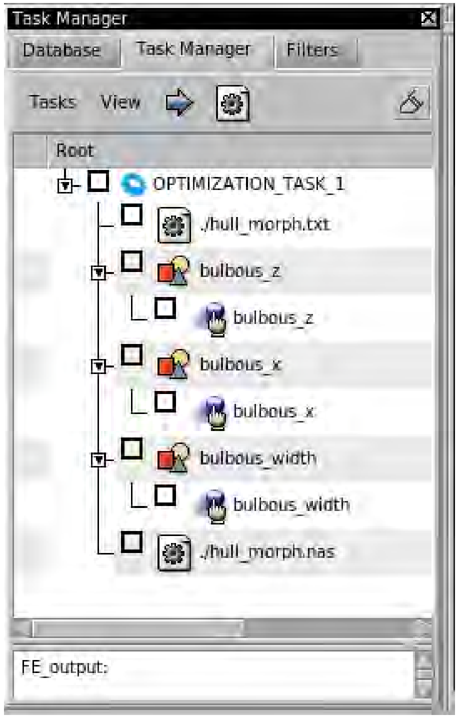
Parametric morphing applied on FE or geometry

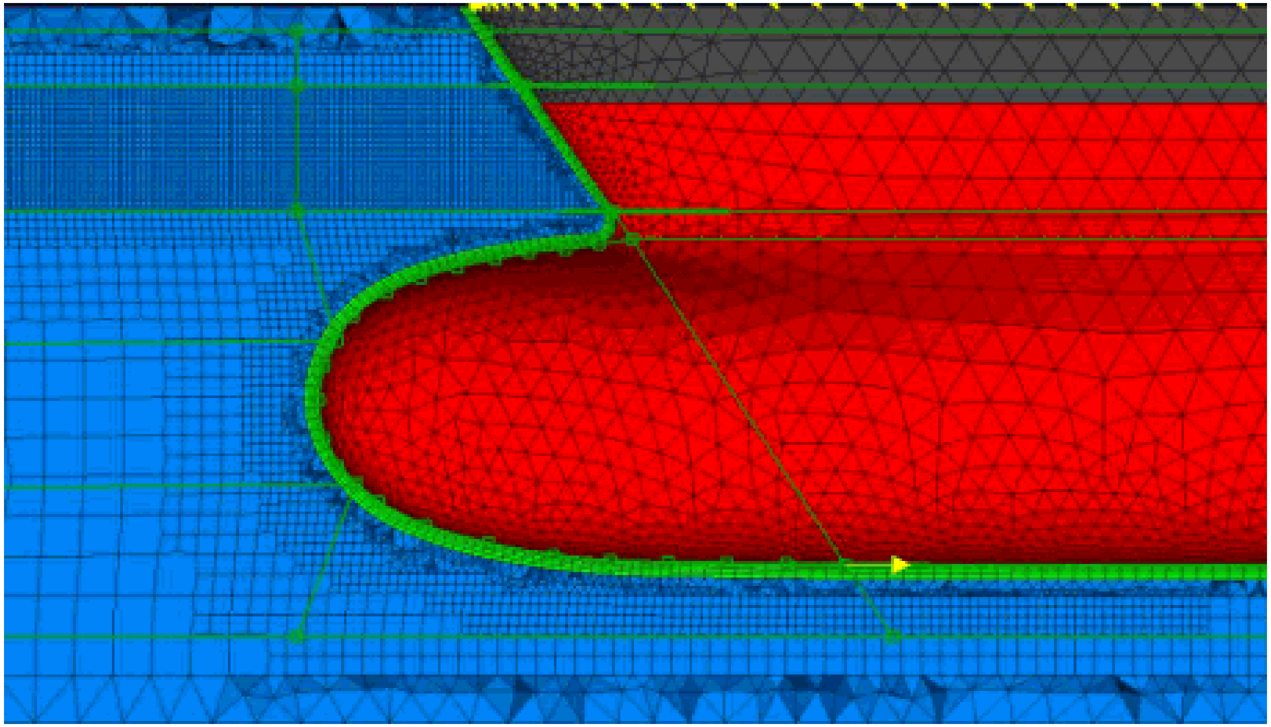


Shape optimization of the bulbous bow

- 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

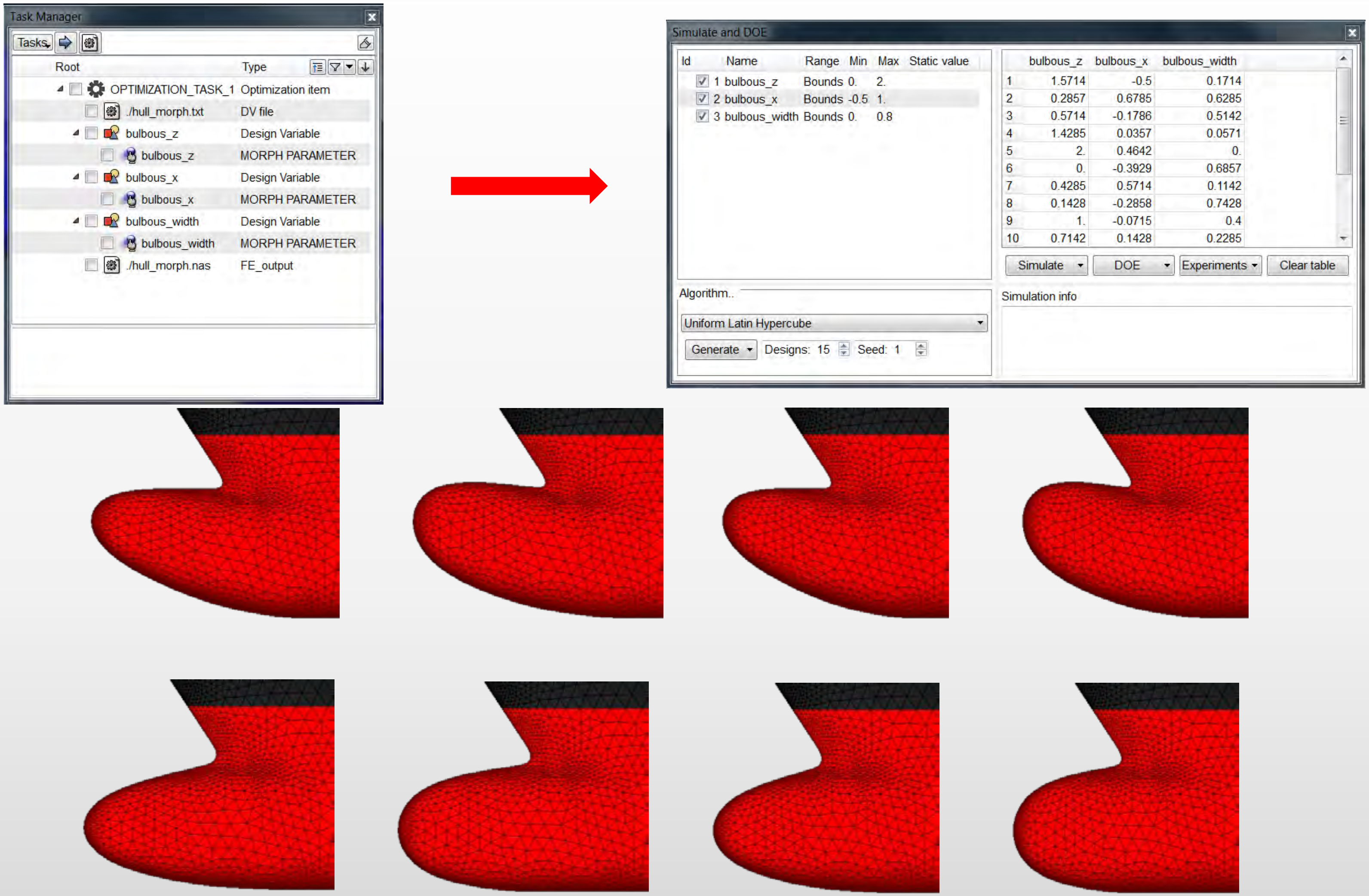






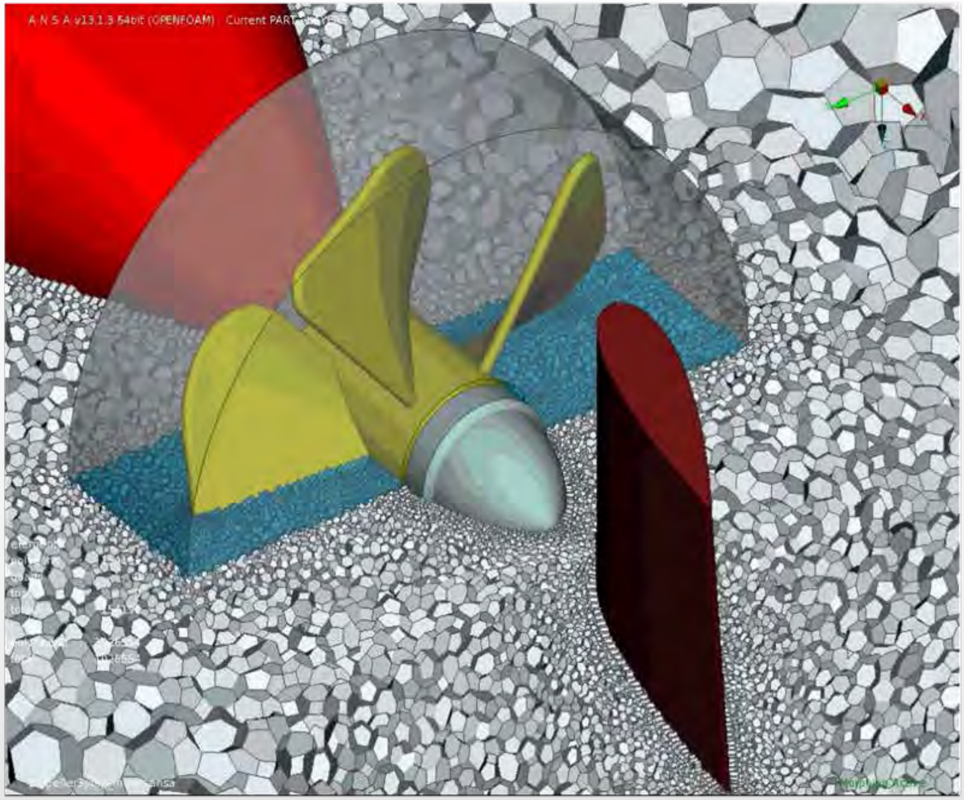
Shape optimization of the bulbous bow

Definition of Design of Experiments



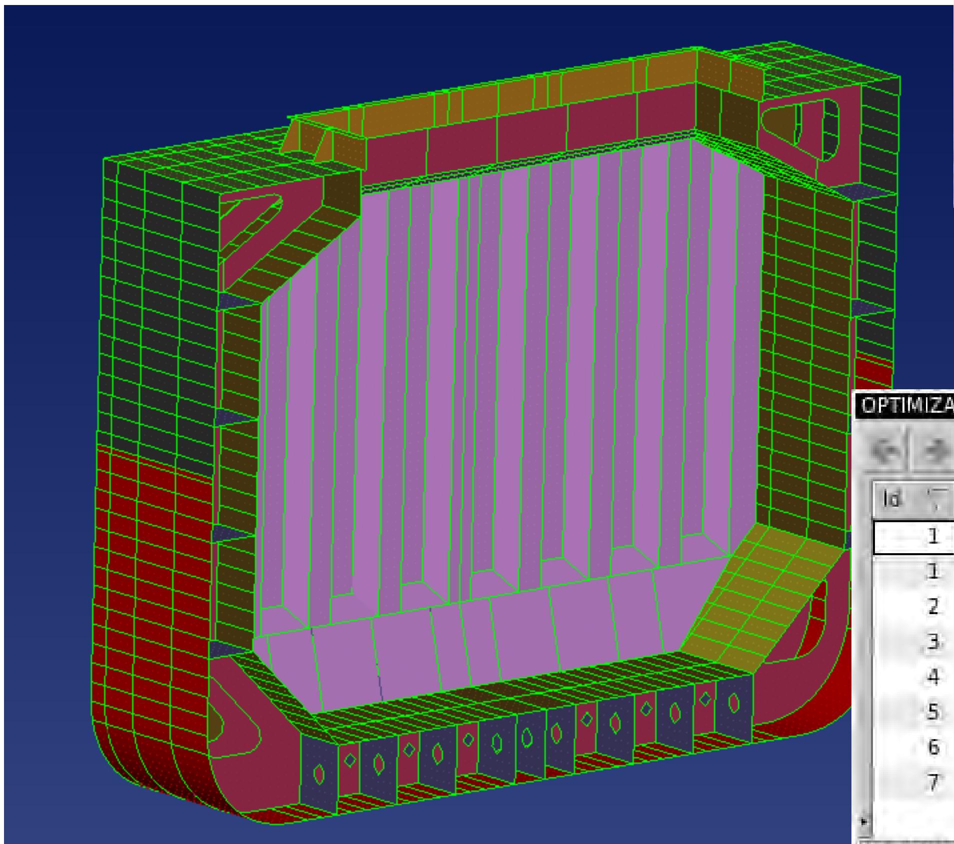
Shape optimization using the Morphing Tool

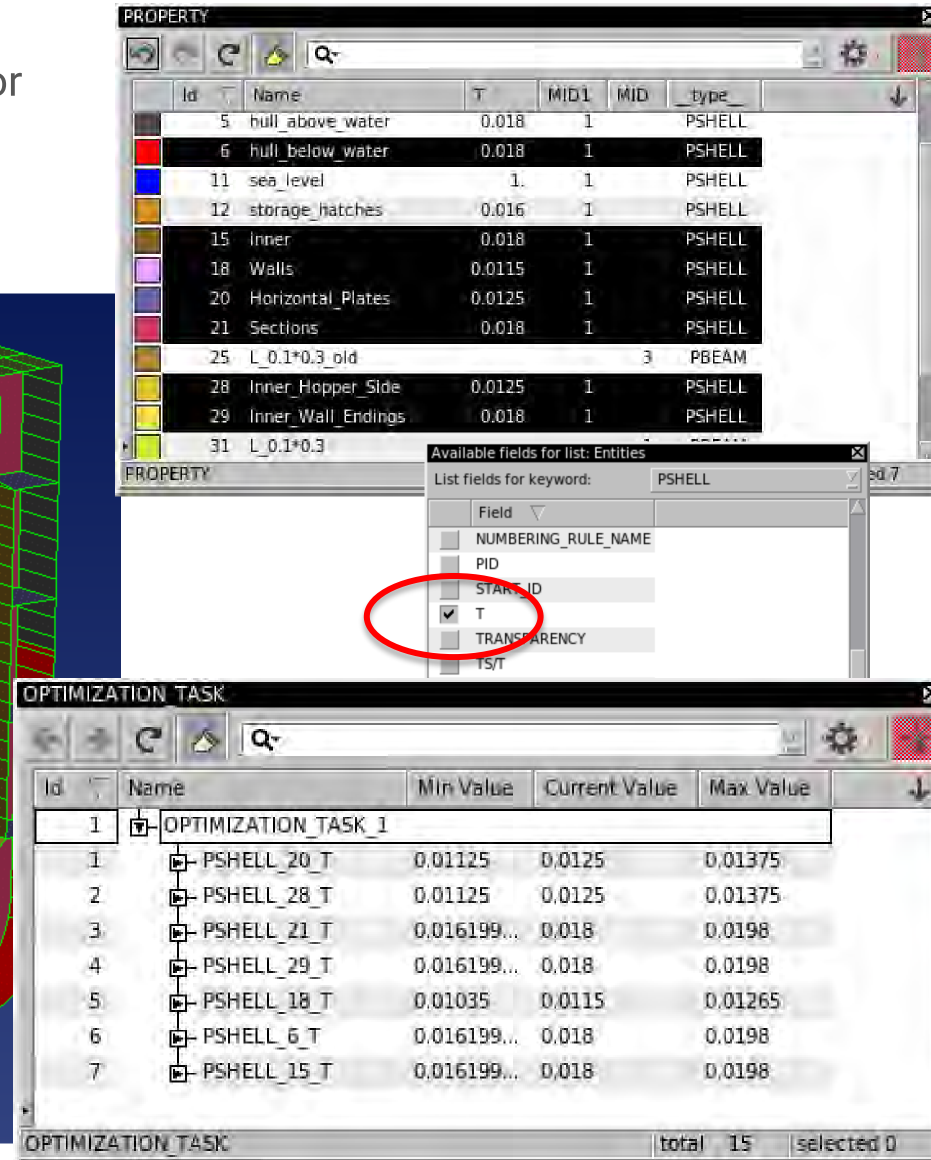
Volume mesh morphing



Shell thickness optimization

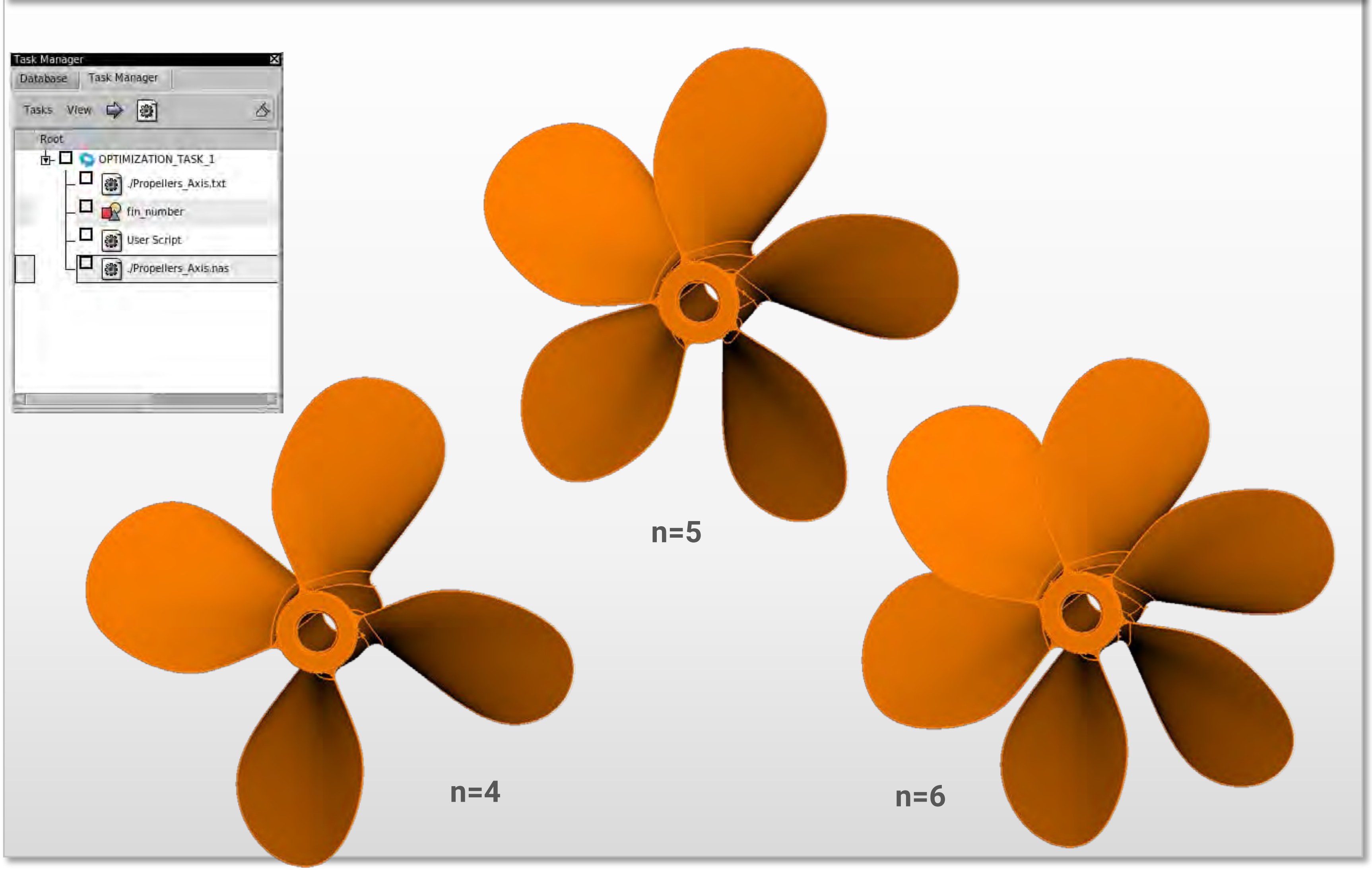
Automatic definition of design variables for shell thickness and creation of the Optimization Task



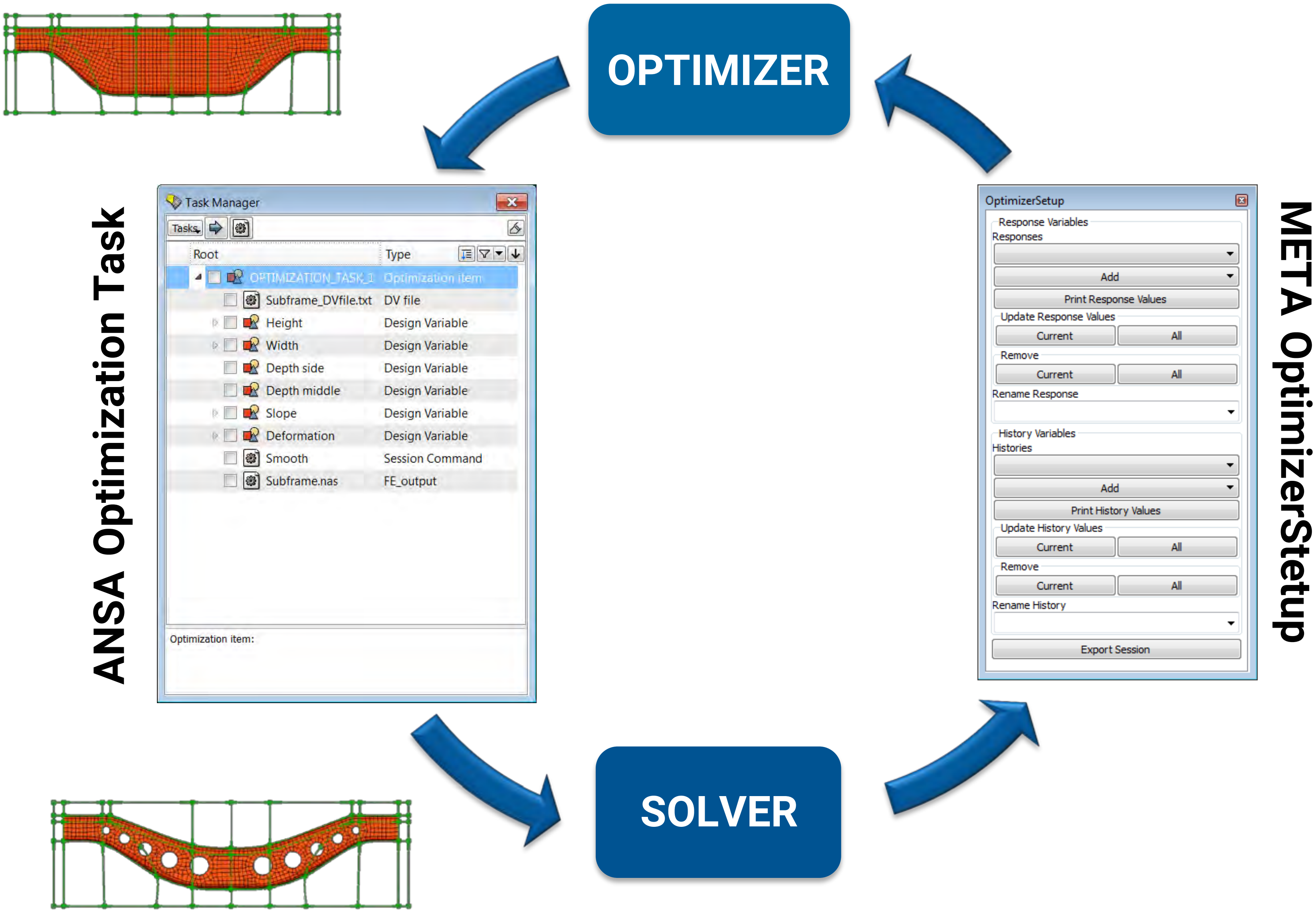


Creating / importing features parametrically

Defining the fin number of a propeller as design variable

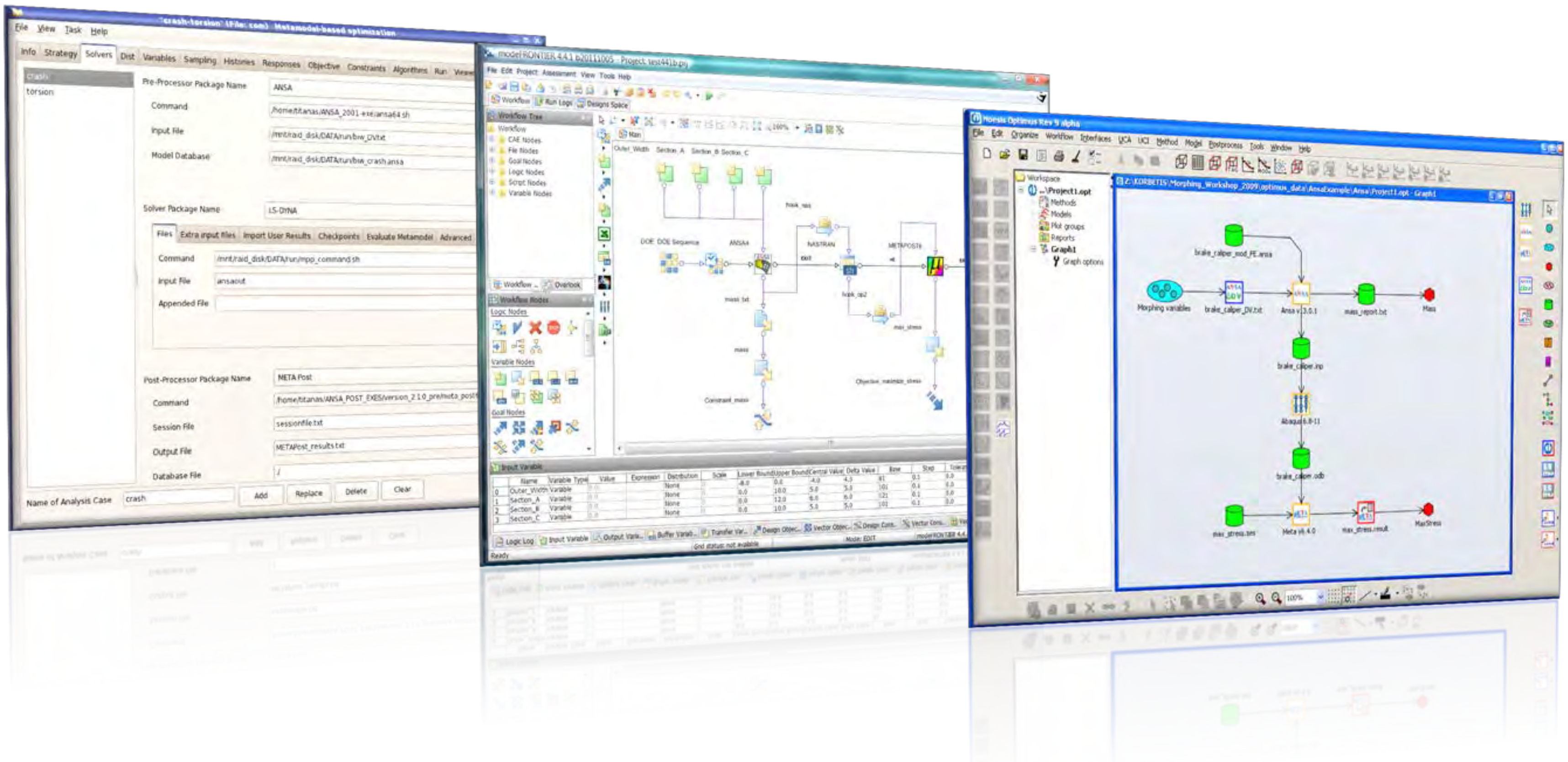


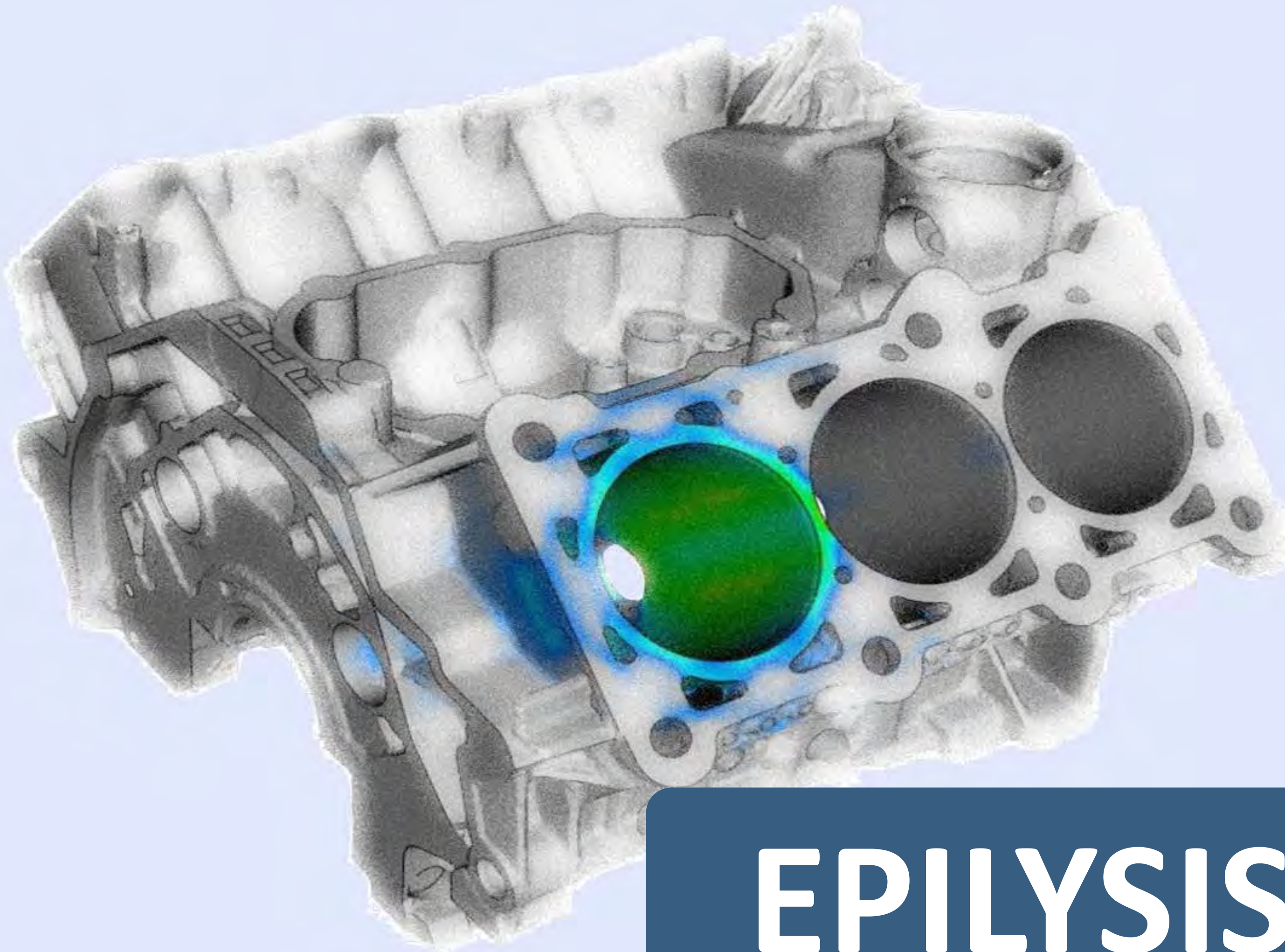
Coupling ANSA and META to parametric optimizers



Coupling ANSA and META to parametric optimizers

- LS-OPT of LSTC
- modeFRONTIER of ESTECO
- OPTIMUS of NOESIS
- Isight of SIMULIA
- Heeds of Red Cedar

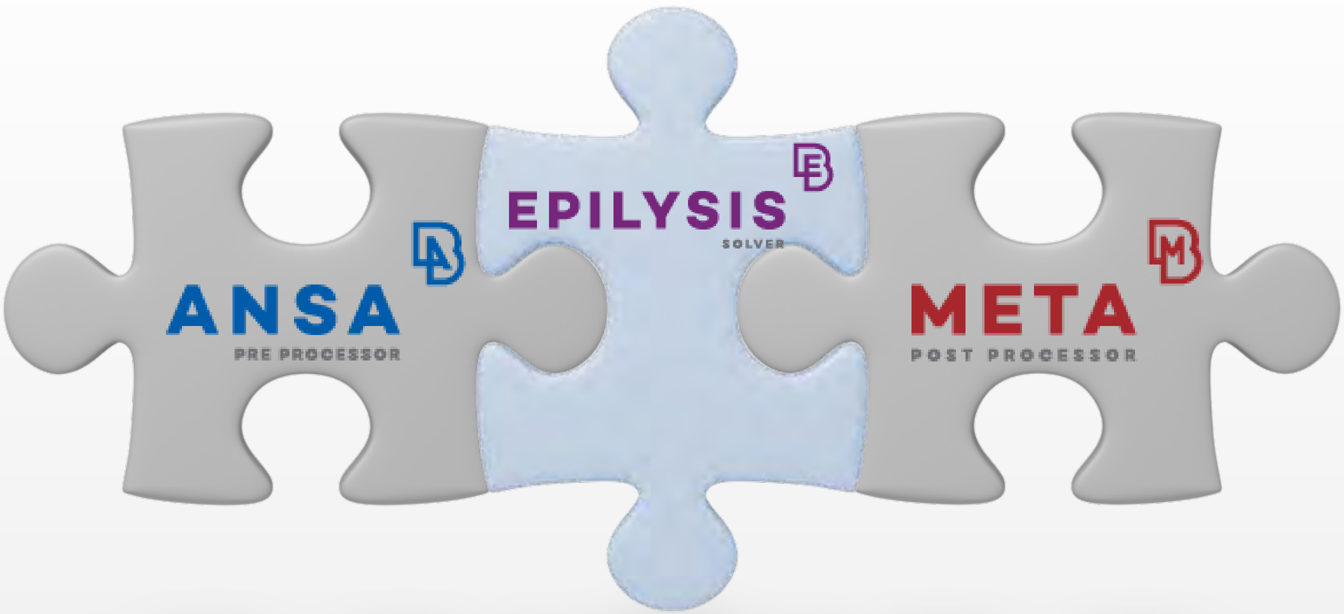




EPILYSIS

EPILYSIS

Solver for FE analysis



- General-purpose FE Analysis Software
- One Solver for many engineering problems
- Standalone & integrated in ANSA

Επίλυσις

[epi-li-sis]

noun 1. solution

EPILYSIS

EPILYSIS Characteristics

Programming Language

- C++
- Double Precision

Quality

- Benchmarks accurate (NAFEMS, SFM and other – More than 3500 tests)
- Robustness
- Repeatability

Performance

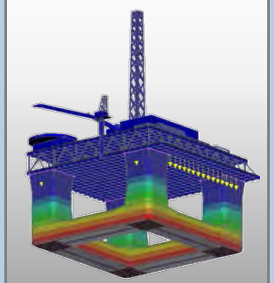
- Shared Memory Parallel Processing (SMP)
- Automatic utilization of system resources without time consuming tuning
- Multiple high-performance direct sparse linear solvers

Easy to Use

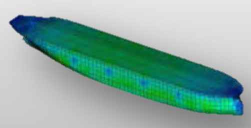
EPILYSIS

Linear analyses

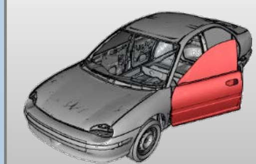
Static



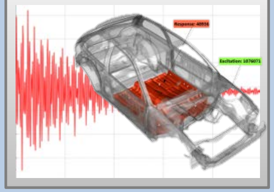
Real Eigenvalue



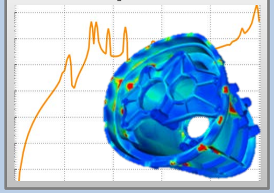
Direct Transient Response



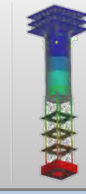
Direct Frequency Response



Modal Transient Response

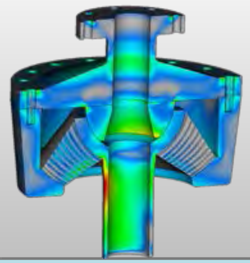


Modal Frequency Response



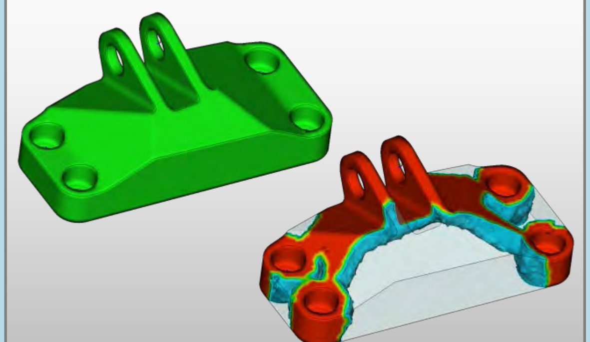
Non - linear analyses

Static: linear elements / materials -non linear contacts



Optimization

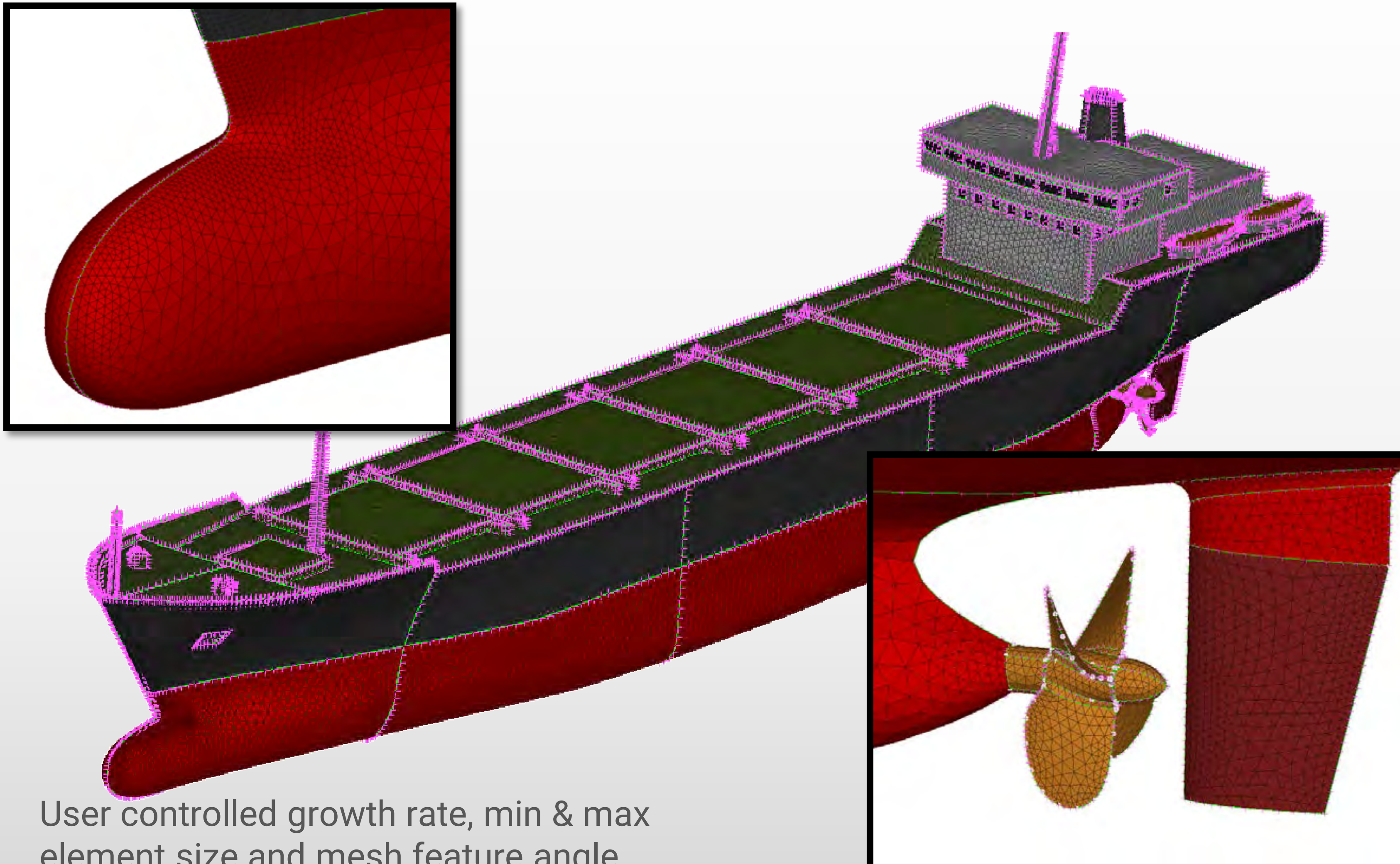
Topology optimization



CFD Analysis

Model definition for CFD analysis

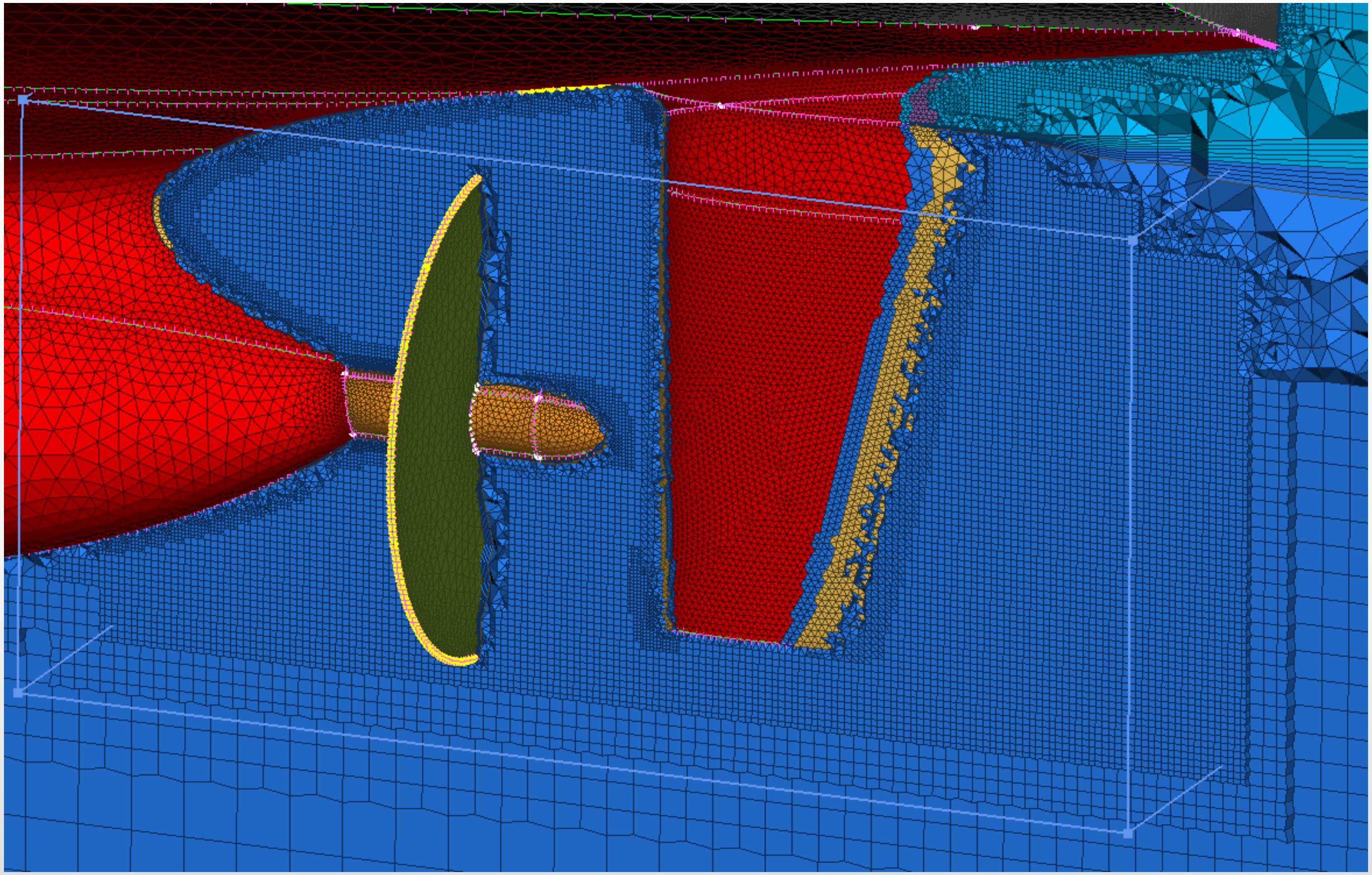
Fully automatic Curvature Dependant surface meshing



User controlled growth rate, min & max element size and mesh feature angle

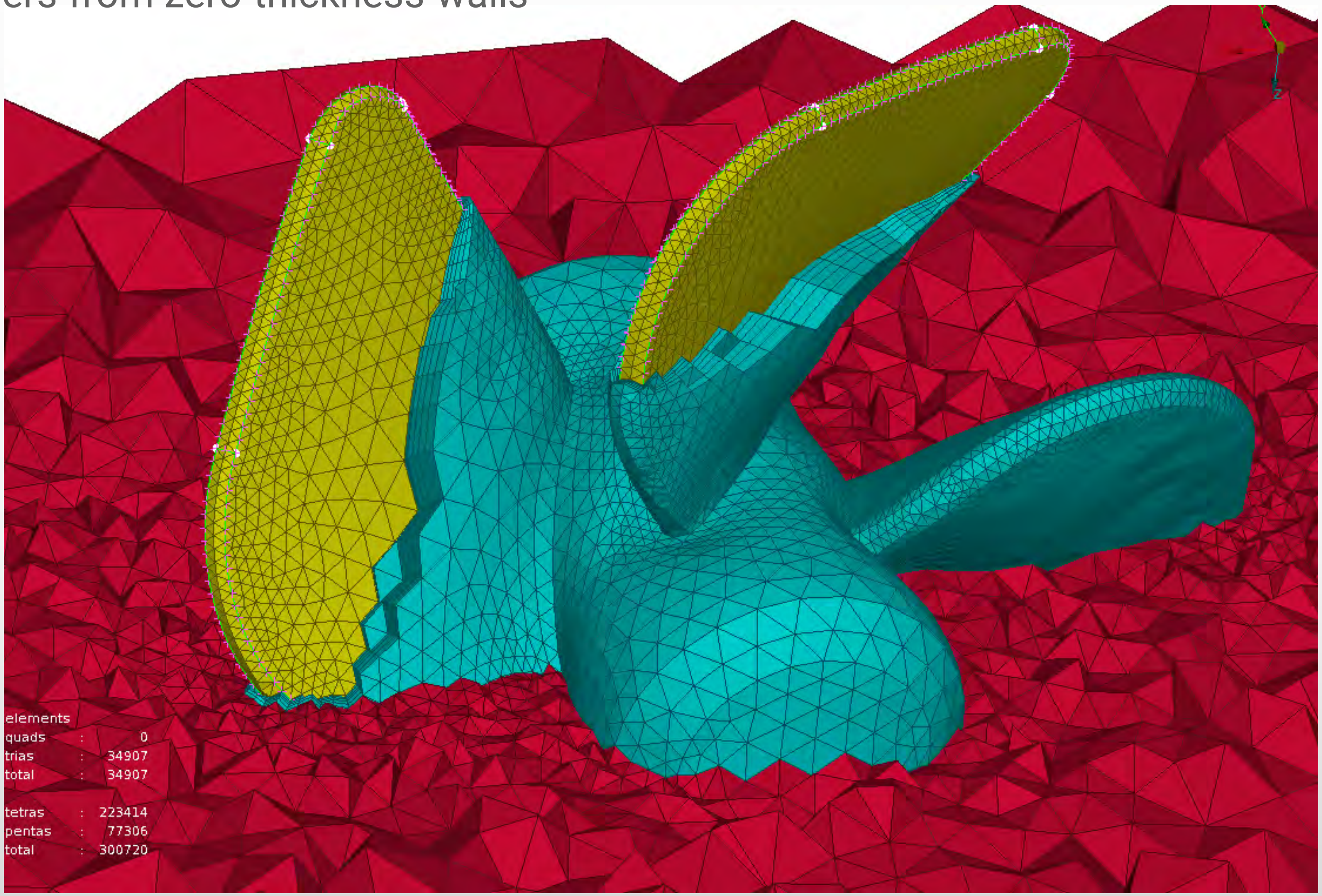
Model definition for CFD analysis

Local refinement using SIZE BOXES



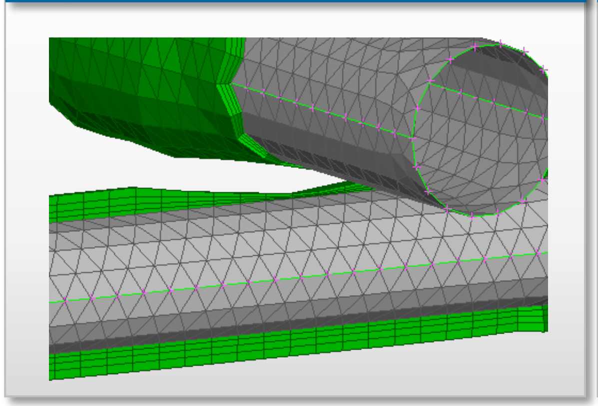
Boundary layers generation

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

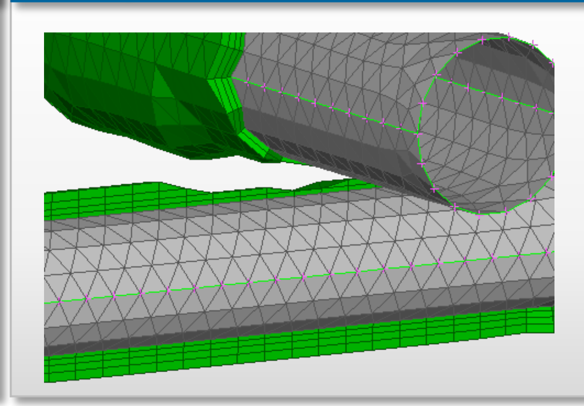


Advanced boundary layers generation

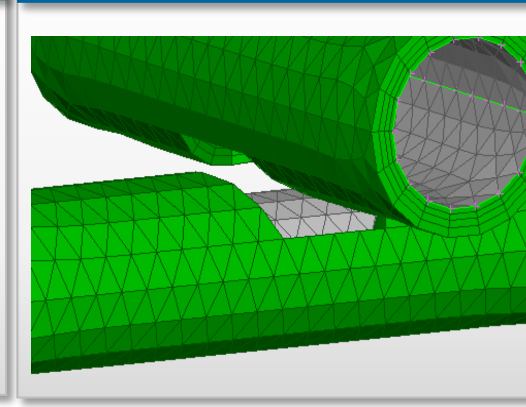
Squeeze



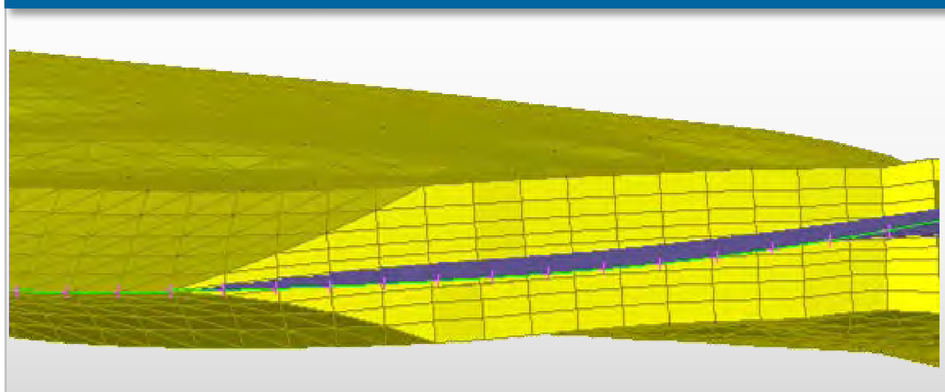
Collapse

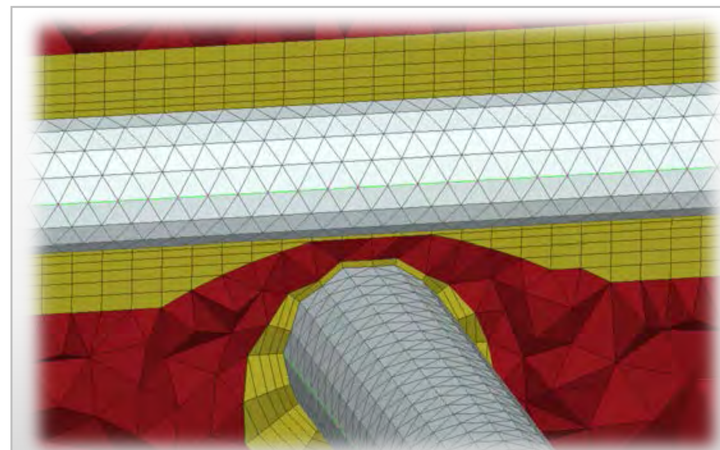


Extrude

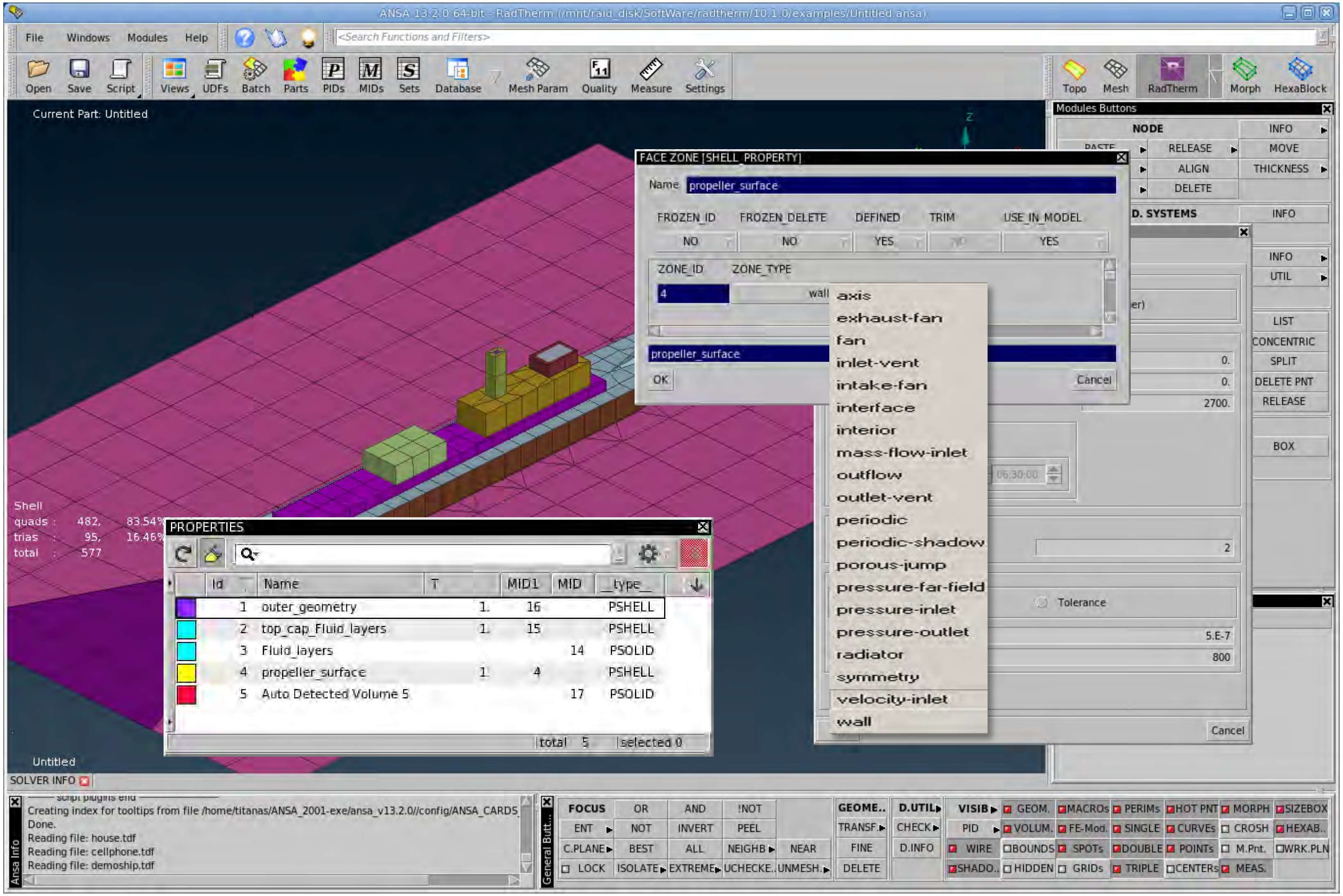


Collapse free edges



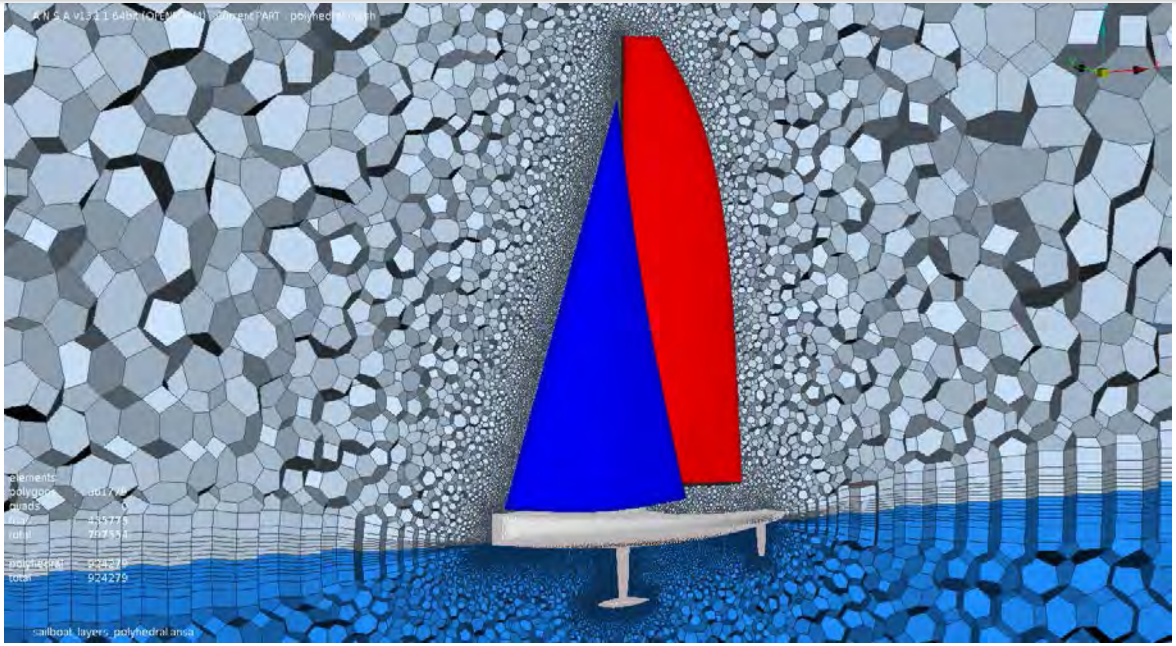


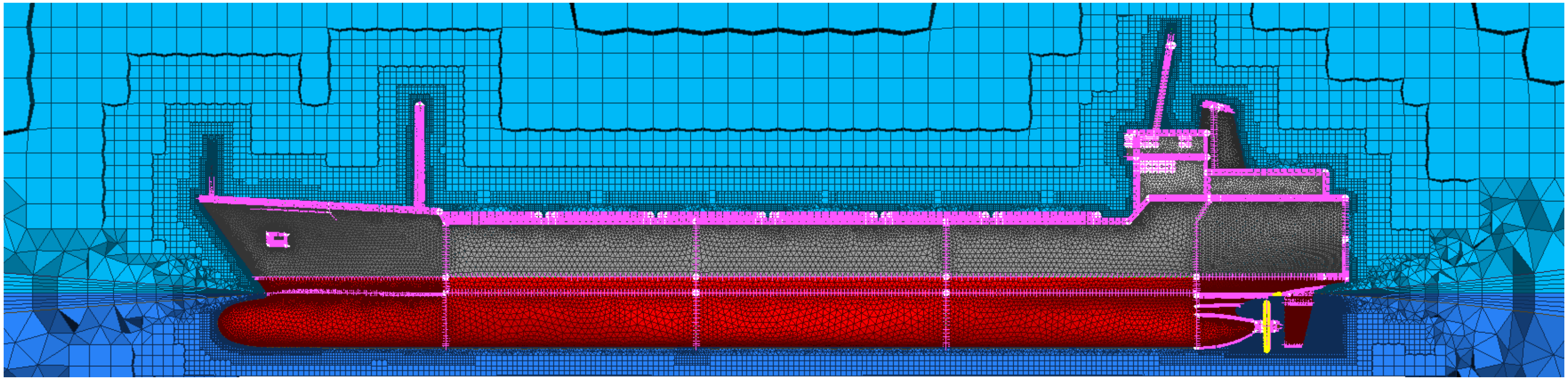
Boundary Condition type specification for various CFD solvers



Model definition for CFD analysis

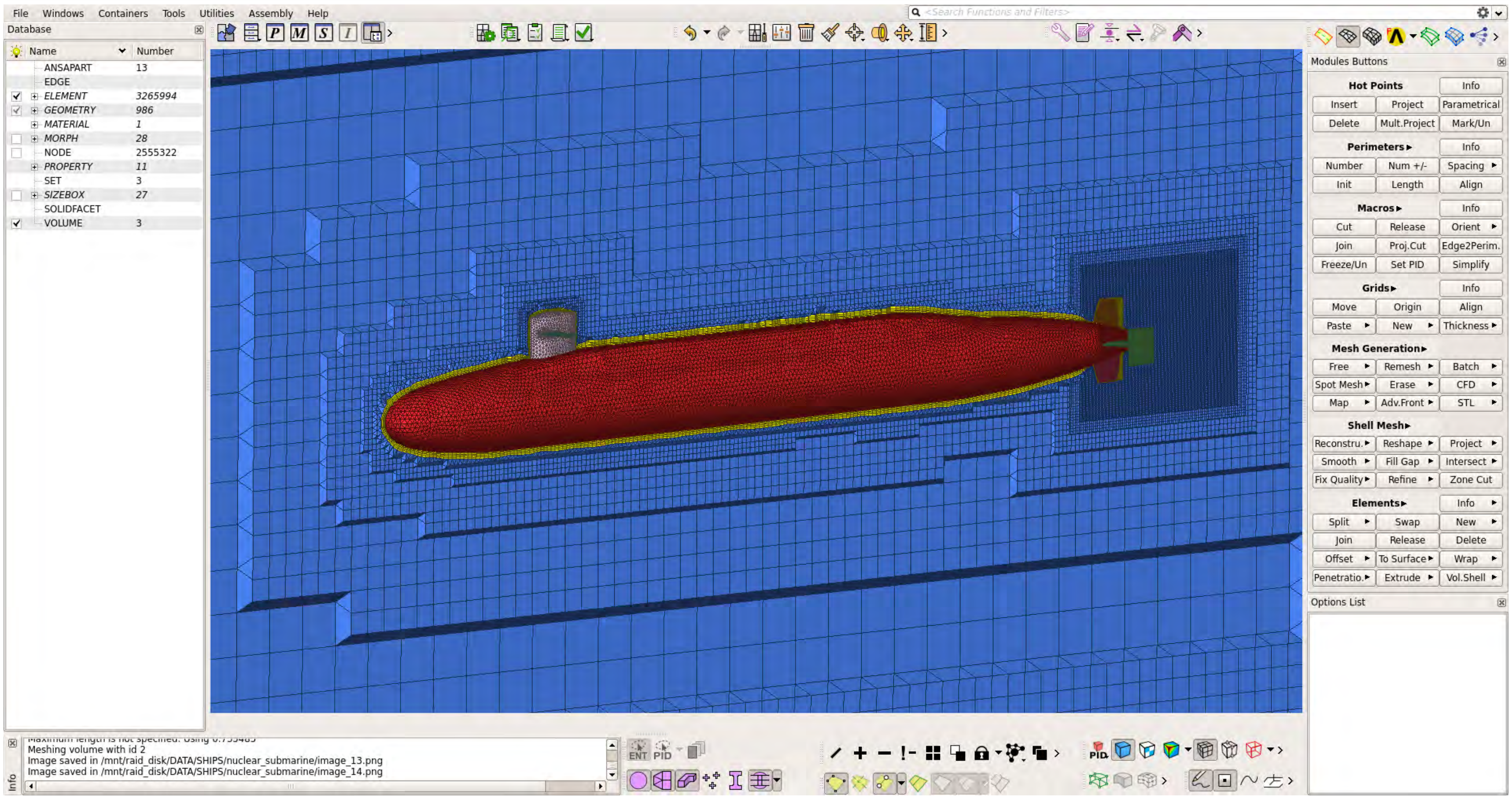
Fast and robust volume meshing for all types of elements





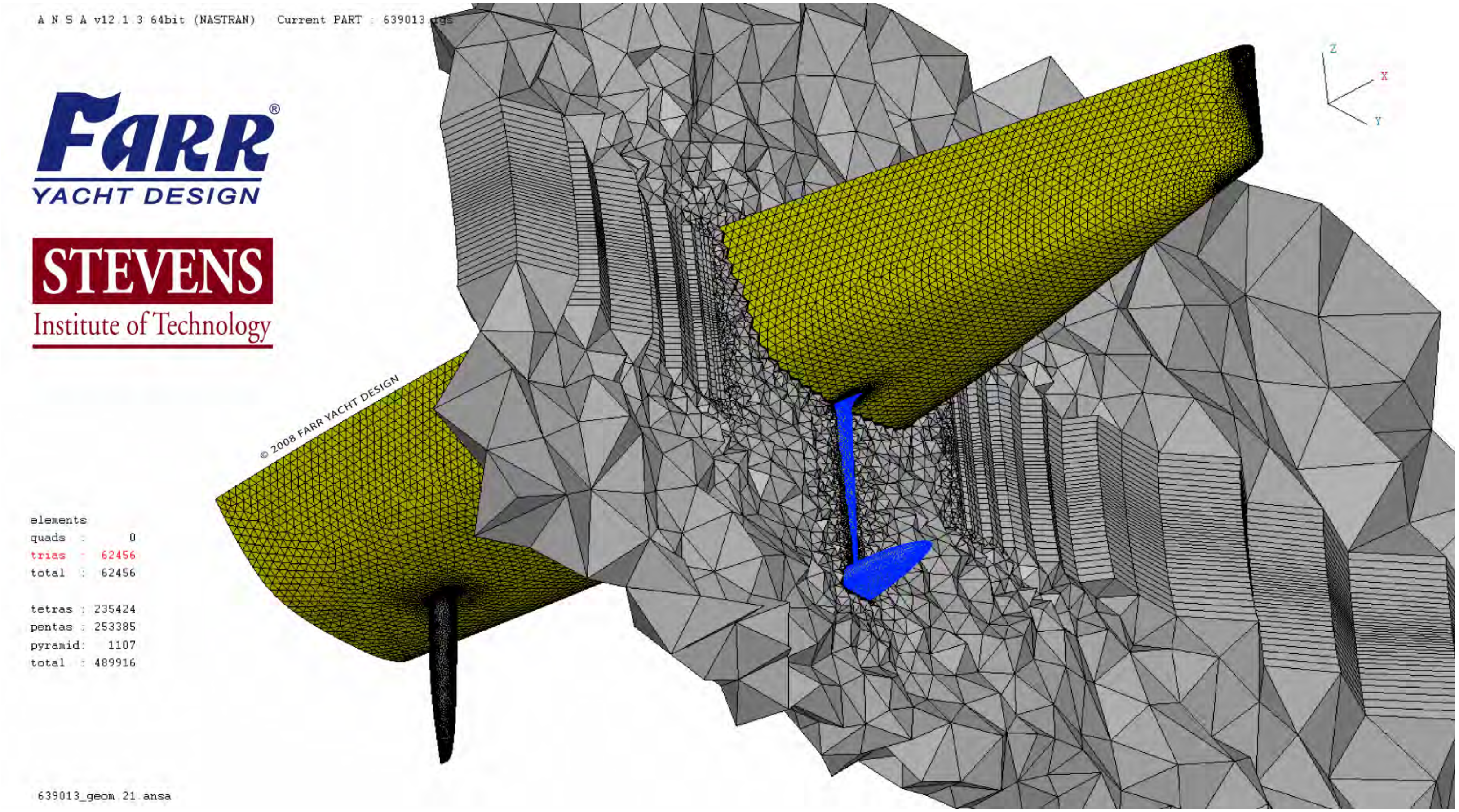
Model definition for CFD analysis

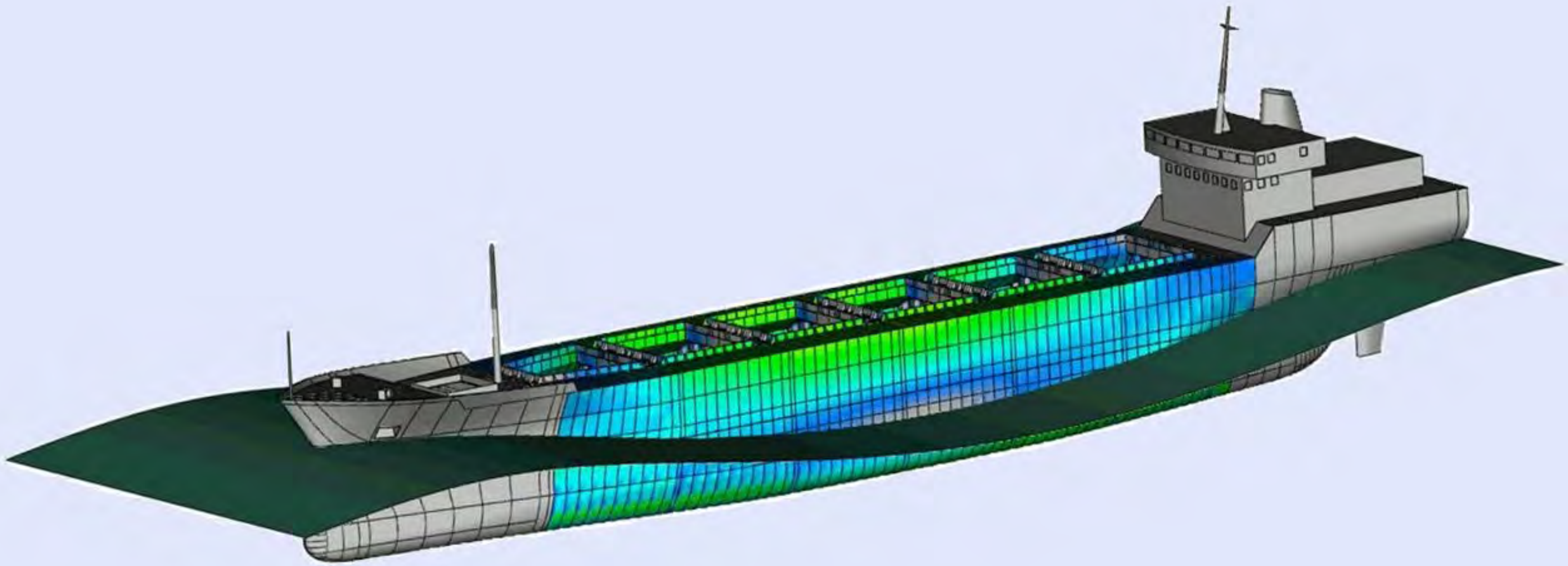
Fast and robust volume meshing for all types of elements



Model definition for CFD analysis

Fast and robust volume meshing for all types of elements

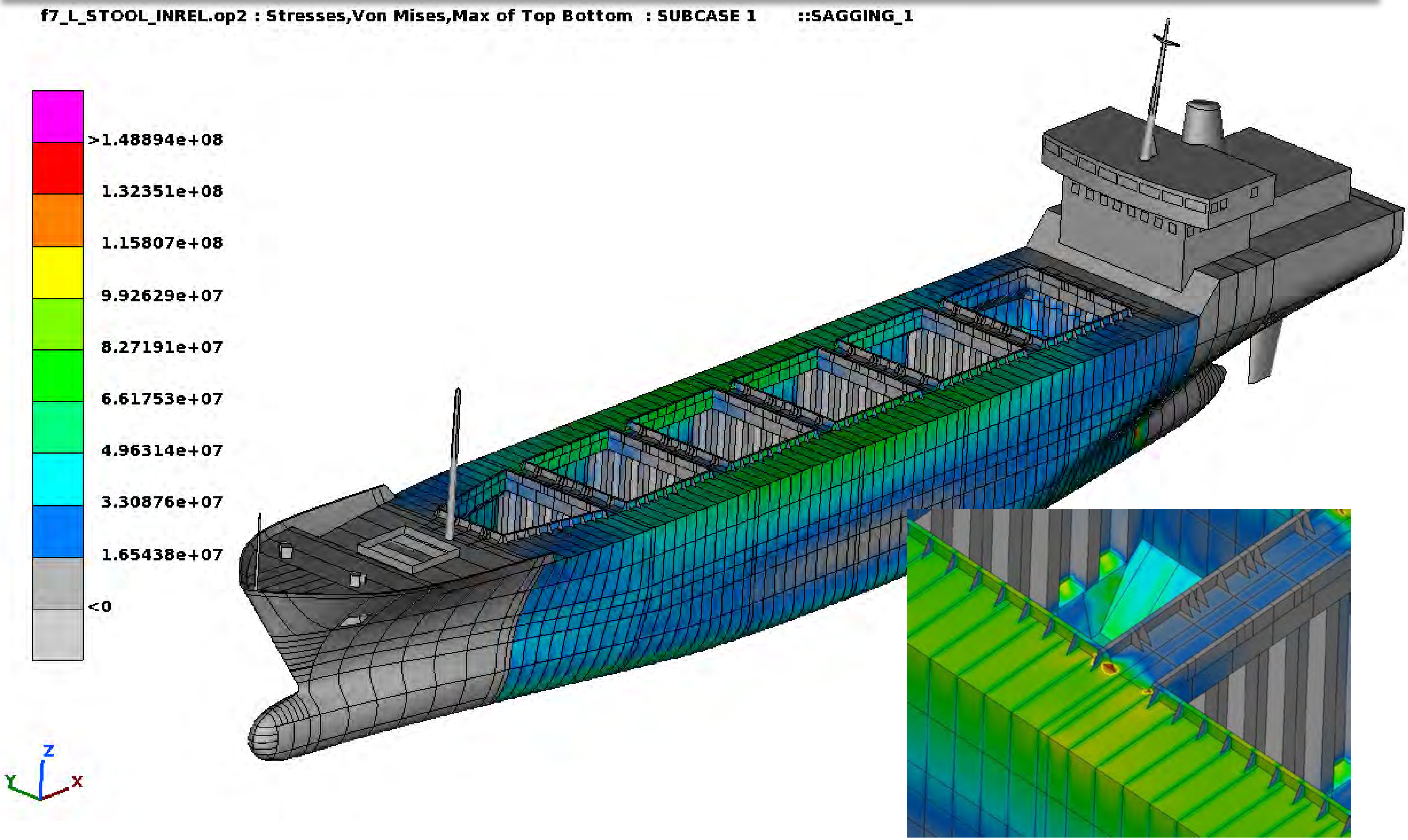




Post Processing

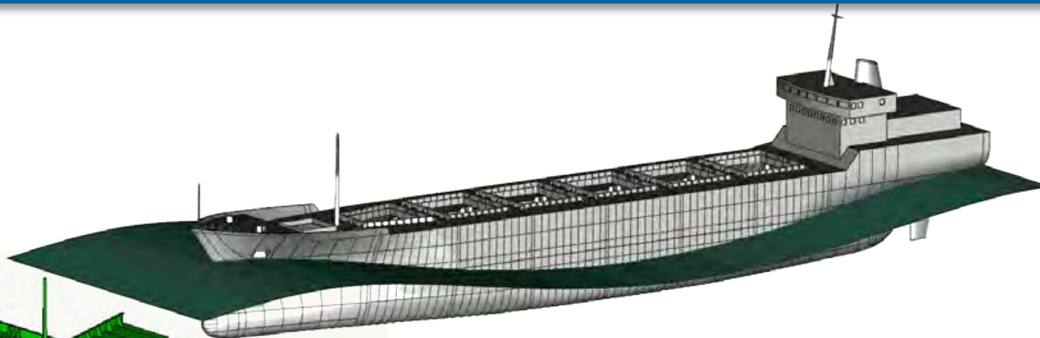
Viewing results in META

Global and local stress inspection



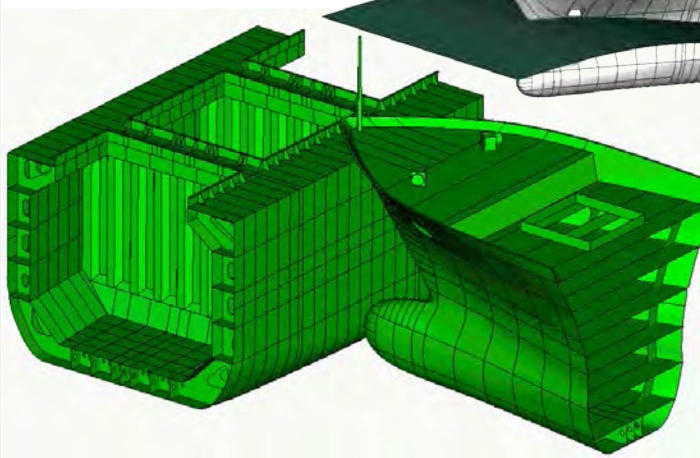
Viewing results in META

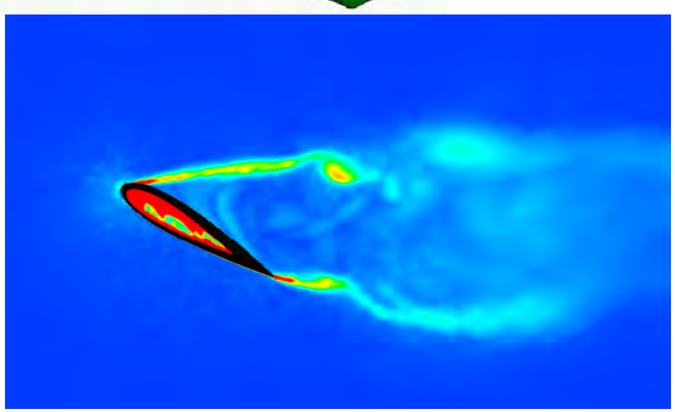
Supports results from various solvers and analyses

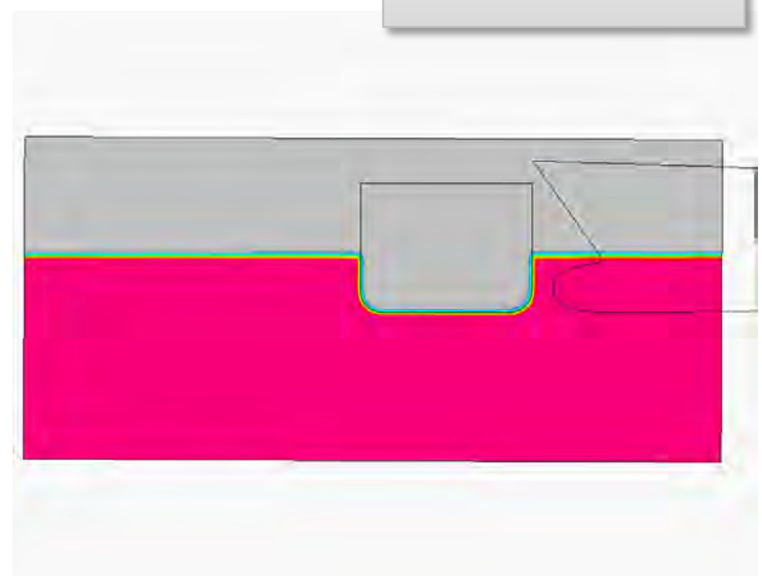


Results

- Static
- Dynamic
- CFD
- ALE

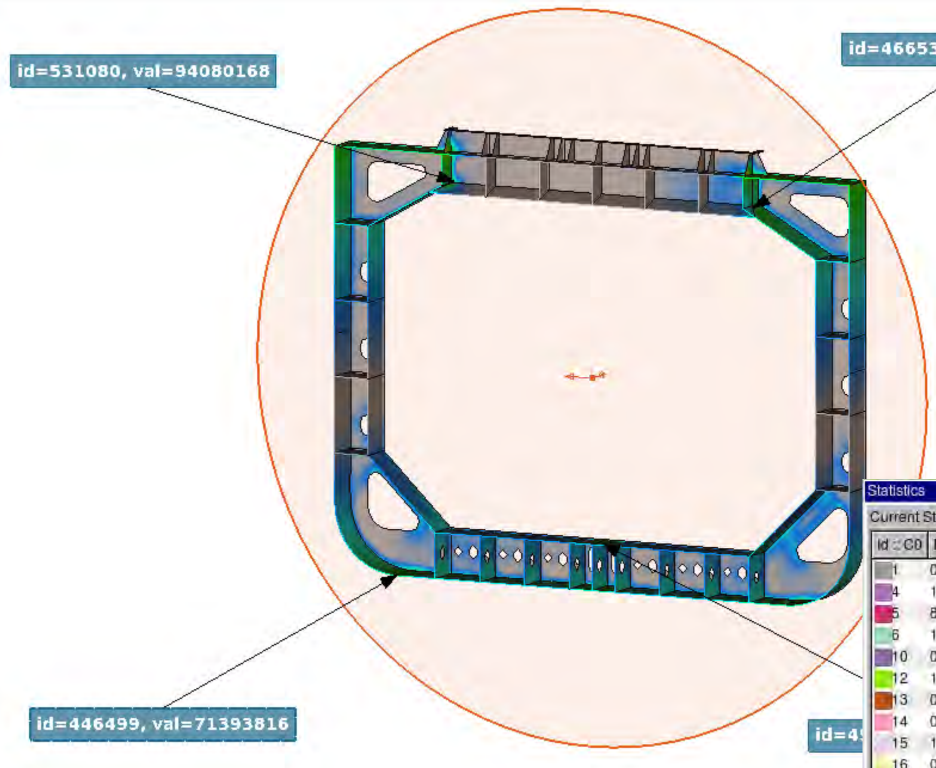


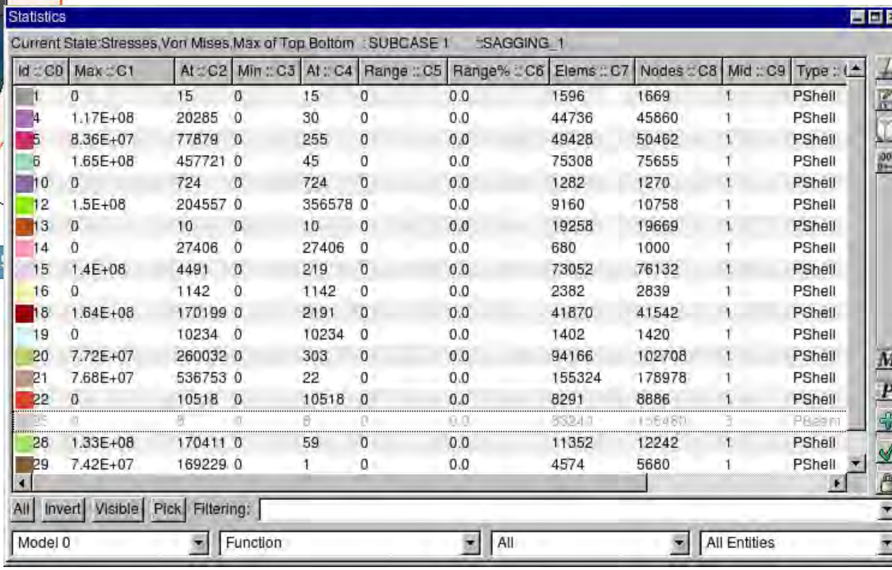




META Reporting capabilities

Creating sections, annotations, statistics, reports…




Statistics

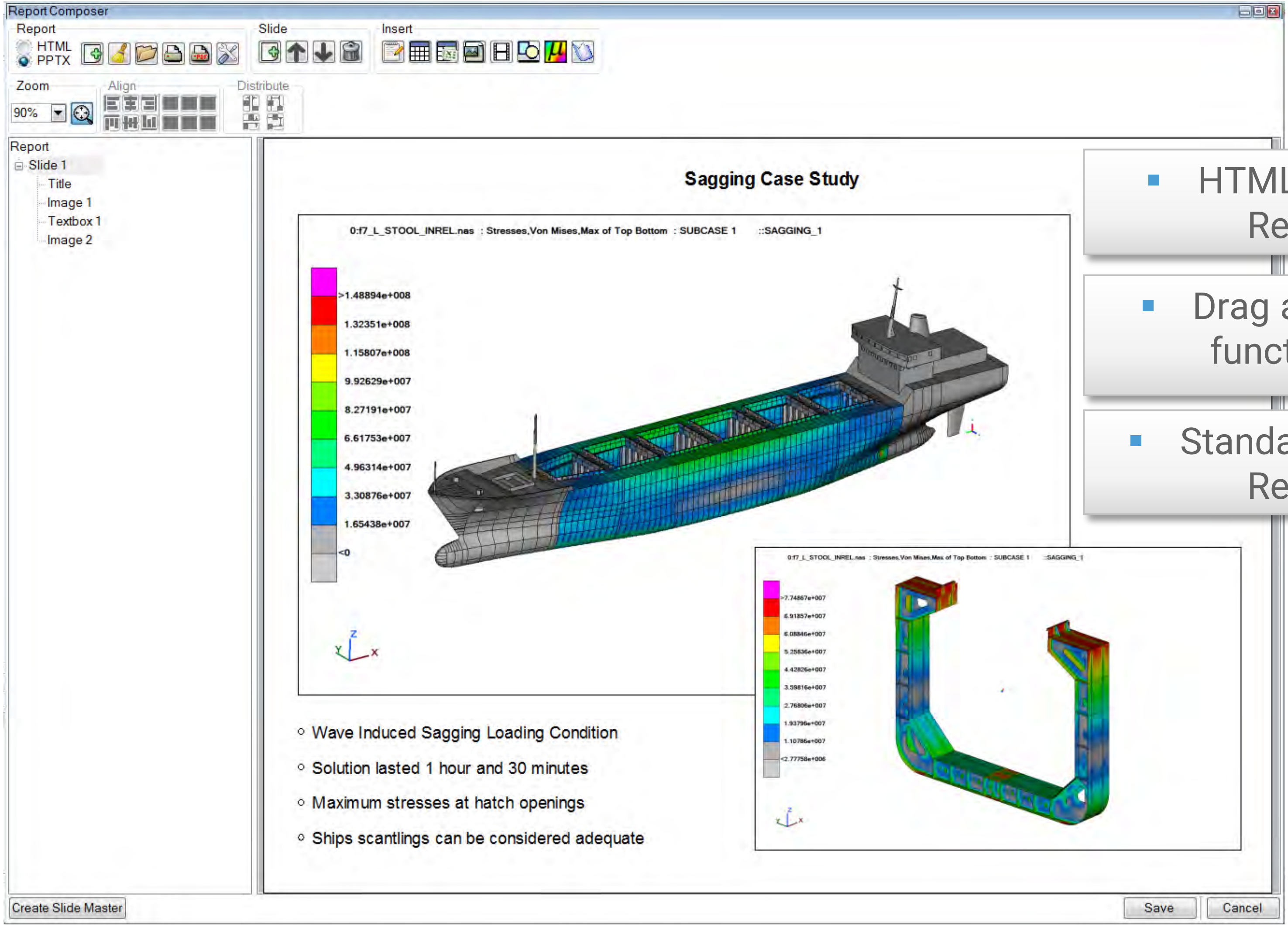
Current State:Stresses,Von Mises,Max of Top Bottom :SUBCASE 1 :SAGGING_1

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	[illegible]	[illegible]	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

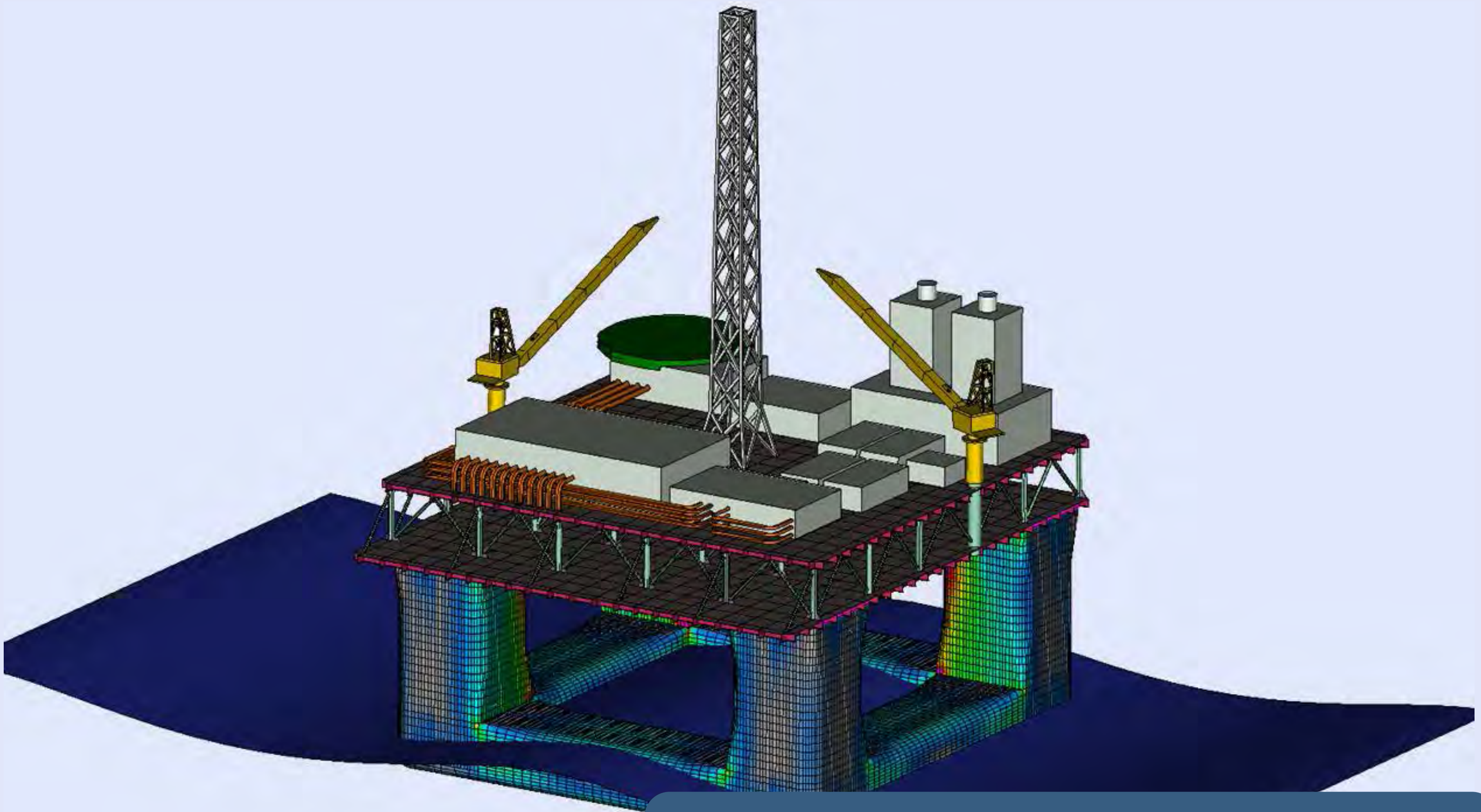
All Invert Visible Pick Filtering:

Model 0 | Function | All | All Entities

META Reporting capabilities

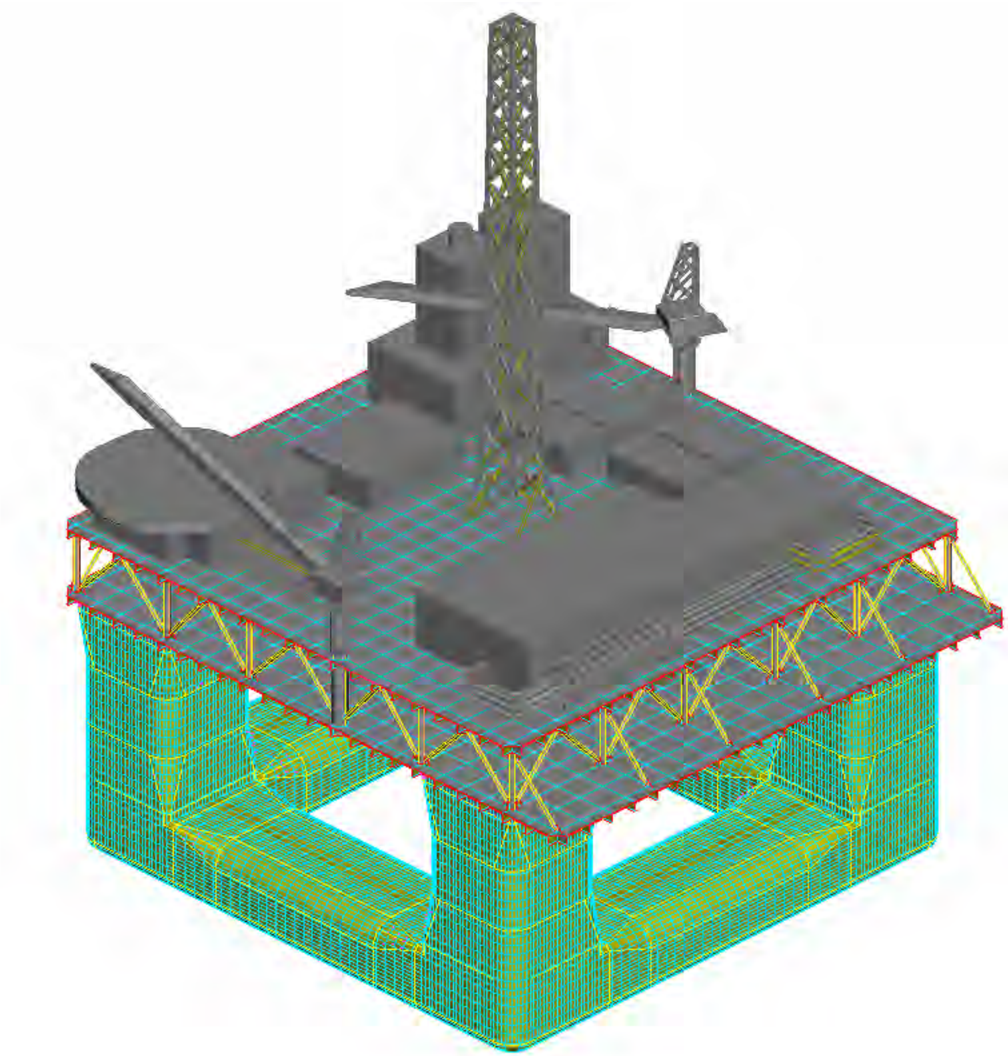


- HTML / PPTX Reports
- Drag and Drop functionality
- Standard Model Reports

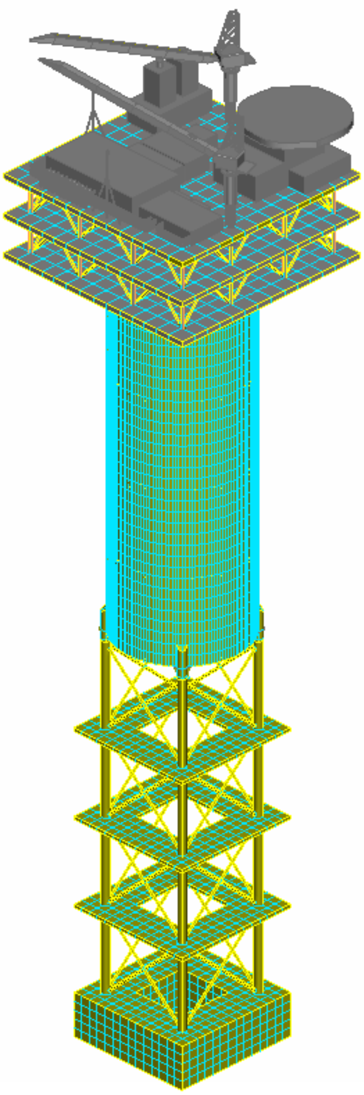


OFFSHORE

Offshore models

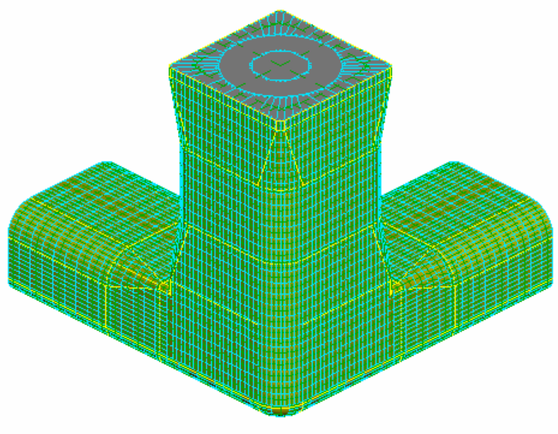


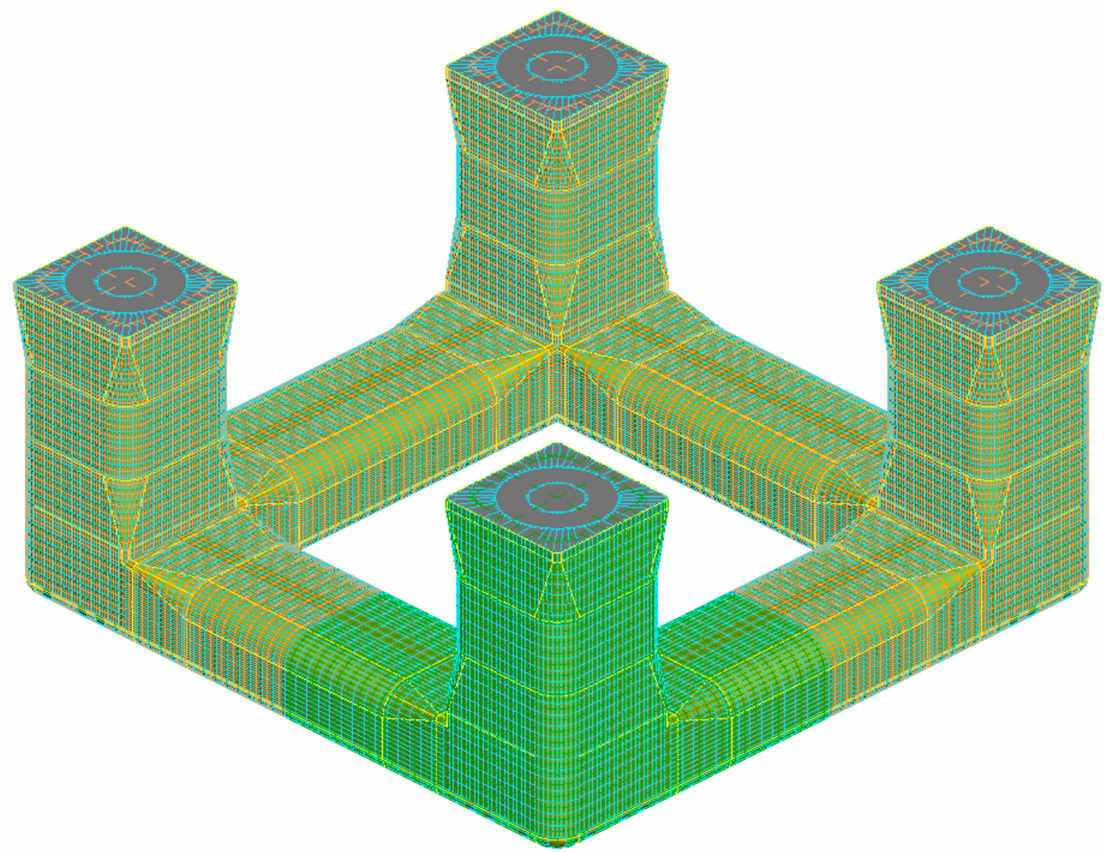
Semi-Submersible offshore platform



SPAR offshore platform

Geometry Handling

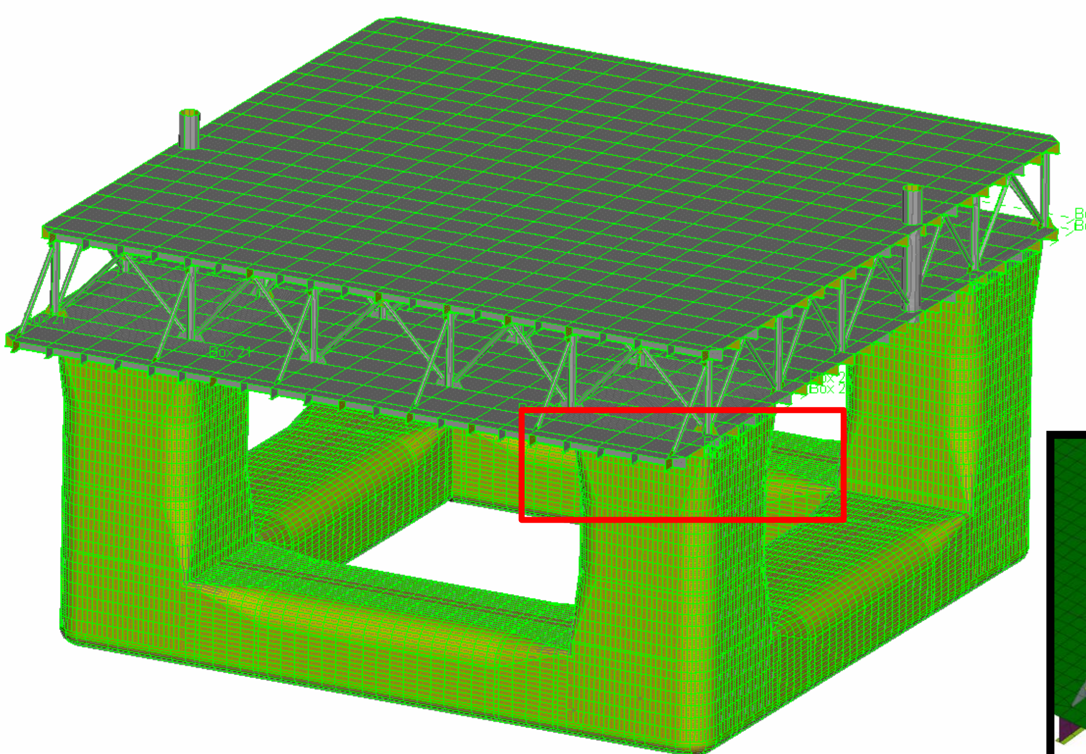


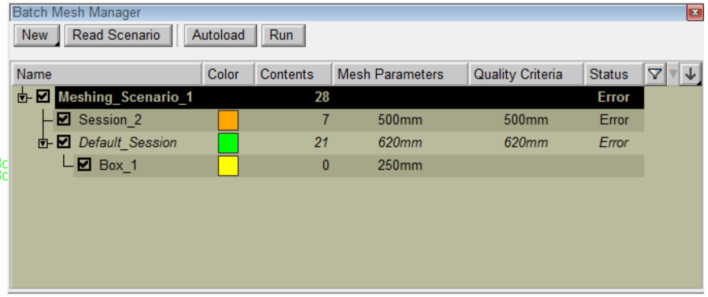


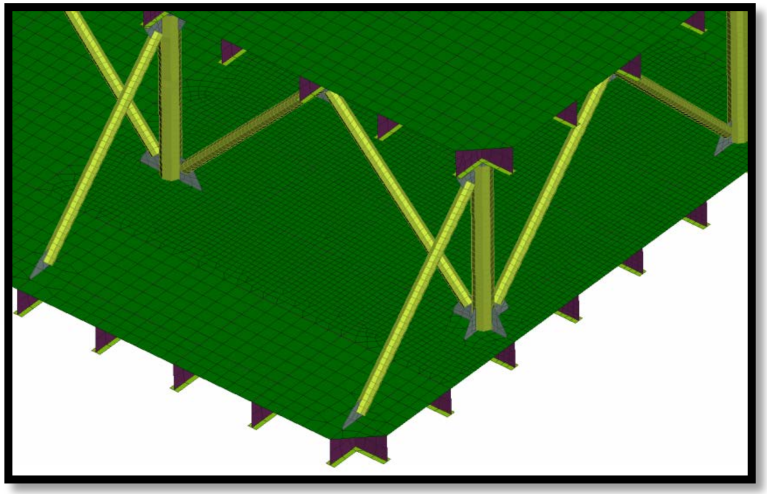
- **75% TIME & EFFORT REDUCTION ON :**
  - Geometry Creation
  - Geometry Clean Up
  - Meshing Generation
  - Meshing Refinement

- Automatic creation of symmetrical entities
- Linked with the original entities by symmetry, translation, rotation & transformation
- Actions applied to the parent entities are applied automatically to the linked ones

Batch Meshing Tool



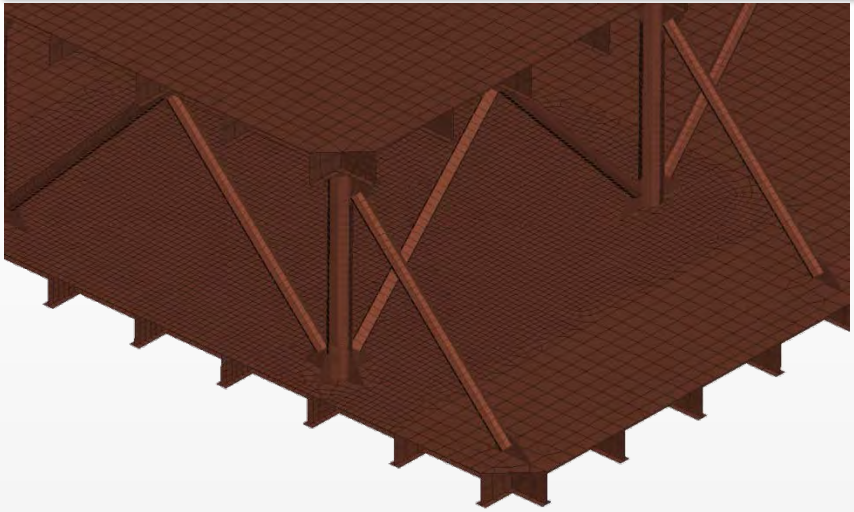


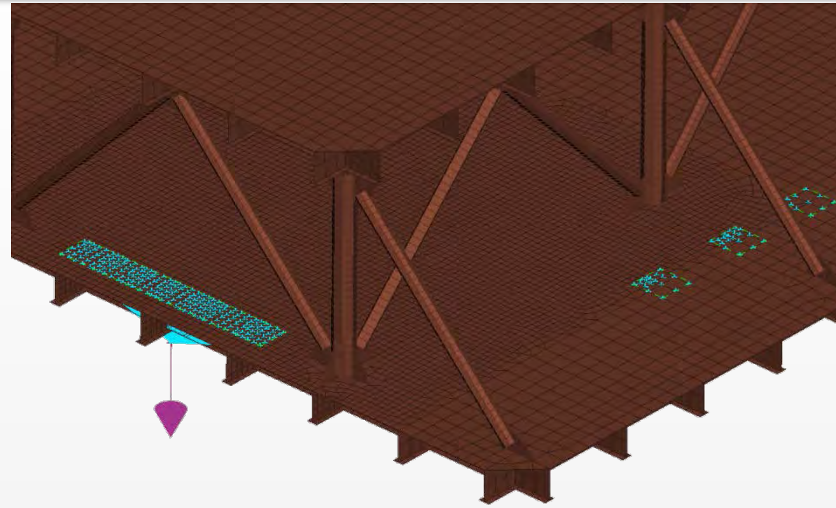


- Automated de-featuring
- User defined mesh parameters and quality criteria
- Automated part assignment in different scenarios
- Special treatment for specific areas of the model defined with boxes

Generic Entity Builders GEBs

Riser and Mooring Forces



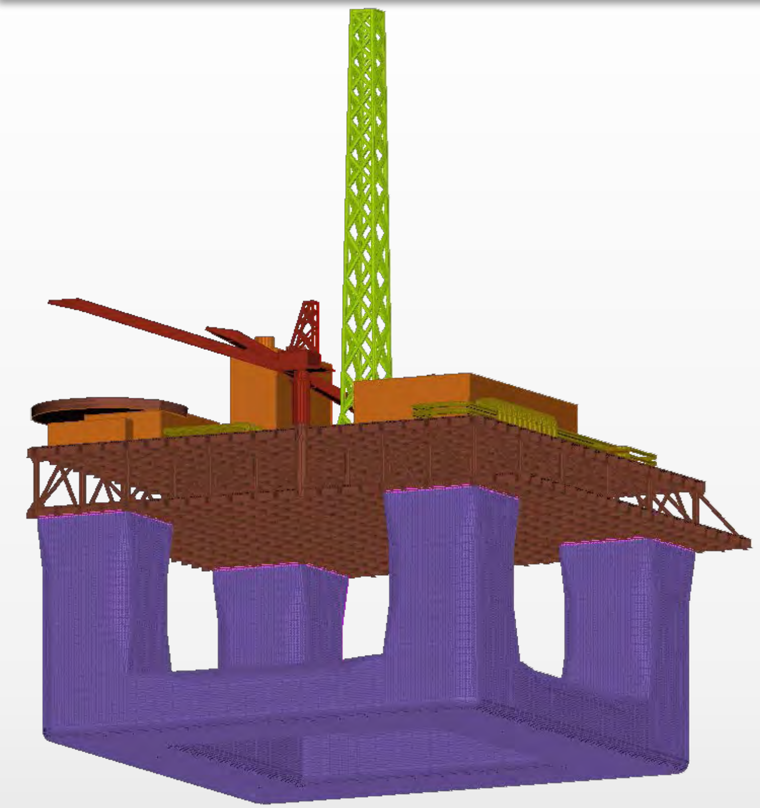


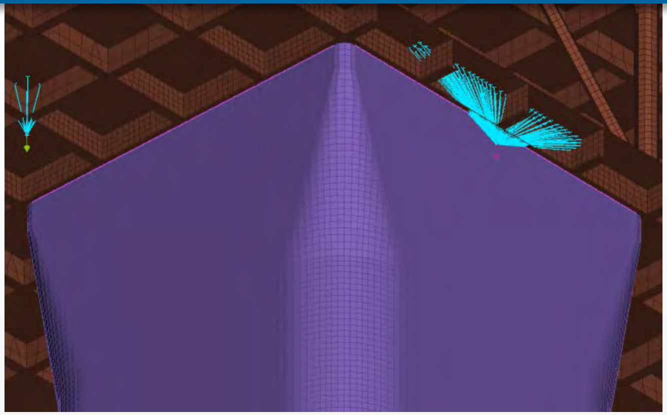
➢ **SEMI-AUTOMATED BOUNDARY CONDITIONS DEFINITION**

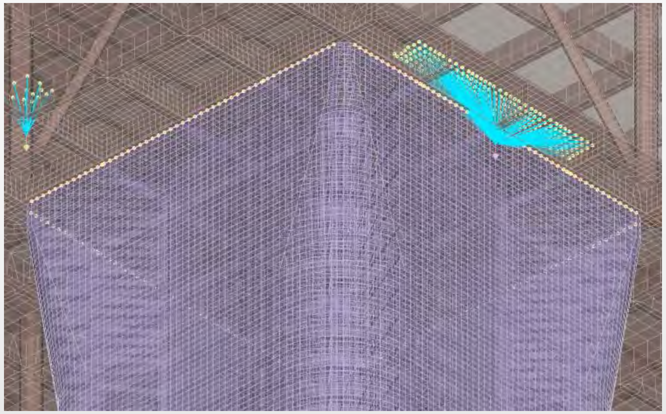
- Performing actions determined by predefined rules
- Automated application on different mesh representations
- Use of library items

Connections Handling

Hull and Deck connection



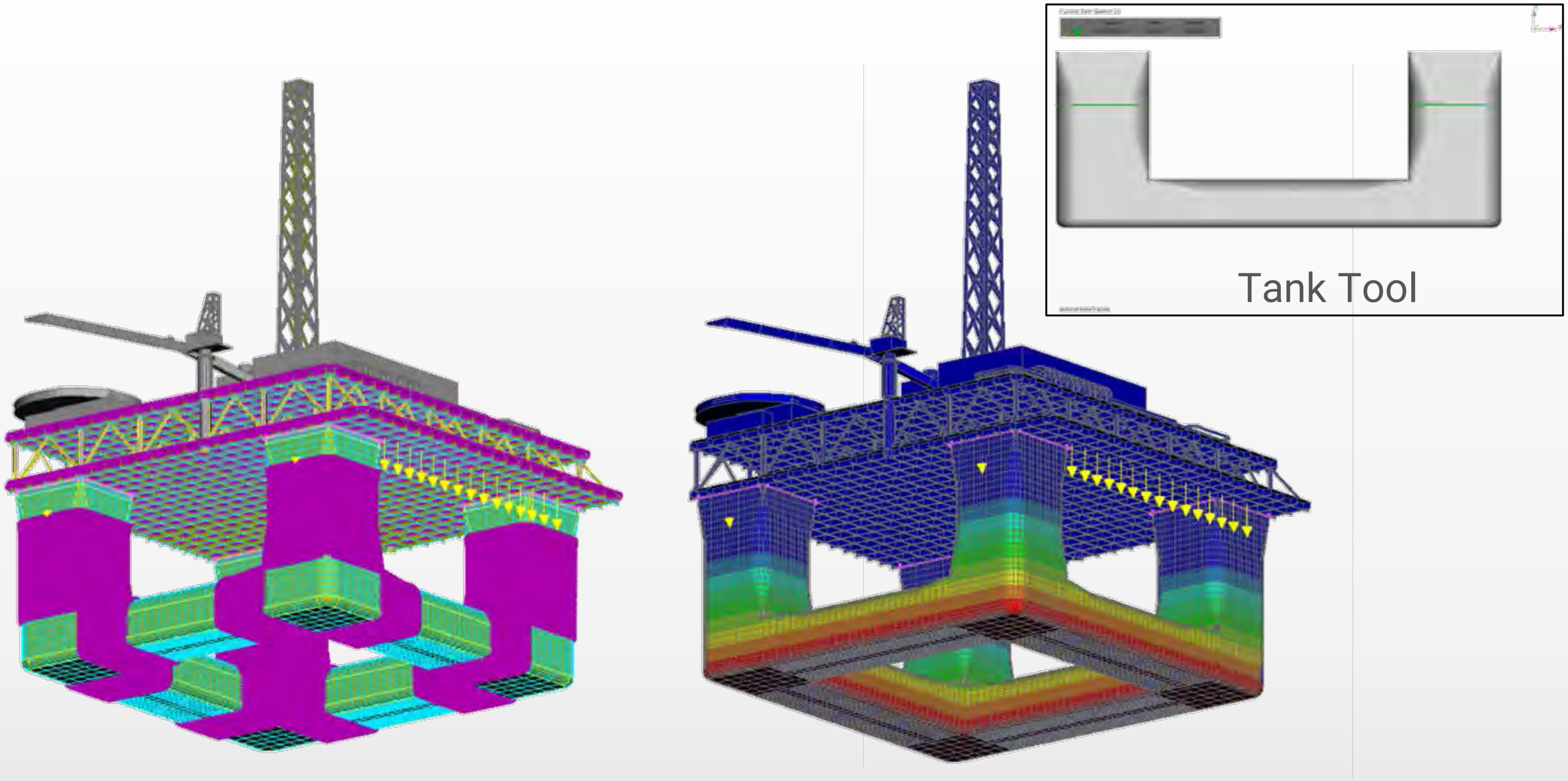




- Connection lines definition for application of various FE representations
- User specified connection parameters
- Massive connection generation

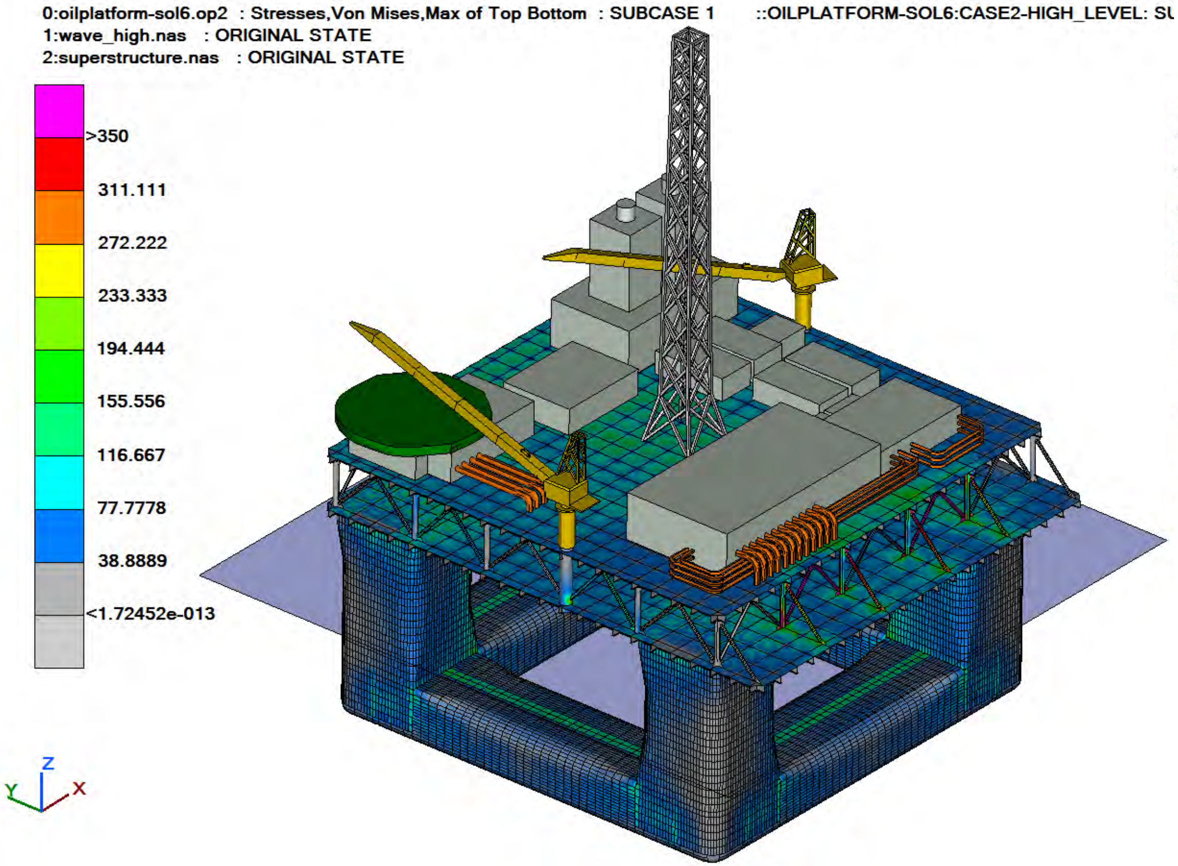
State of Equilibrium

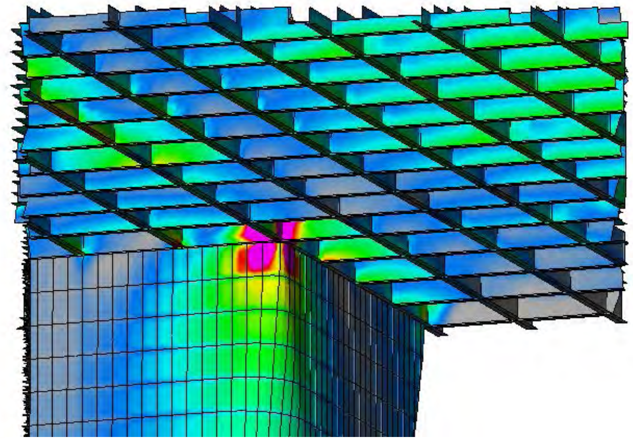
Fully loaded SEMI platform

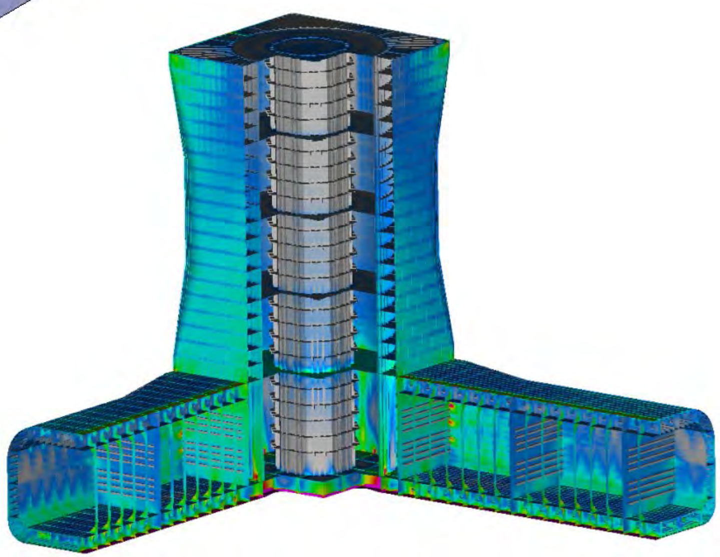


- Auxiliary mass distribution
- Waterline calculation in Tank Tool
- Buoyancy application with Marine & Offshore tool

Results in META



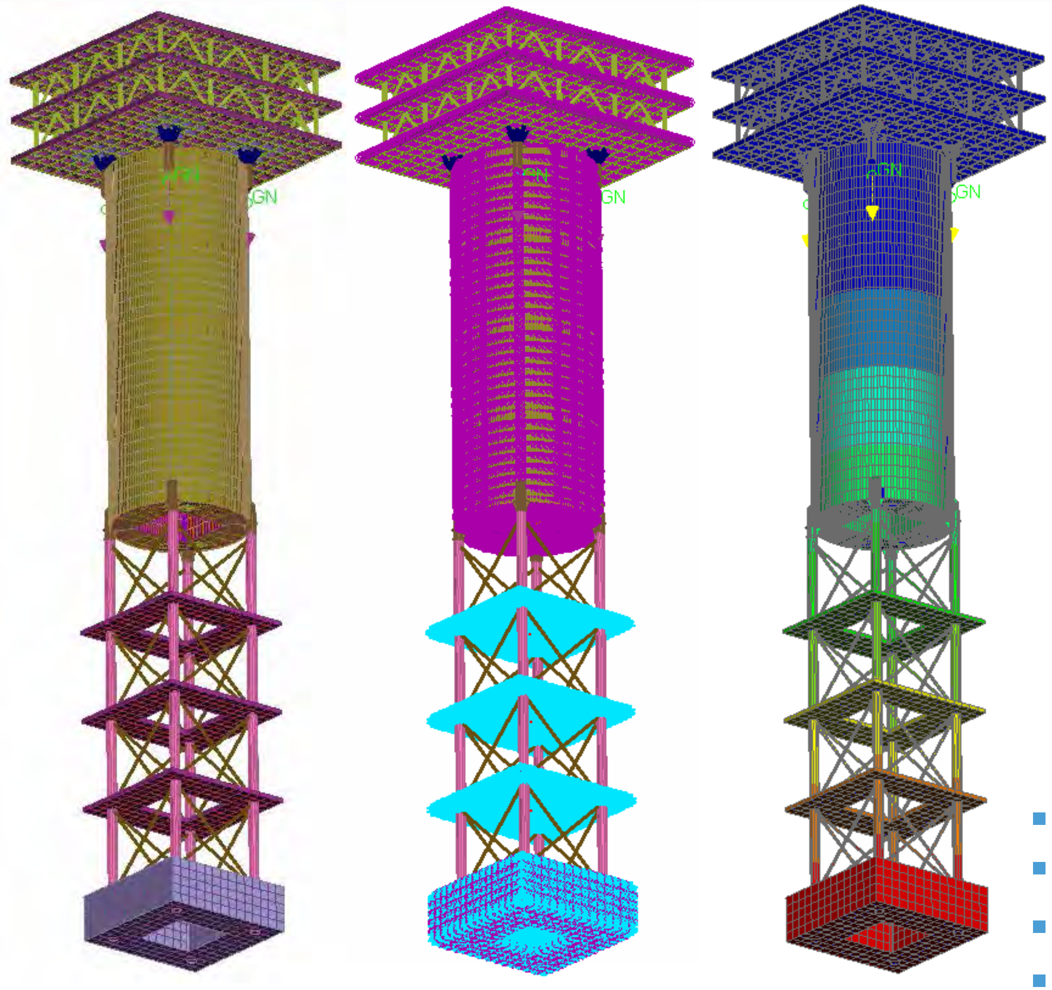


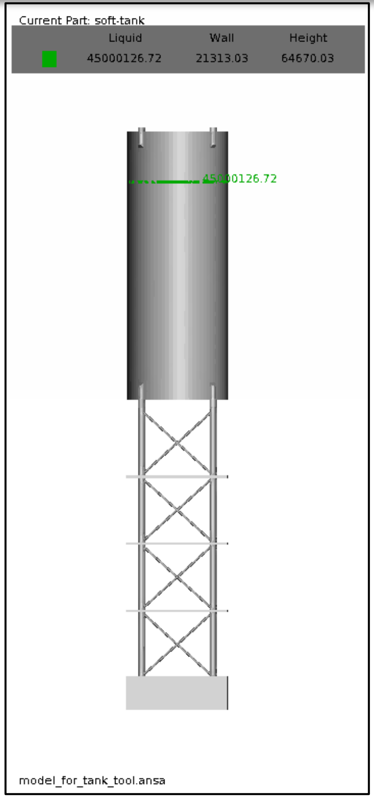


- Von Misses stresses
- The most Critical area
- Displacements

State of Equilibrium

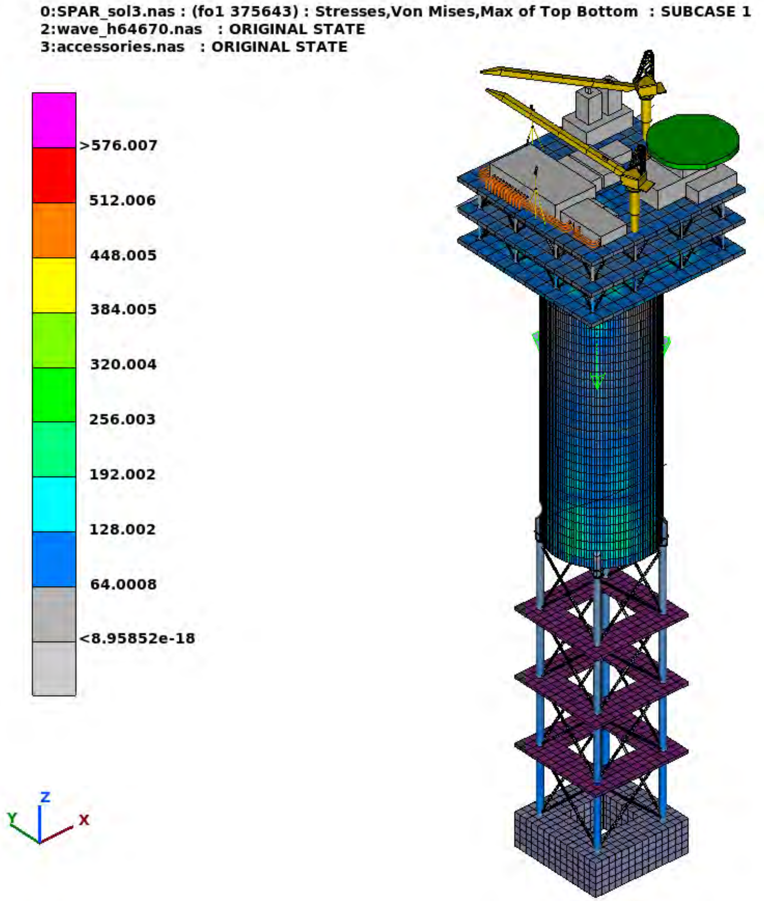
Fully loaded SPAR platform

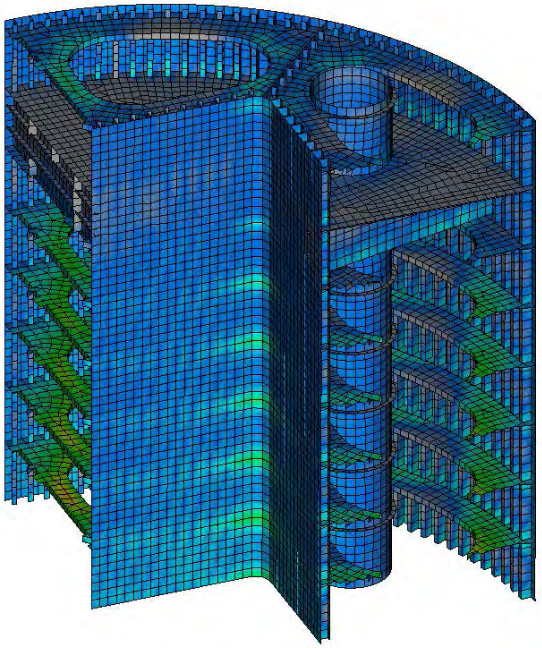


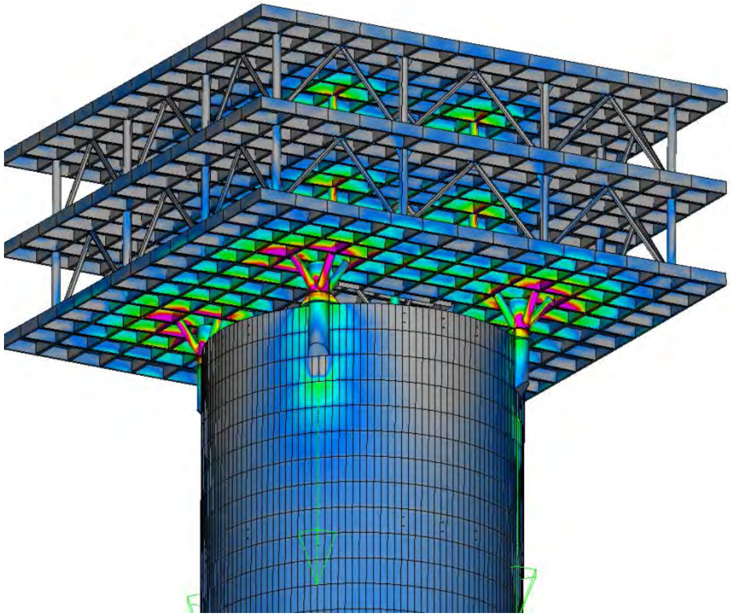


- Mooring Forces defined with GEBs
- Rigidization of the Soft Tank
- Auxiliary mass distribution
- Waterline calculation in Tank Tool
- Buoyancy application

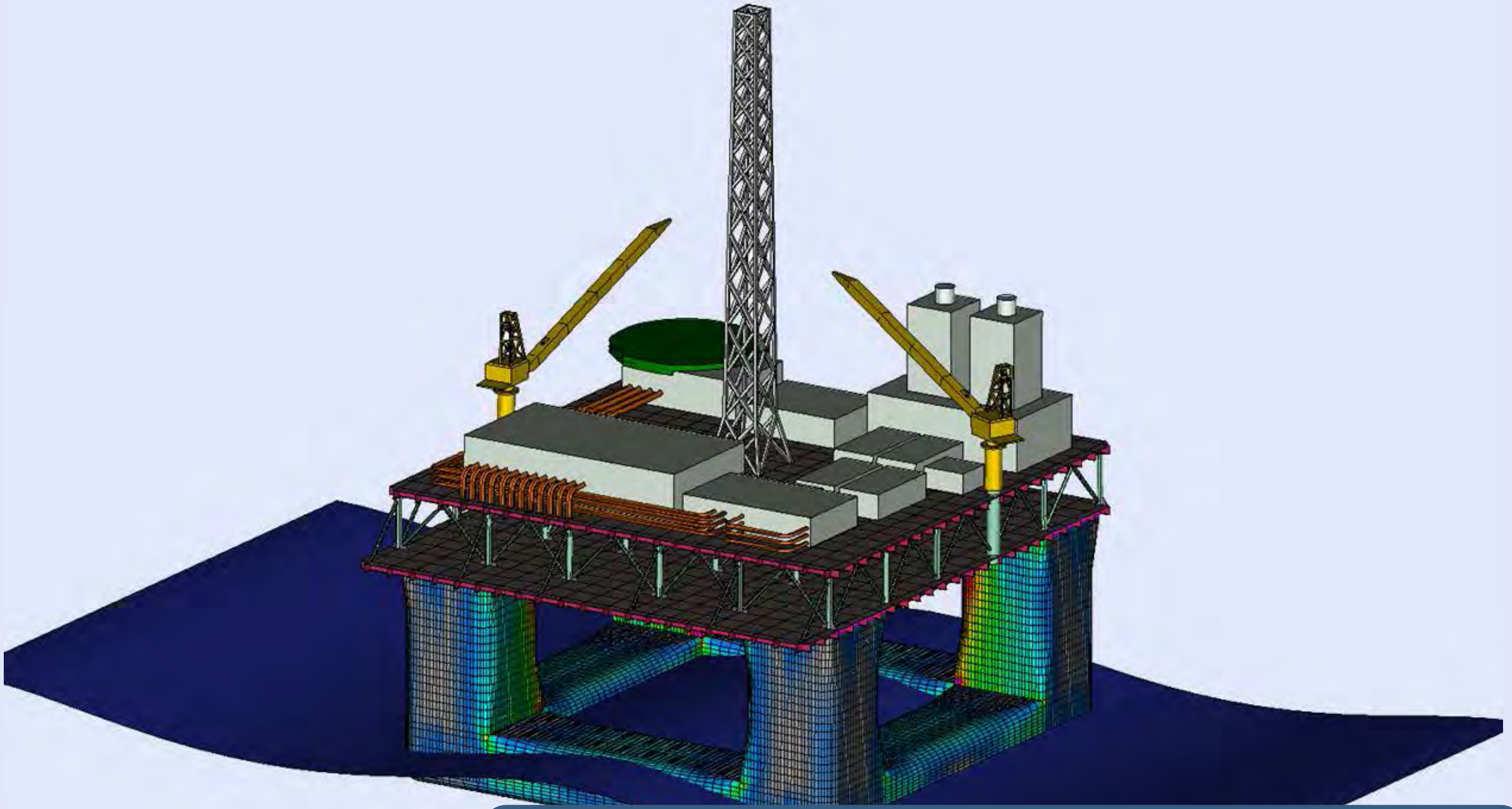
Results in META





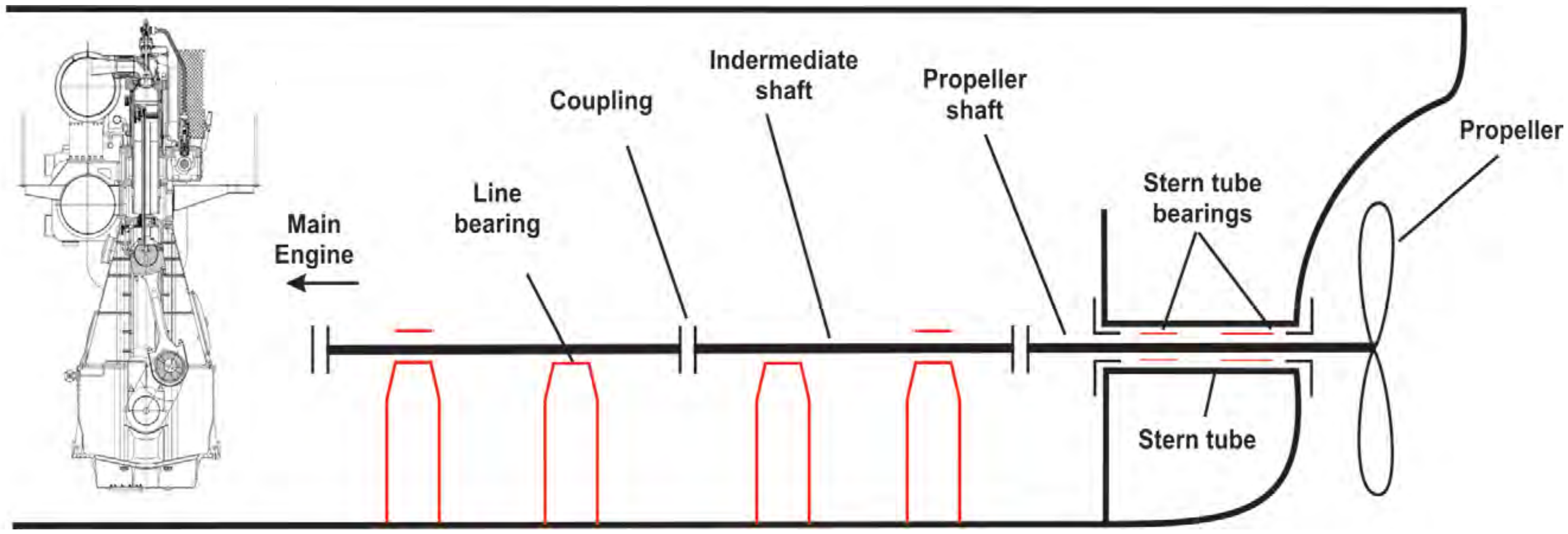


- Von Misses stresses
- The most Critical area
- Displacements



CASE STUDIES

Shaft alignment calculation



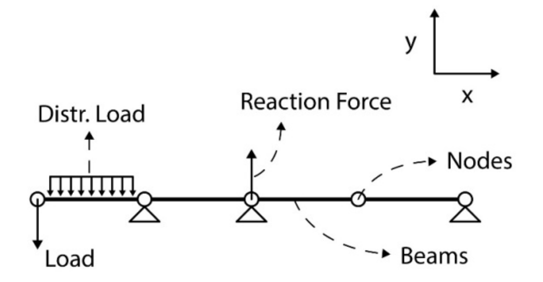
Presented at:
COMPIT 2014 12-14 May, Redworth, UK

Shaft alignment calculation

Process workflow

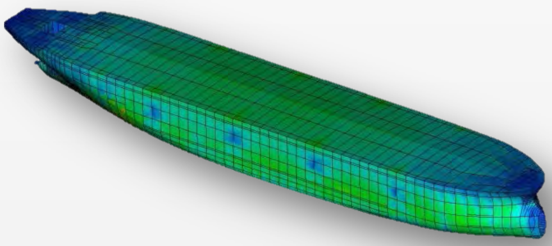
Matrix analysis

- Statically indeterminate multi-supported beams
- Bearing stiffness and clearance
- Dry dock conditions



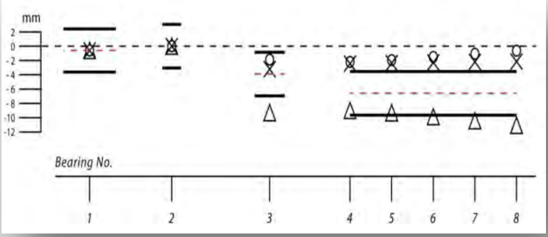
FE analysis

- Hydrostatic equilibrium
- Hull deformations calculation
- Determination of vertical displacements at the bearing locations



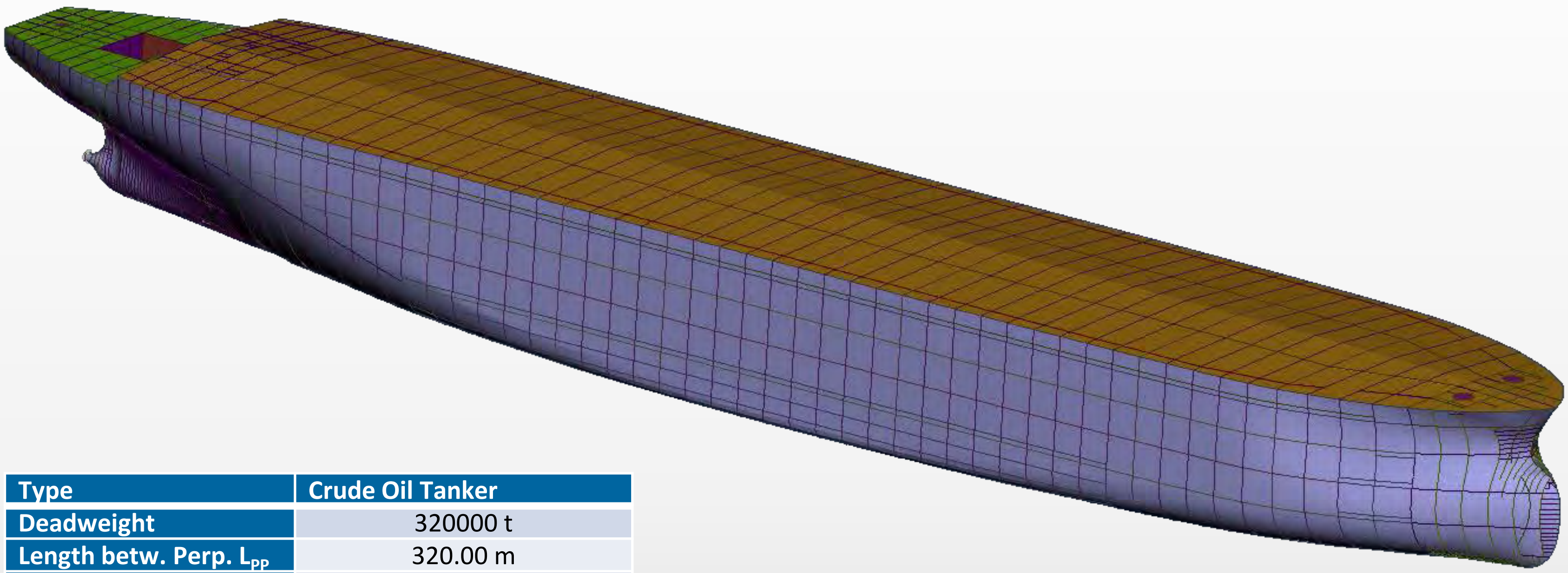
RE-evaluation

- Re-evaluation of static shaft equilibrium



Shaft alignment calculation

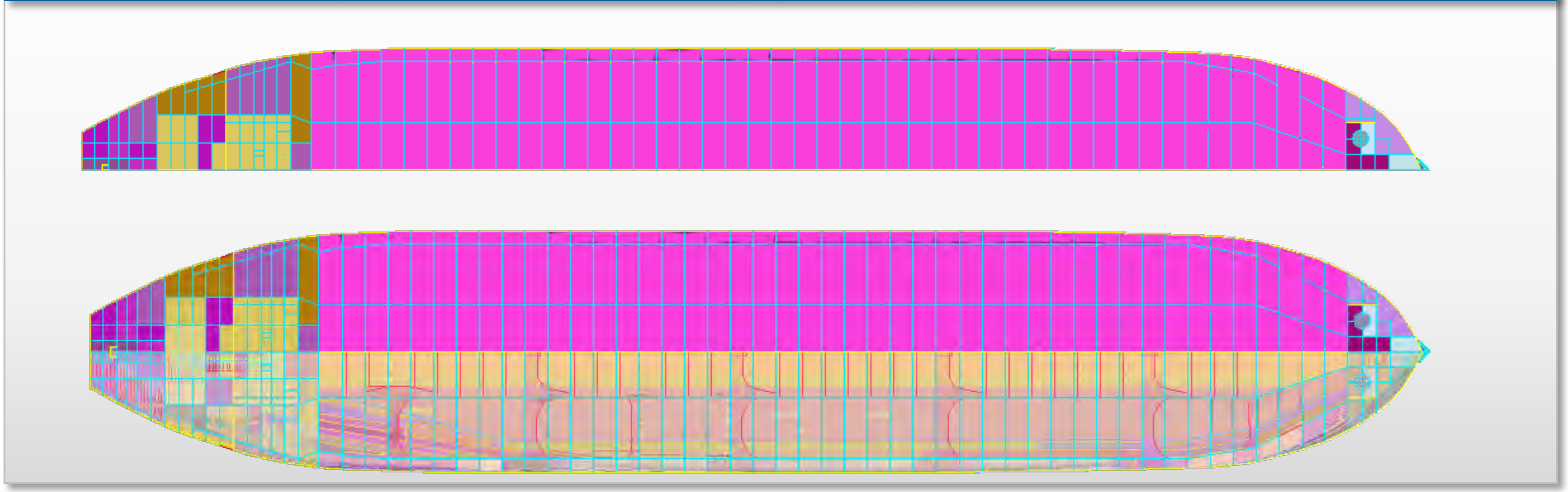
The geometrical model

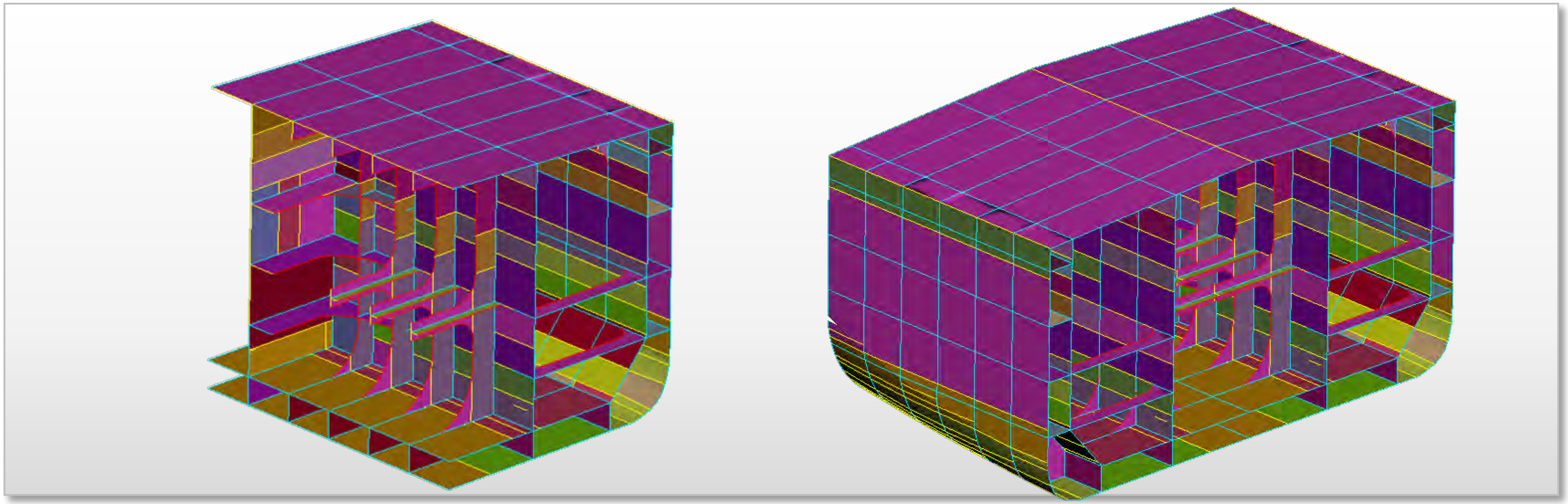


Type	Crude Oil Tanker
Deadweight	320000 t
Length betw. Perp. L_{PP}	320.00 m
Breadth B	60.00 m
Depth D	30.50 m
Scantling draft T	22.50 m
Service speed V_s	15.9 kn
Main engine	Wärtsilä 7RT-FLEX84T-D
Keel laid	April 2010

Shaft alignment calculation

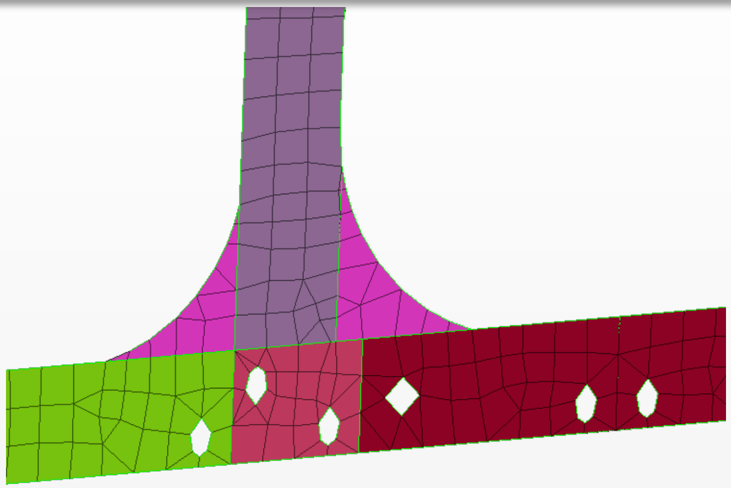
Definition of the symmetrical model using geometry representation

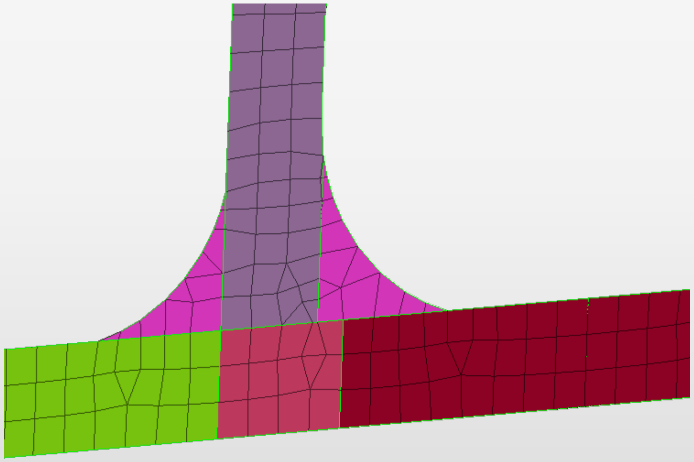




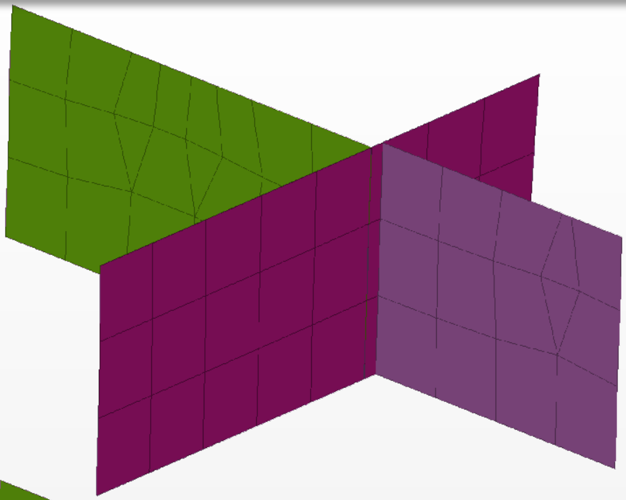
Shaft alignment calculation

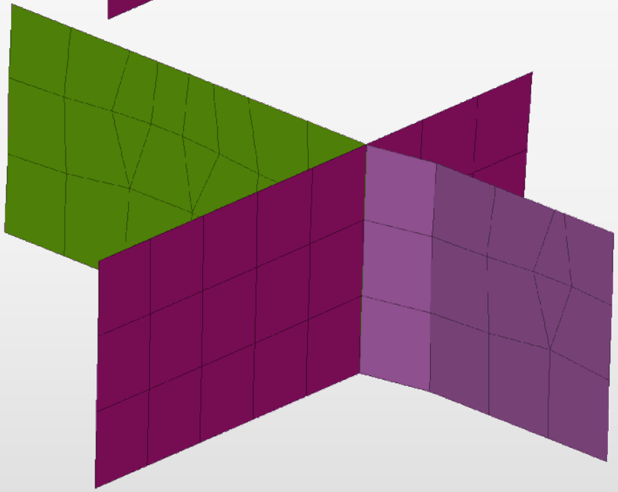
FE model simplification





- Removing holes with diameter smaller than 1m

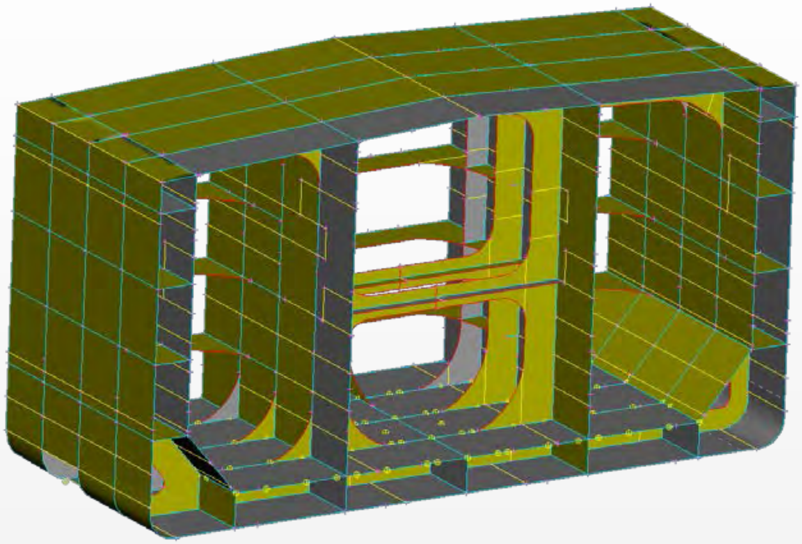


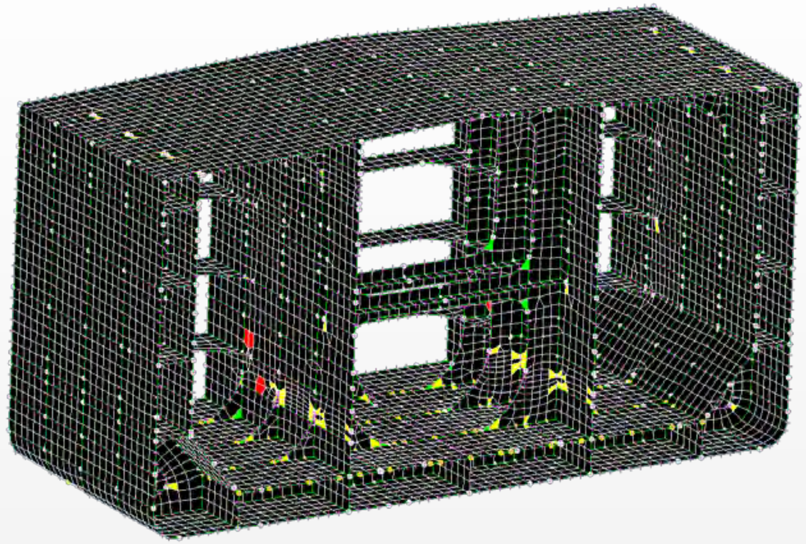


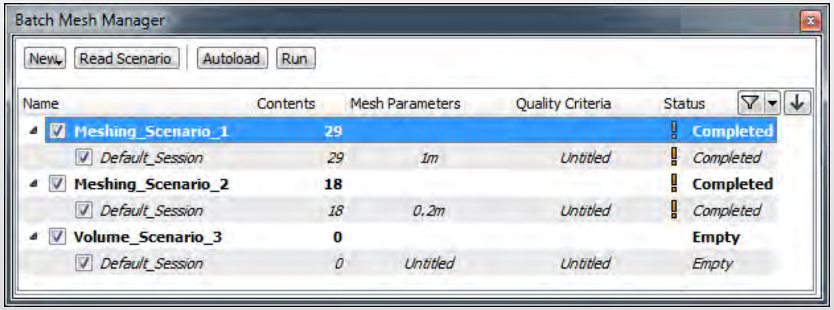
- Moving T-Junction ribs to avoid narrow elements

Shaft alignment calculation

Automatic meshing using the Batch Meshing tool of ANSA





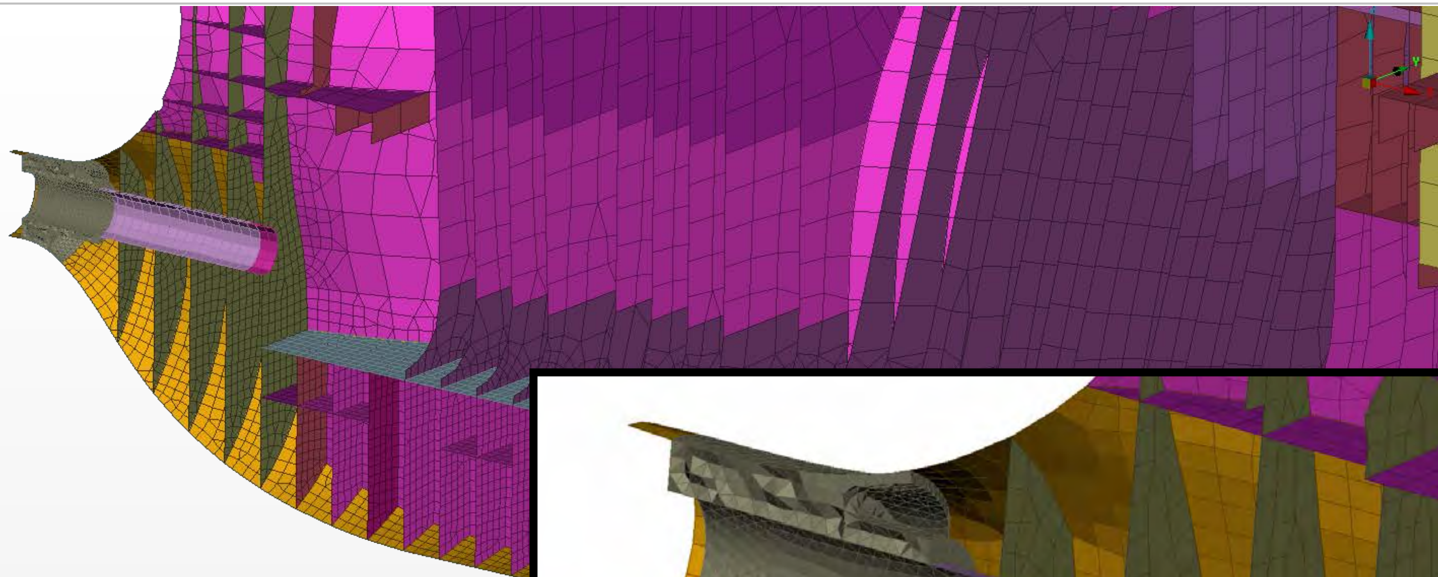

Batch Mesh Manager

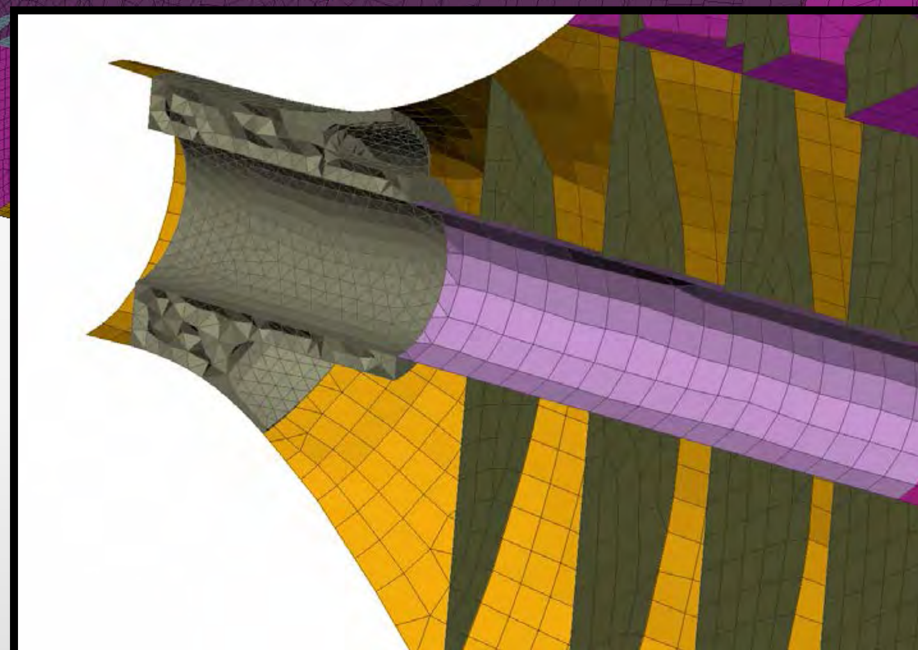
New | Read Scenario | Autoload | Run

Name	Contents	Mesh Parameters	Quality Criteria	Status
Meshing_Scenario_1	29			Completed
Default_Session	29	1m	Untitled	Completed
Meshing_Scenario_2	18			Completed
Default_Session	18	0.2m	Untitled	Completed
Volume_Scenario_3	0			Empty
Default_Session	0	Untitled	Untitled	Empty

Global Meshing Parameters (Scenario I)	
Element length	0.95 m
Filling openings with diameter	< 1m
Engine room floor Meshing Parameters (Scenario II)	
Element length	0.2
Filling openings with diameter	< 0.5m
Quality Criteria	
Skewness (Nastran)	30°
Aspect ratio (Nastran)	3
Angle (Quads)	45-135°
Angle (Trias)	30-120°
Minimum Element Length	0.01 m
Maximum Element Length	1.5 m

Shaft alignment calculation



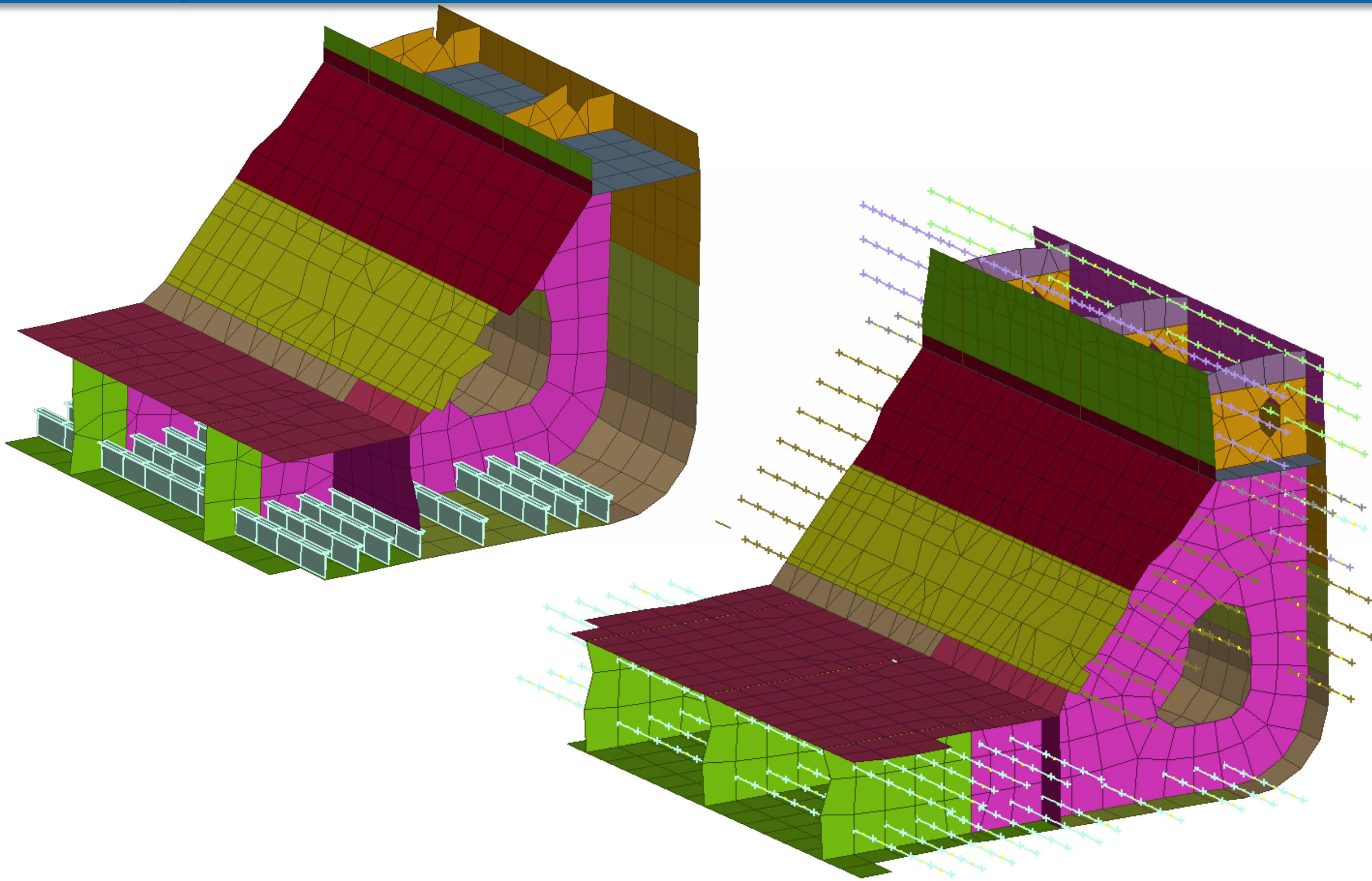


- Fine mesh on engine room
- Solid mesh on stern tube

Total number of elements	
Shell elements	402000
Beam elements	143000
Solid tetrahedrals	17000

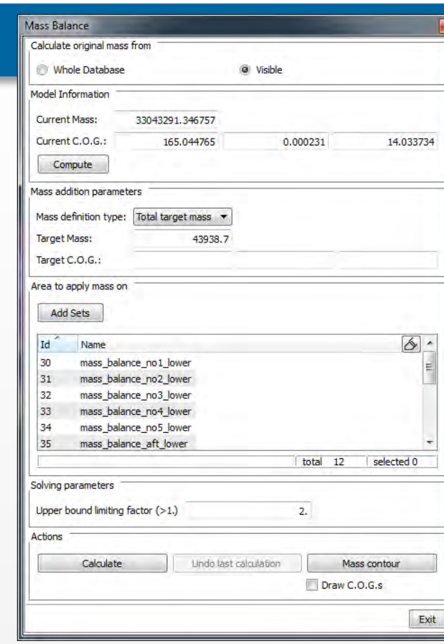
Shaft alignment calculation

Stiffeners representation with BEAMS and TRUSS

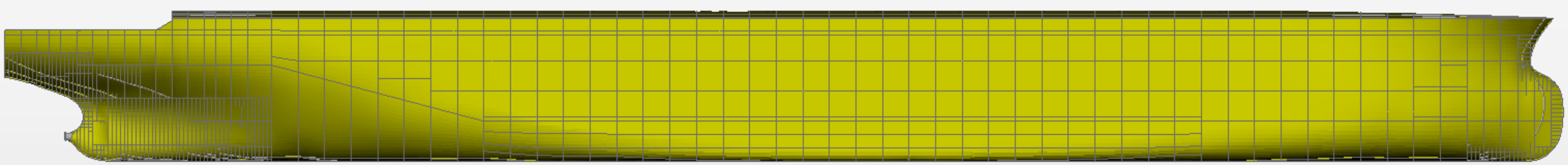


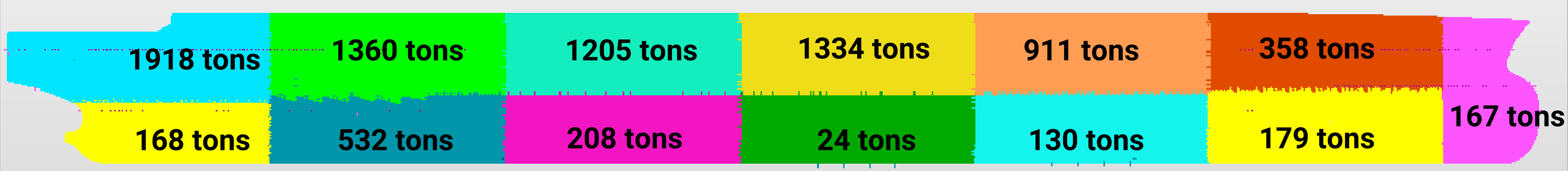
Shaft alignment calculation

Non-structural mass distribution



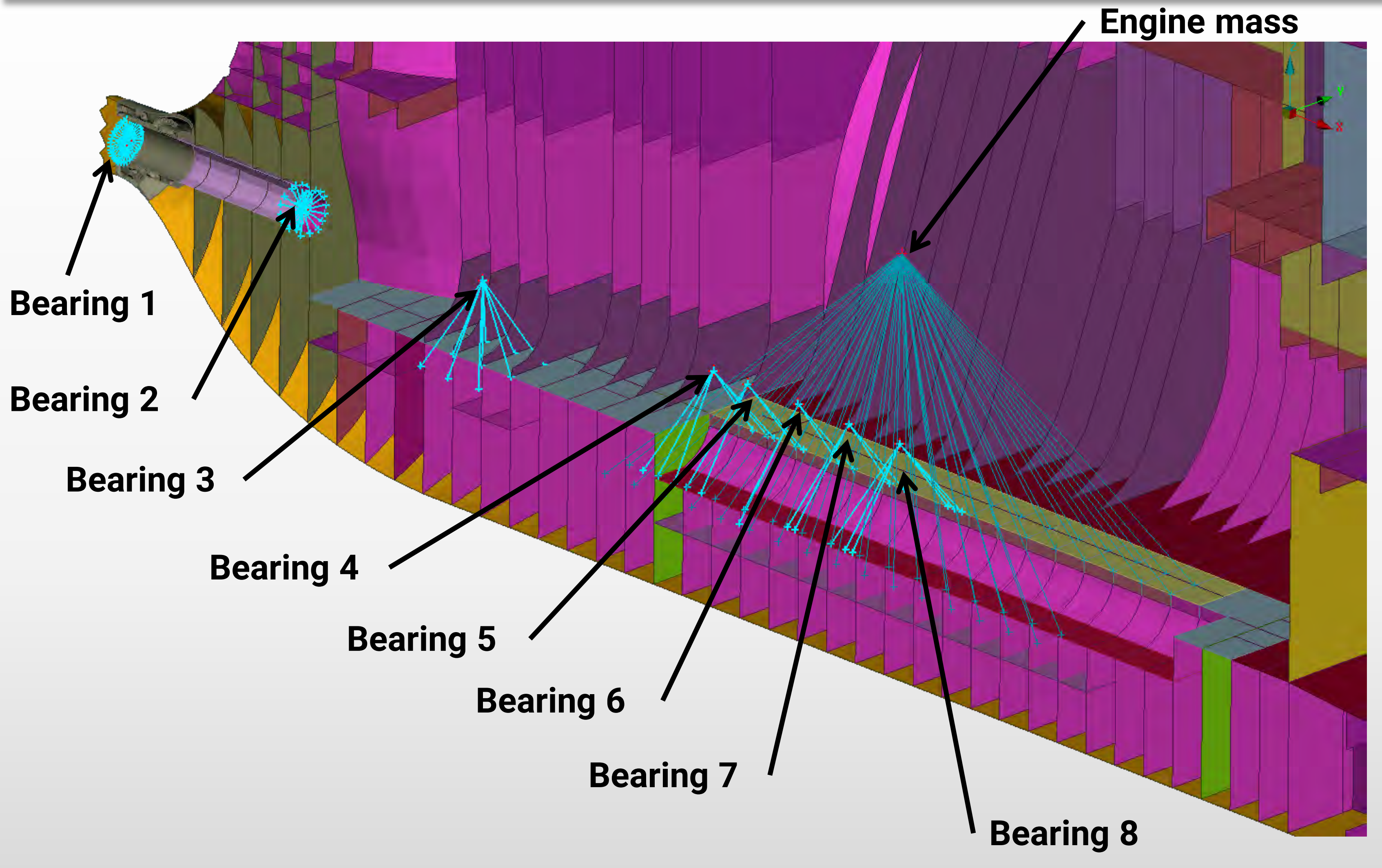
- FE structure: 34442 tons
- Lightship: 43938.7 tons
- Added mass: 9496.7 tons





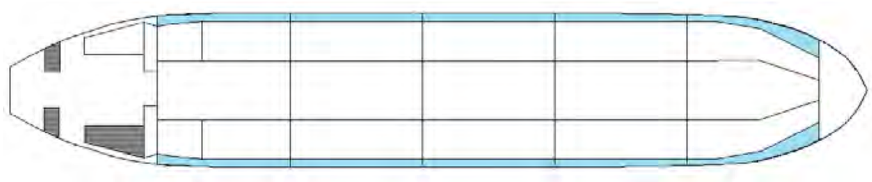
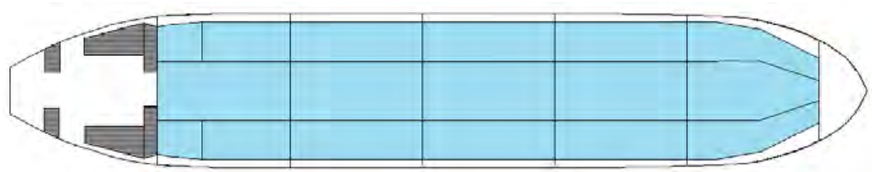
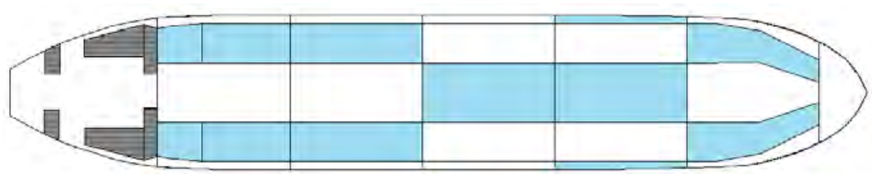
Shaft alignment calculation

Engine and bearings representation using RBE2 and RBE3



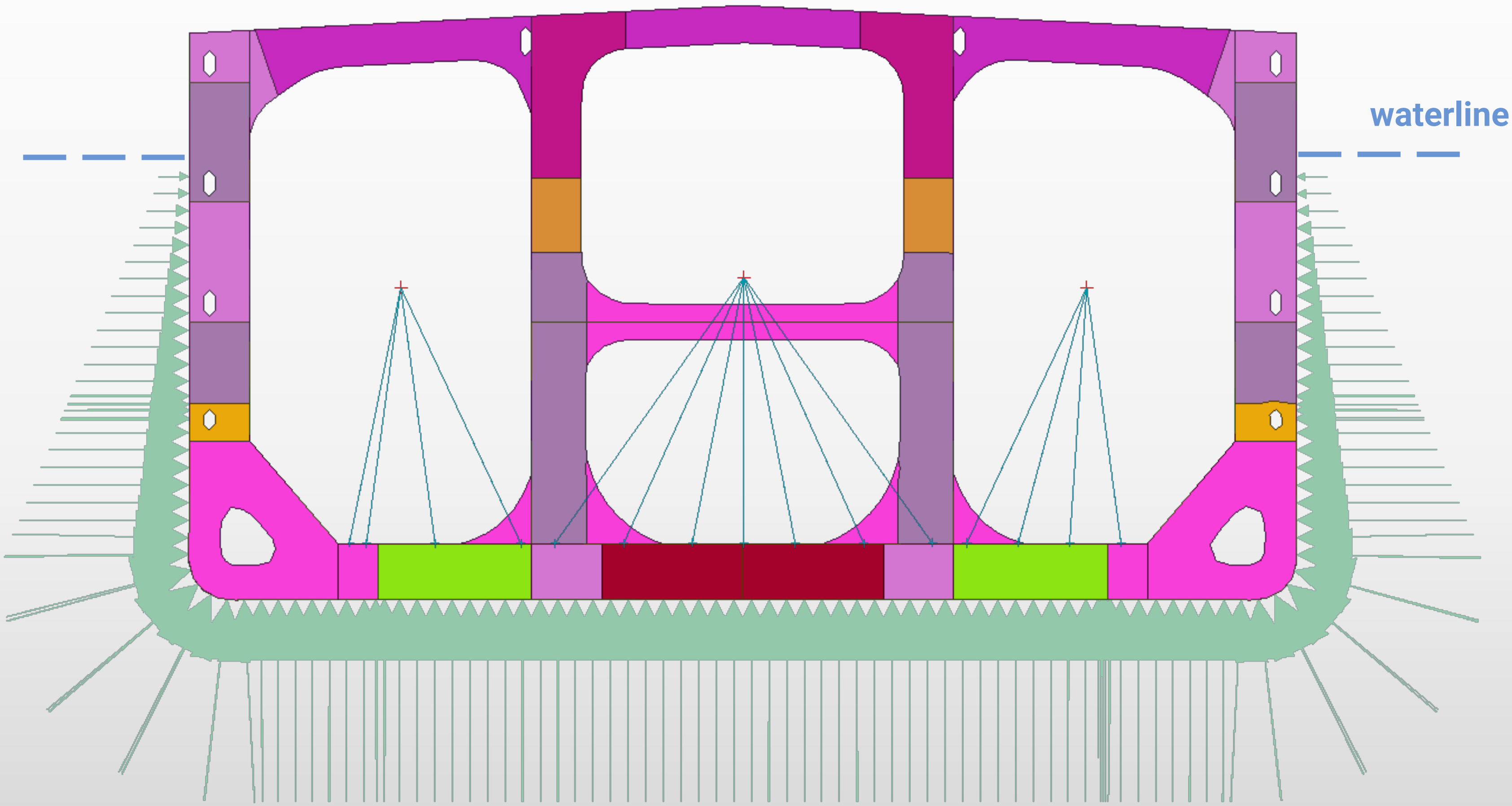
Shaft alignment calculation

Loading conditions

Ballast arrival condition (L.C. 1) **Displacement: 145647 tones** **Draft: 9.69 m** **Trim: 2.12 m**	
Full-load departure condition (L.C. 2) **Displacement: 364074 tones** **Draft: 22.52 m** **Trim: 0.11 m**	
Departure with partial load (L.C. 3) **Displacement: 229276 tones** **Draft: 14.78 m** **Trim: 3.05 m**	

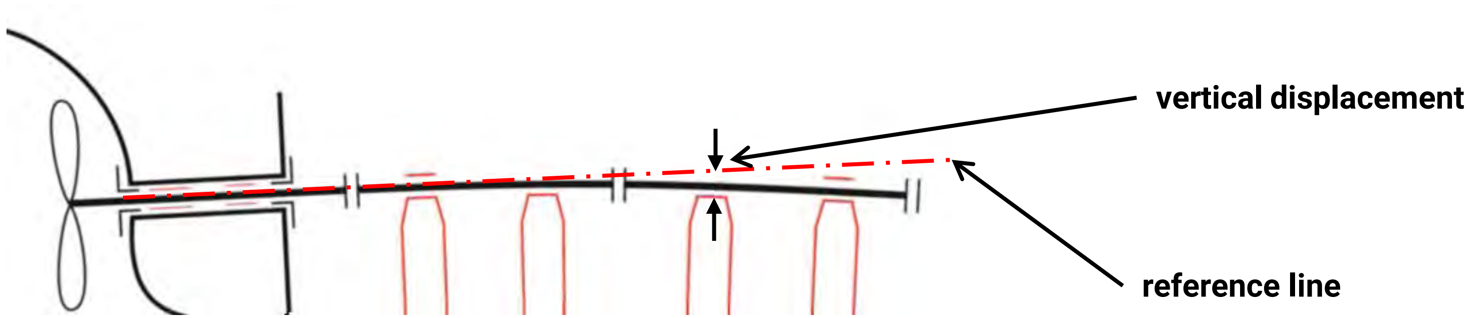
Shaft alignment calculation

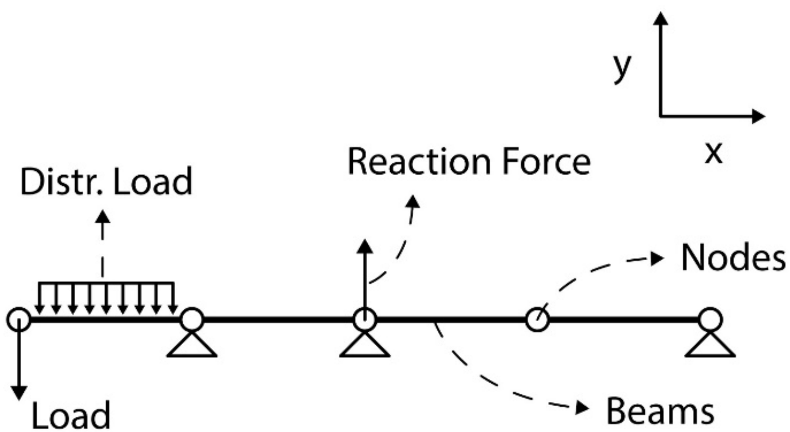
- Application of hydrostatic pressure due to buoyancy
- Application of loads as mass connected with RBE3
- Balance of the hull and Inertia Relief application



Shaft alignment calculation

- Set up reference line
- Define the static conditions of the vessel
- Modeling the shafting system

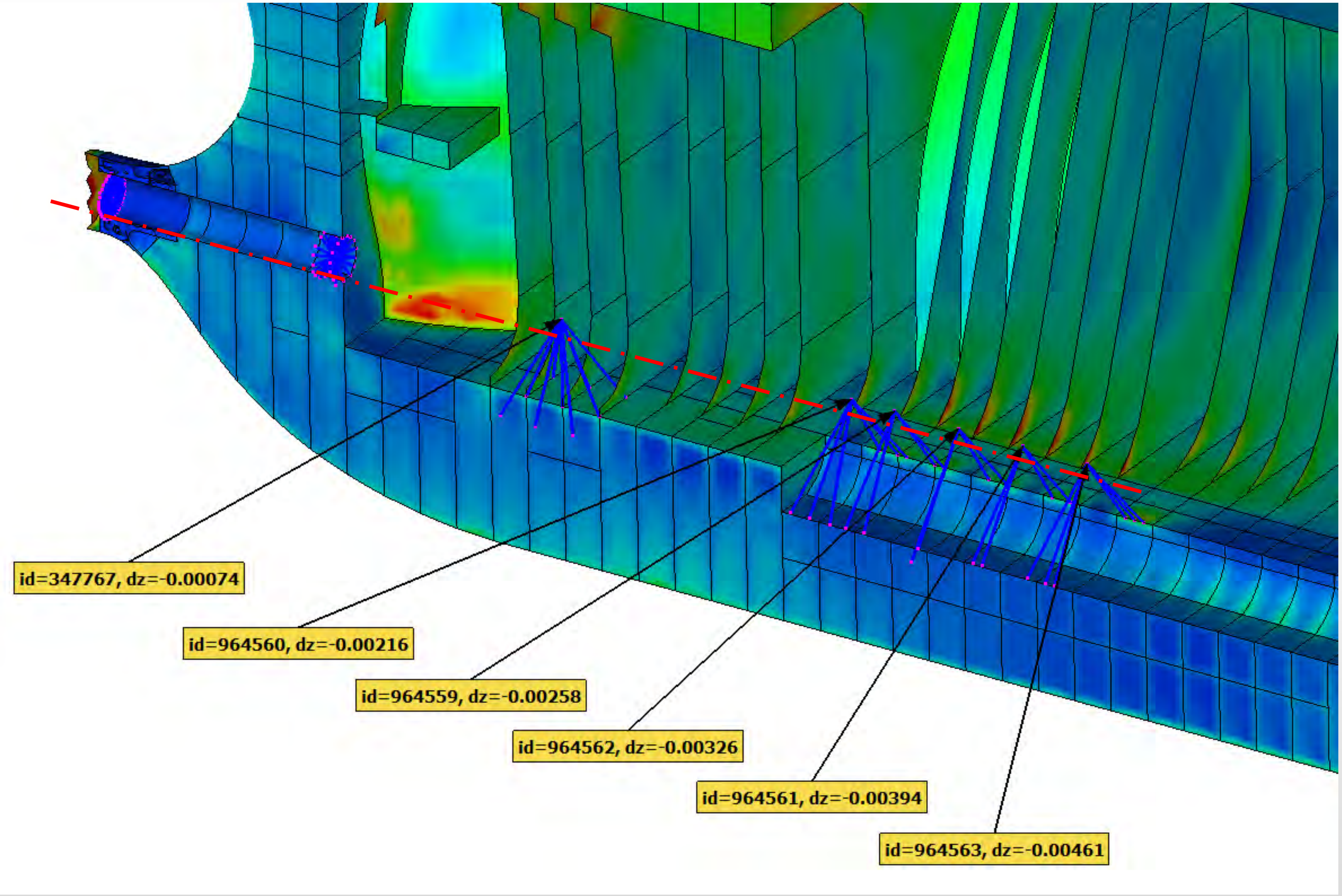




Shaft alignment calculation

Computational Results

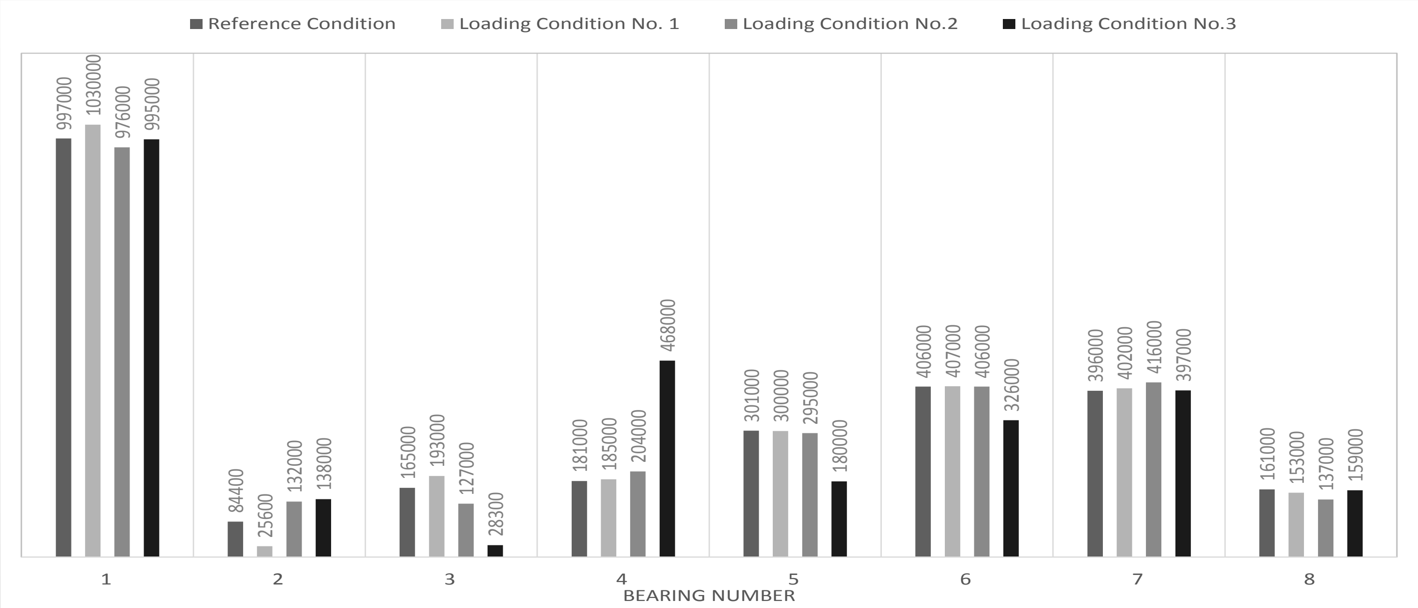
Displacements of bearings according to reference line



Shaft alignment calculation

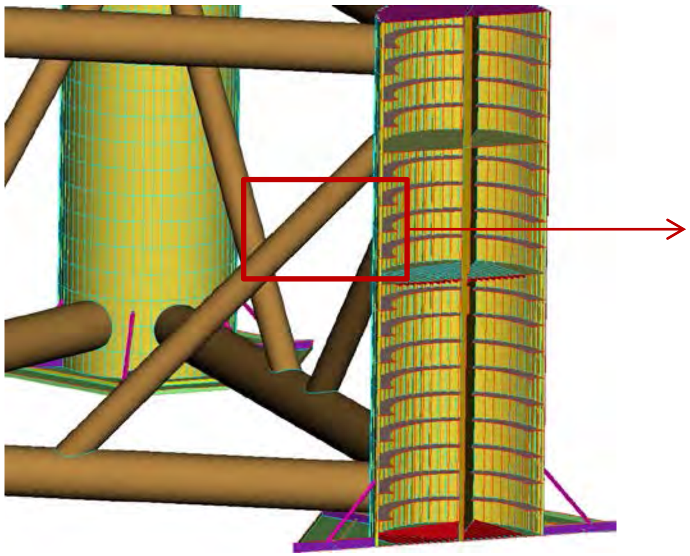
Bearing vertical offsets at different loading conditions

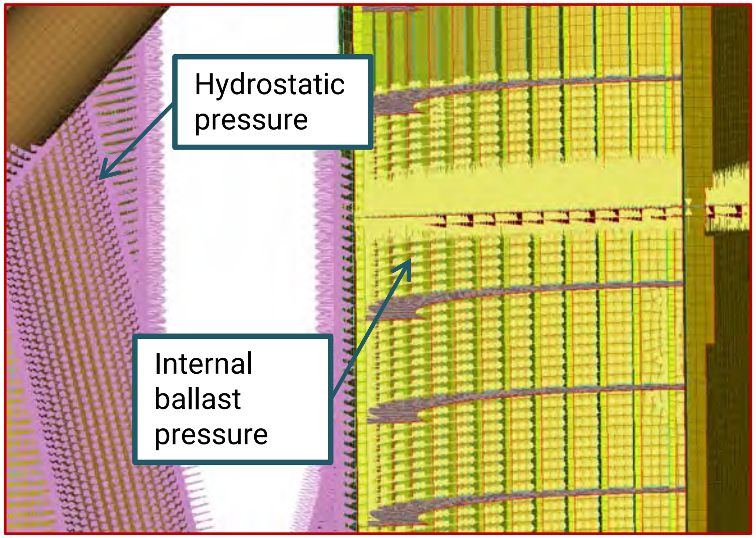
Bearing	Initial case (even keel)	Loading Condition 1	Loading Condition 2	Loading Condition 3
Aft S/T	-0.06	-0.06	-0.06	-0.06
For S/T	0.00	0.00	0.00	0.00
Intermediate	-3.9	-1.89	-4.66	-3.12
M/E 1	-6.60	-2.27	-8.99	-2.44
M/E 2	-6.60	-1.96	-9.32	-2.37
M/E 3	-6.60	-1.50	-9.85	-2.28
M/E 4	-6.60	-1.06	-10.44	-2.20
M/E 5	-6.60	-0.63	-11.07	-2.14



Offshore Wind Turbine Geometry Parameterization and structural analysis

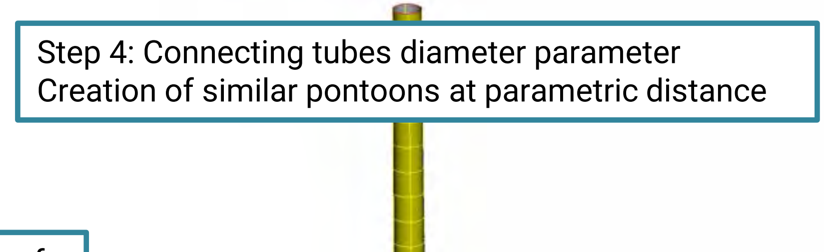
- Structural analysis of offshore wind turbine aiming to see displacements and stresses under load.
- Highly detailed model including ribs and stiffeners
- Pressure loads were auto calculated and applied both for the sea hydrostatic pressure and the Ballast reservoirs.
- Gravity and an equivalent concentrated air pressure at the turbine nacelle

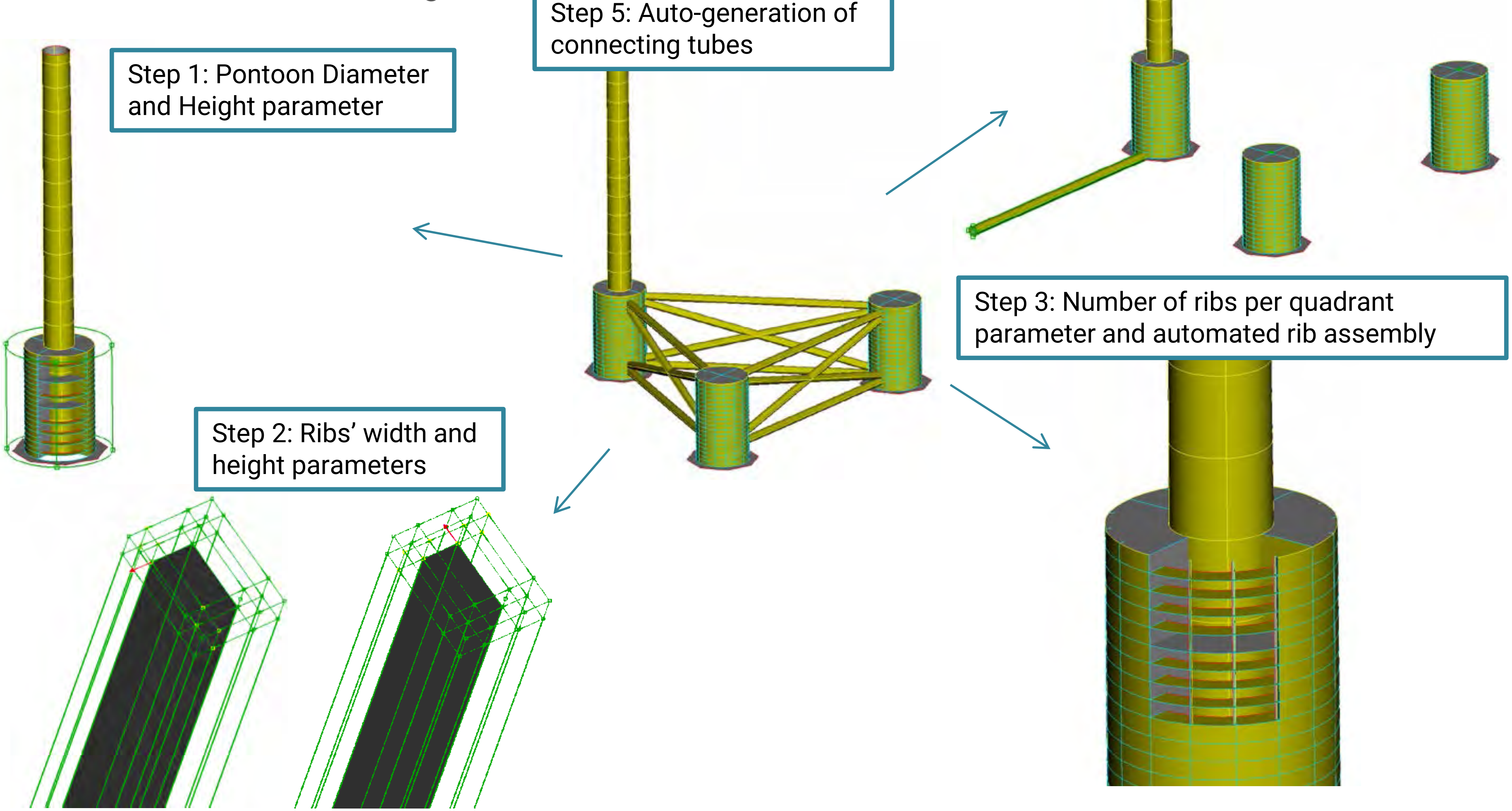




The geometrical model was parameterized in order to automatically generate different designs regarding:

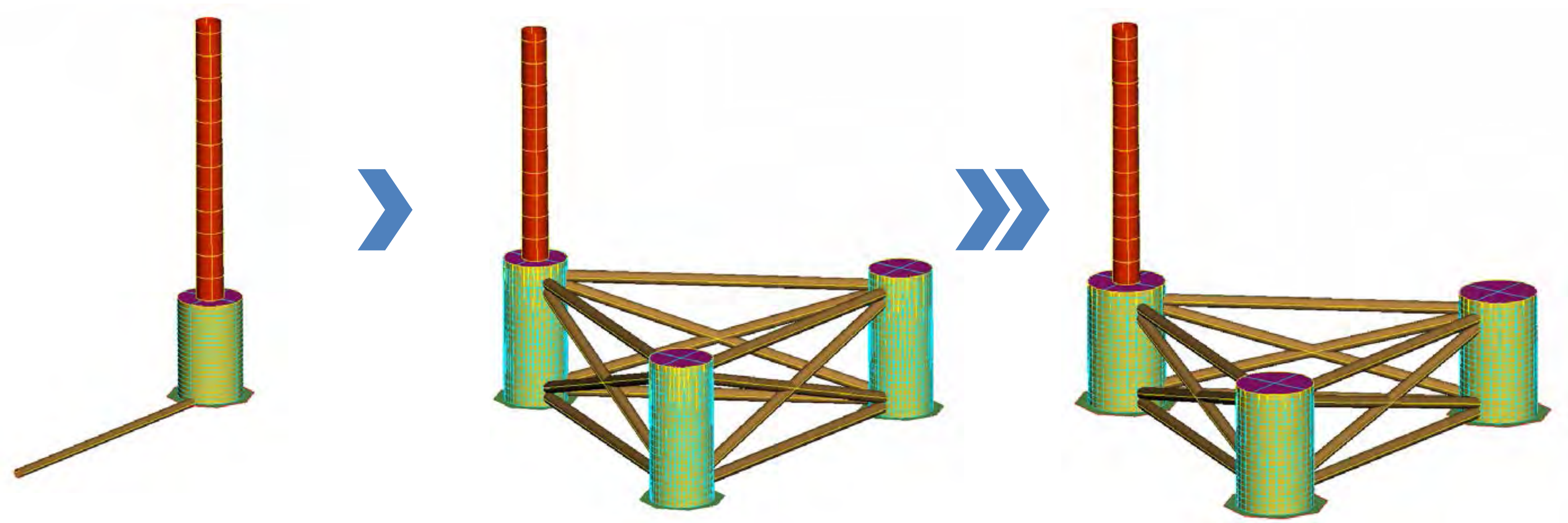
- Pontoon Diameter and Height
- Ribs Width, Height and Number
- Distance between pontoons
- Diameter of connecting tubes





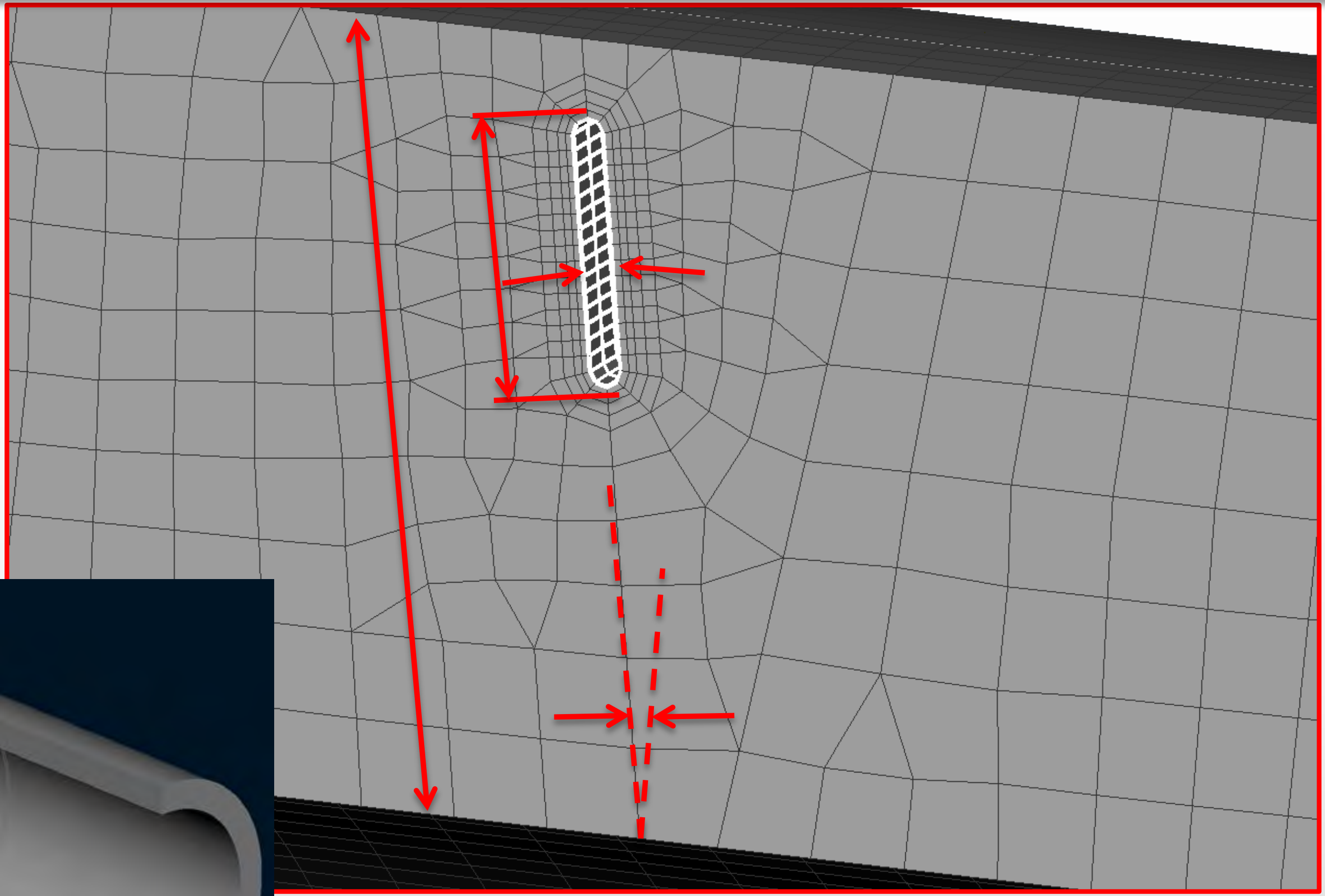
Design Of Experiments

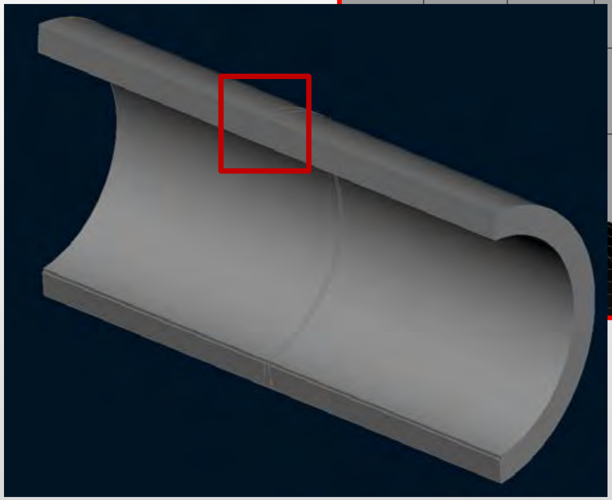
With this automated functionality, Multiple designs can be created with different configurations as a Design Of Experiments study, using several different algorithms (ULH, Random, Full Factorial, Taguchi) to provide the Design Variable values



Automated Crack modeling and parameterization

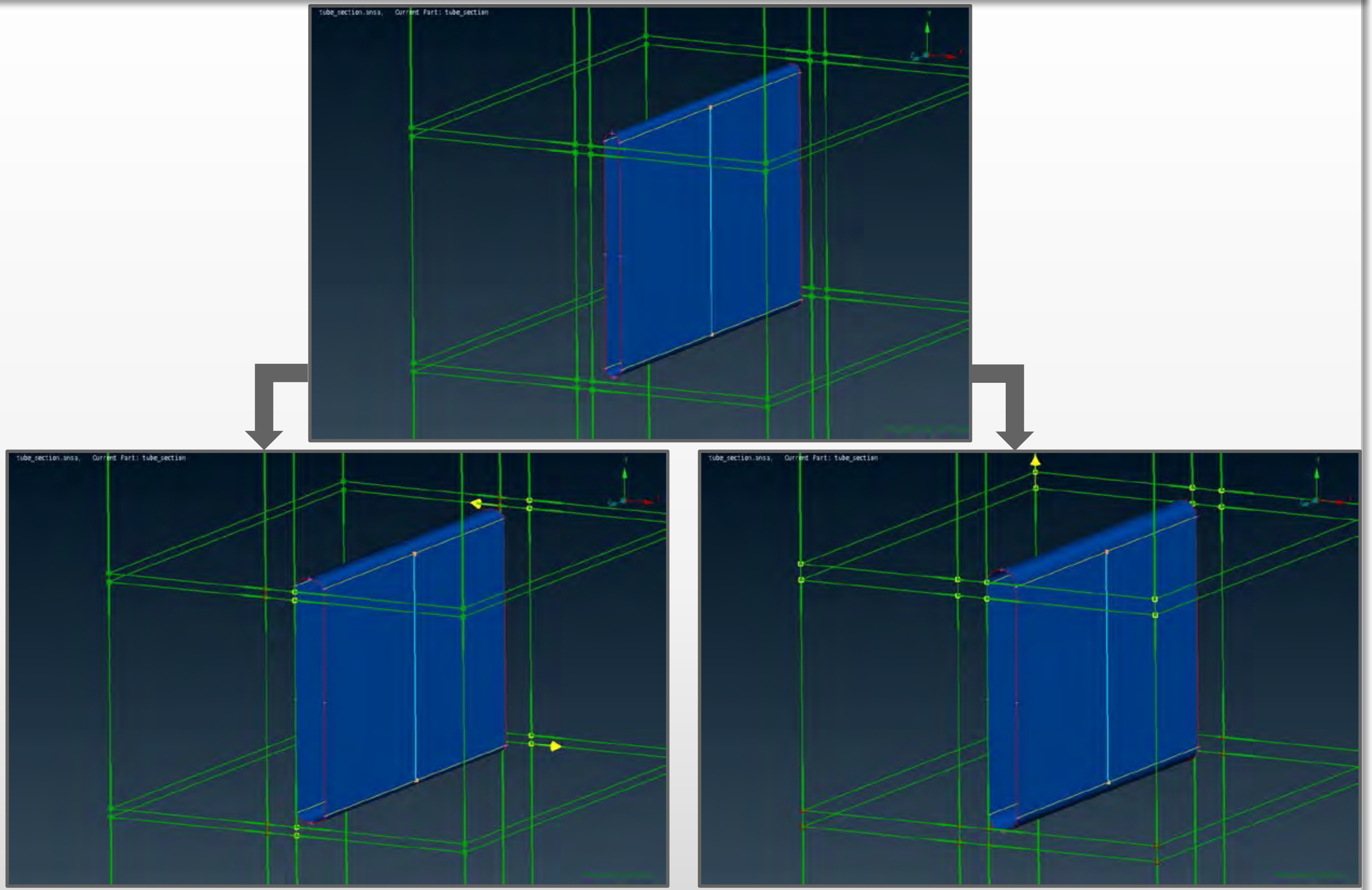
Requirements





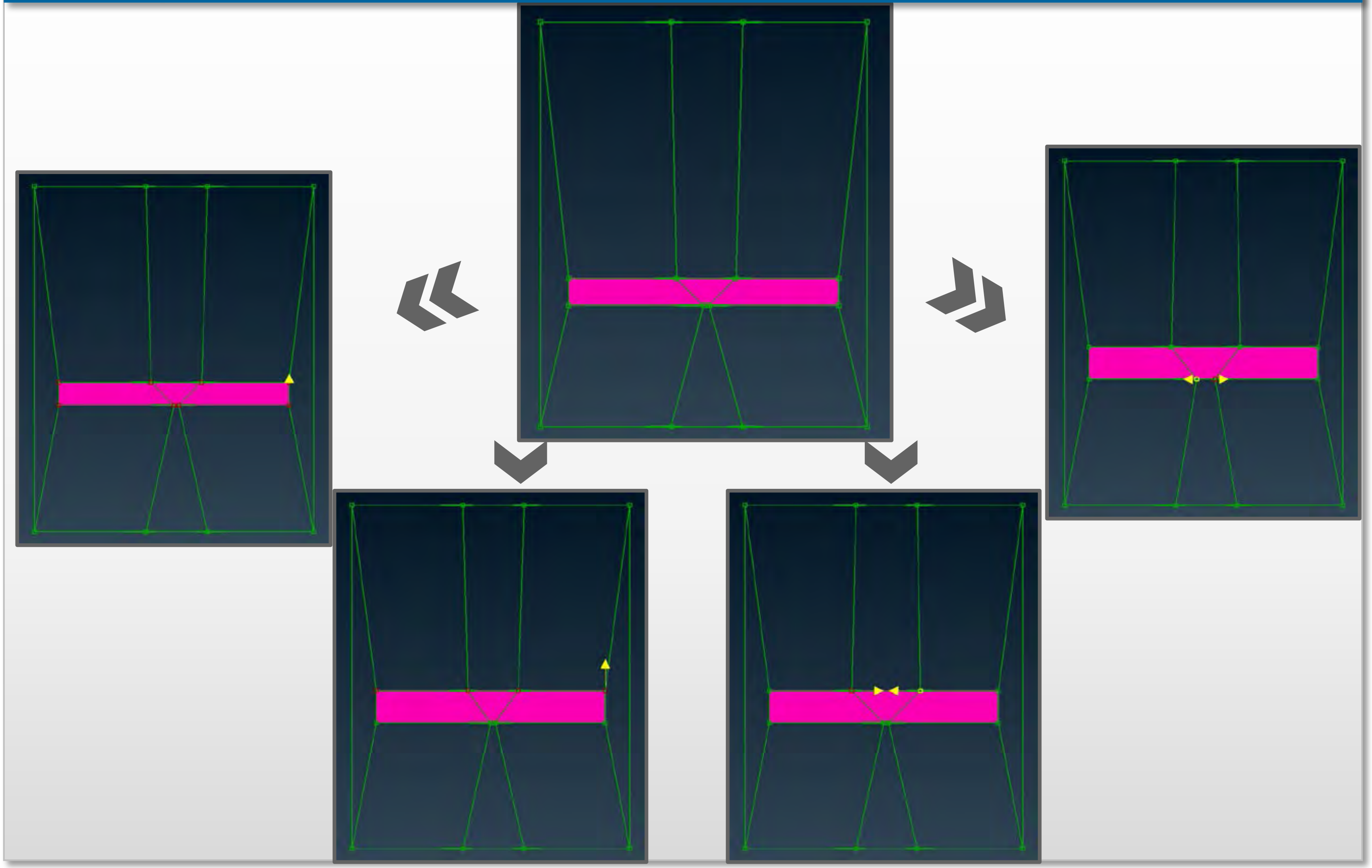
Automated Crack modeling and parameterization

Crack body parameters



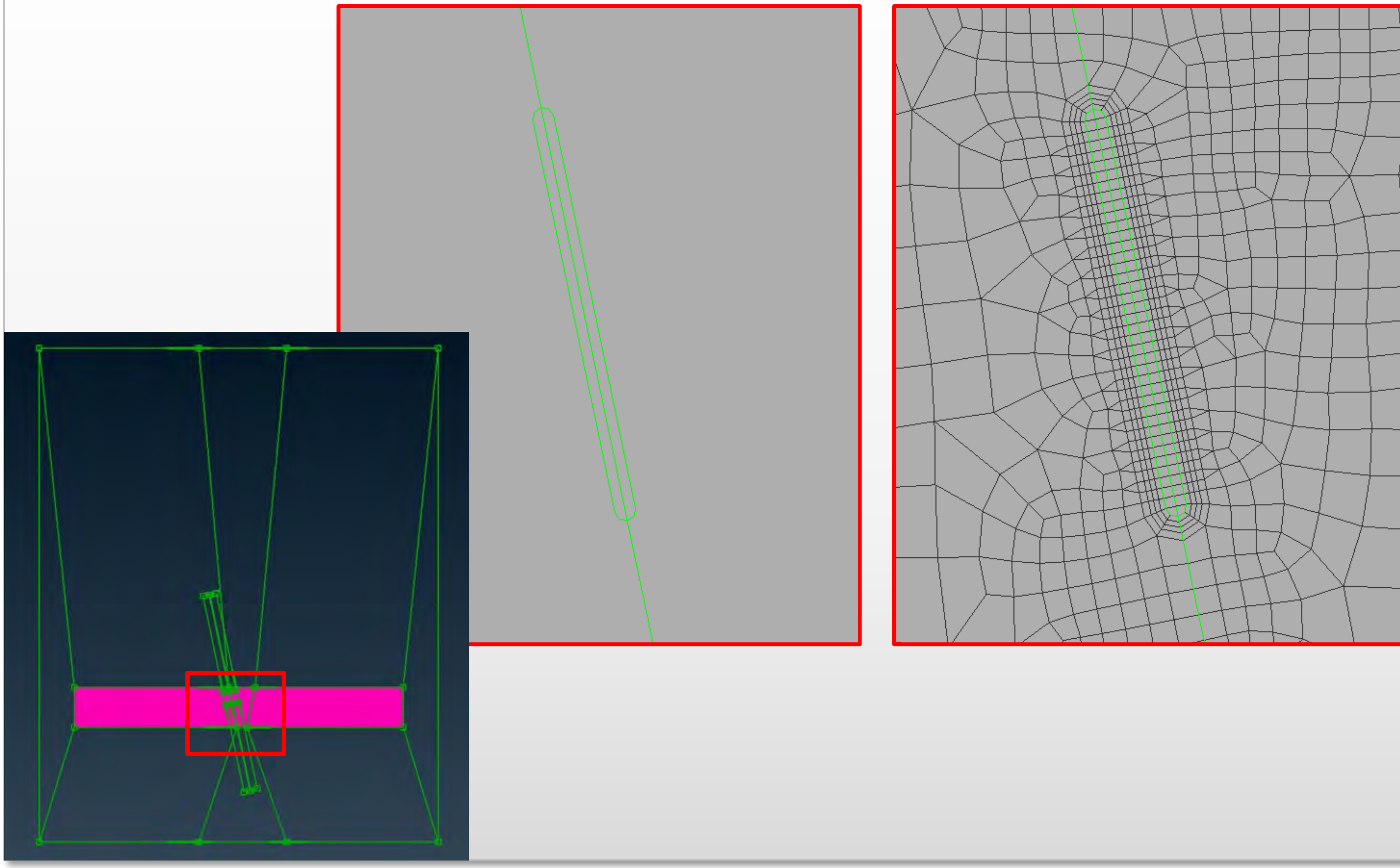
Automated Crack modeling and parameterization

Pipe body parameters



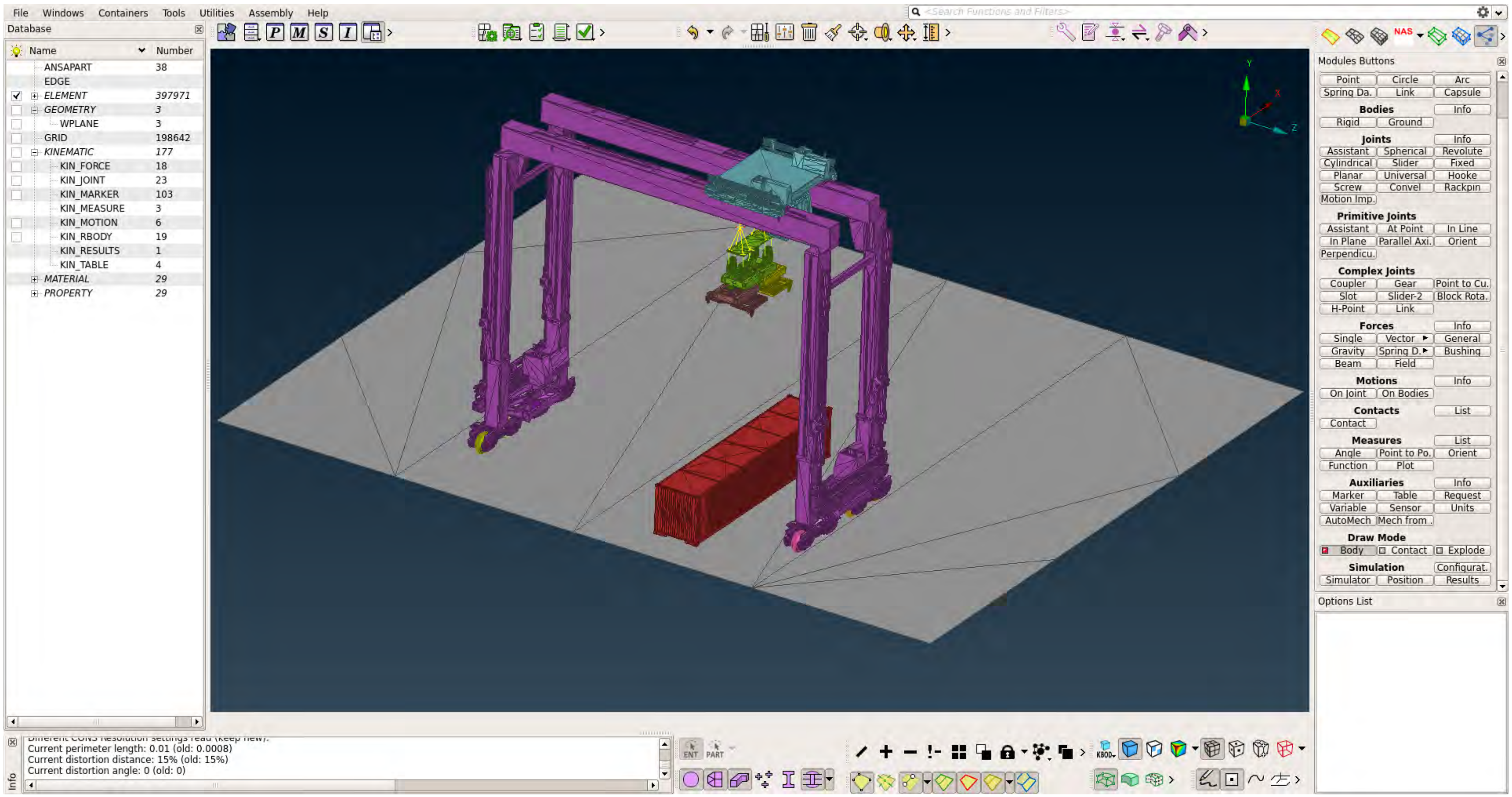
Automated Crack modeling and parameterization

Shell mesh creation



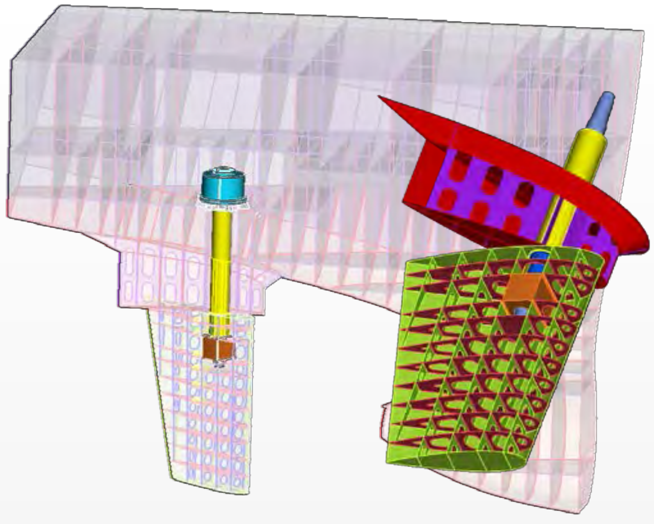
Crane Lifting simulations with the Kinetics Module

Kinetic mechanism definition

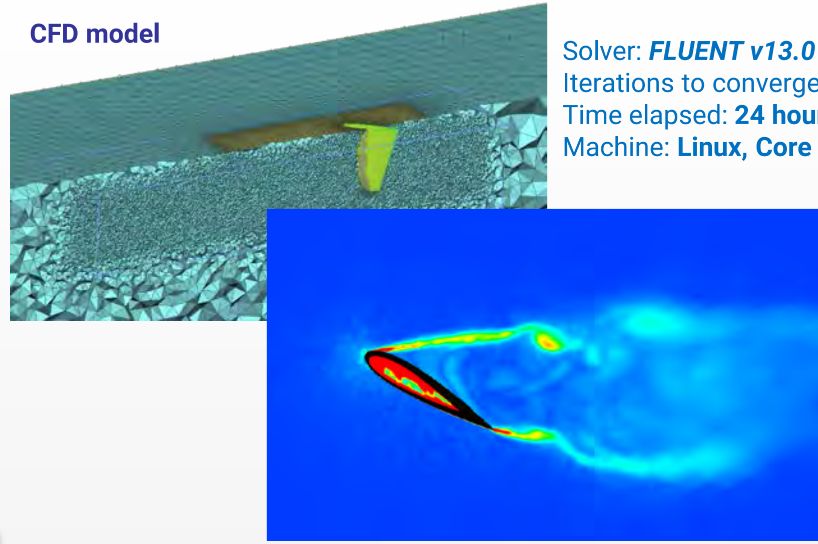


- ✓ 19 bodies
- ✓ 5 sliders
- ✓ 2 spherical
- ✓ 8 revolute
- ✓ 8 links
- ✓ 6 imposed motions
- ✓ 18 spring dampers

Rudder Optimization Study

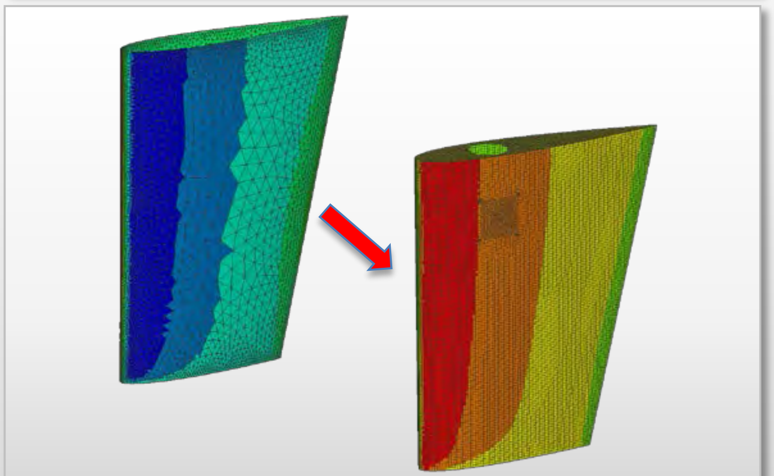


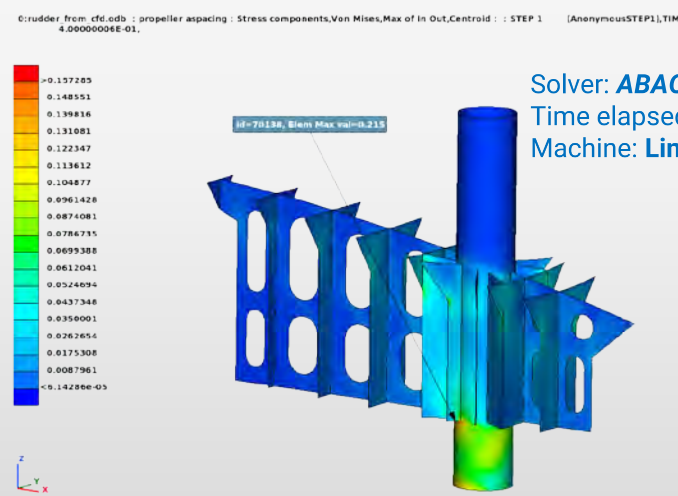
CFD model



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

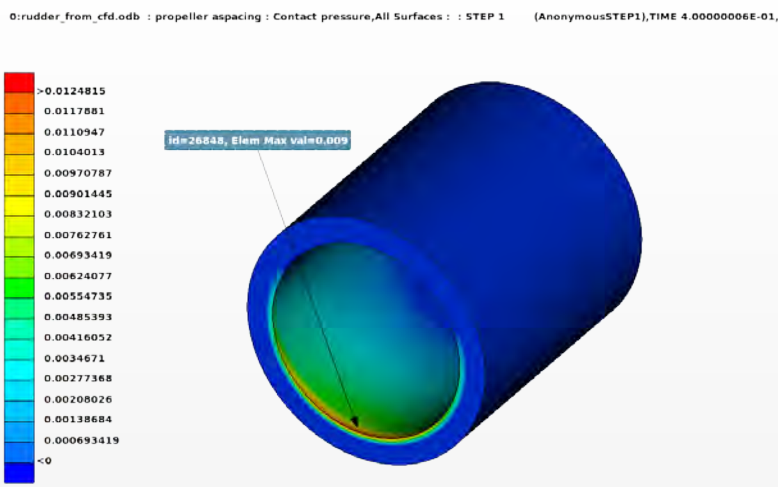
Results Mapping Tool

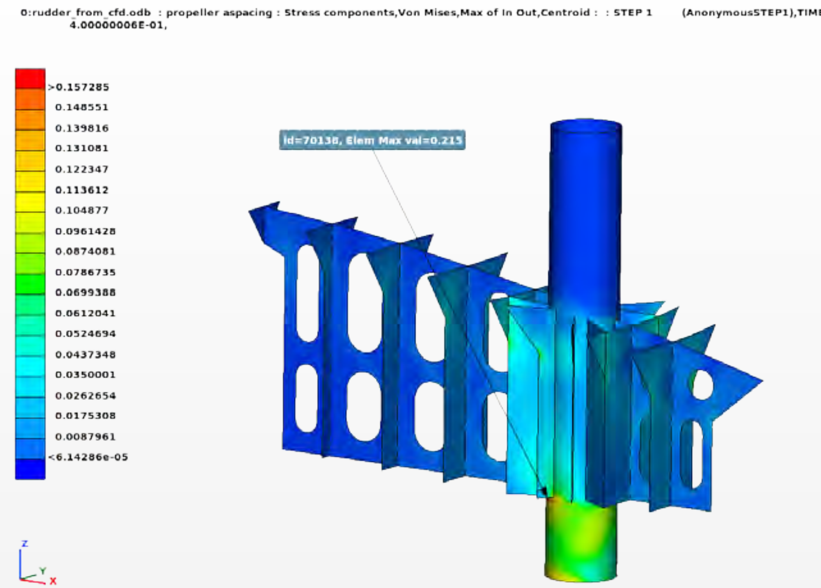


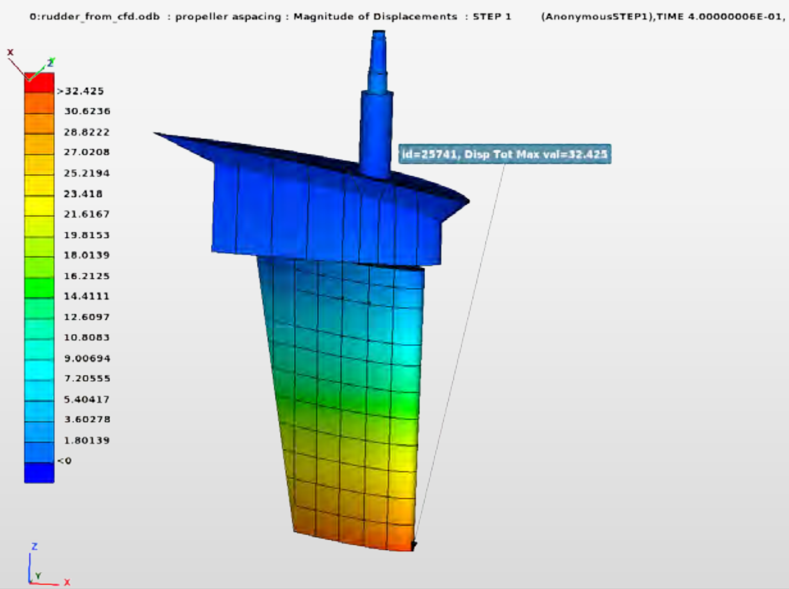


Solver: ***ABAQUS v 6.10***
Time elapsed: **30 min**
Machine: **Linux, Core i7 8 CPUs**

Rudder Optimization Study







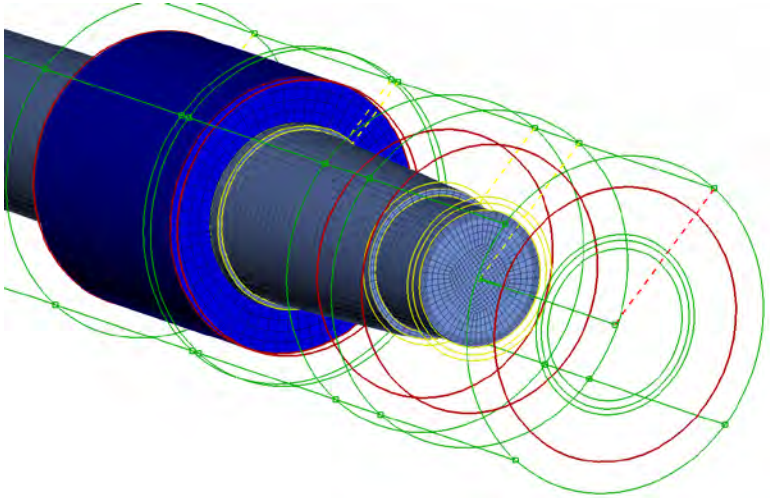
Objectives

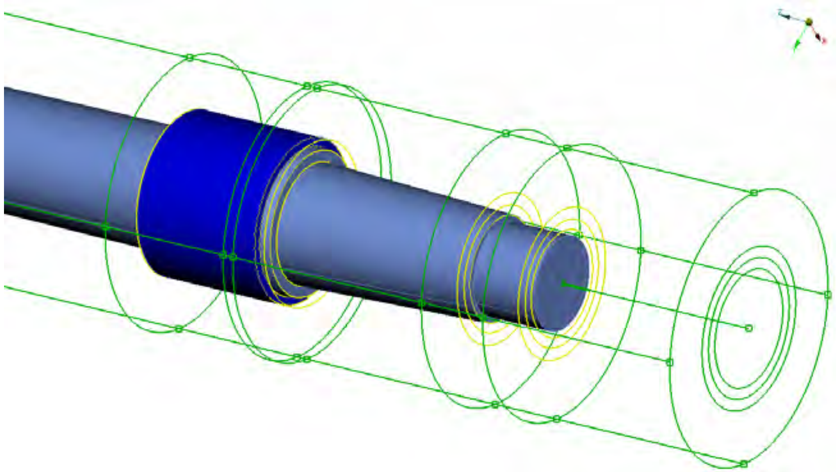
- Minimize maximum contact pressure
- Minimize Model mass

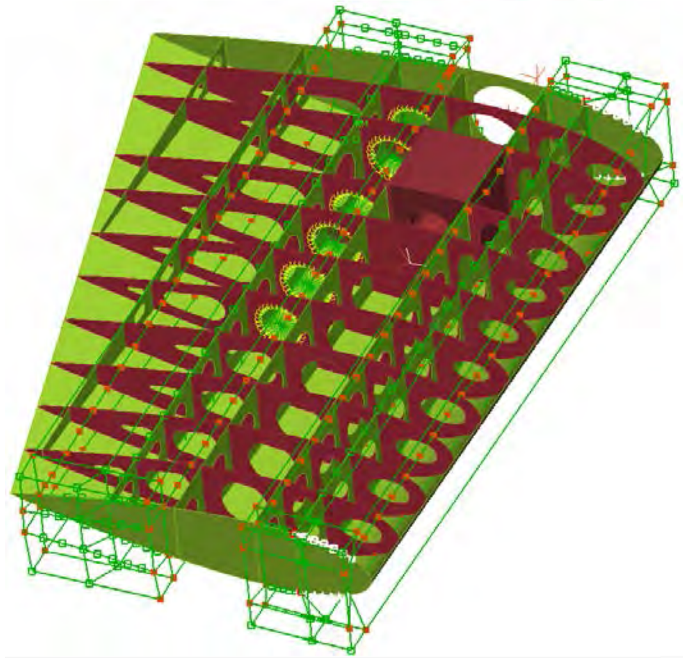
Constraints

- Maximum stresses
- Maximum deflection

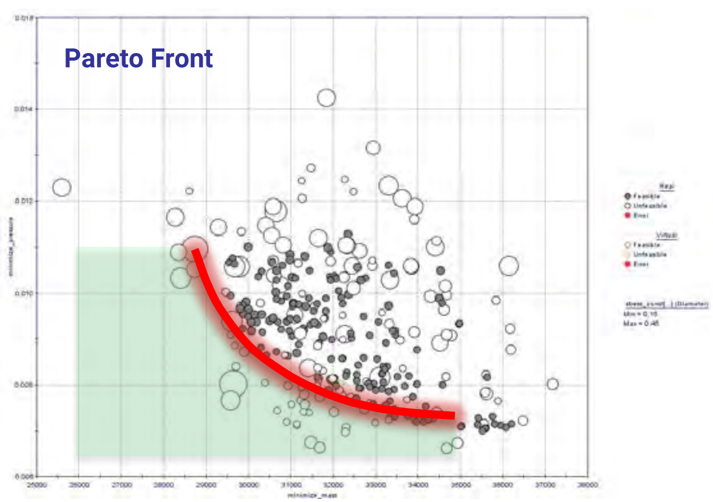
Rudder Optimization Study



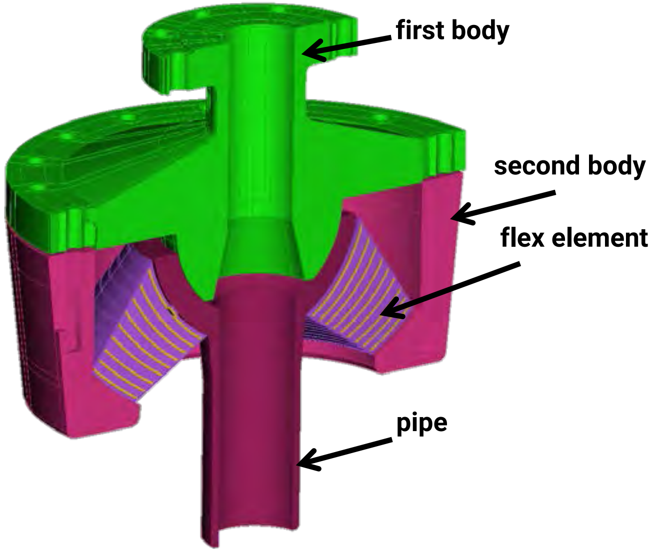




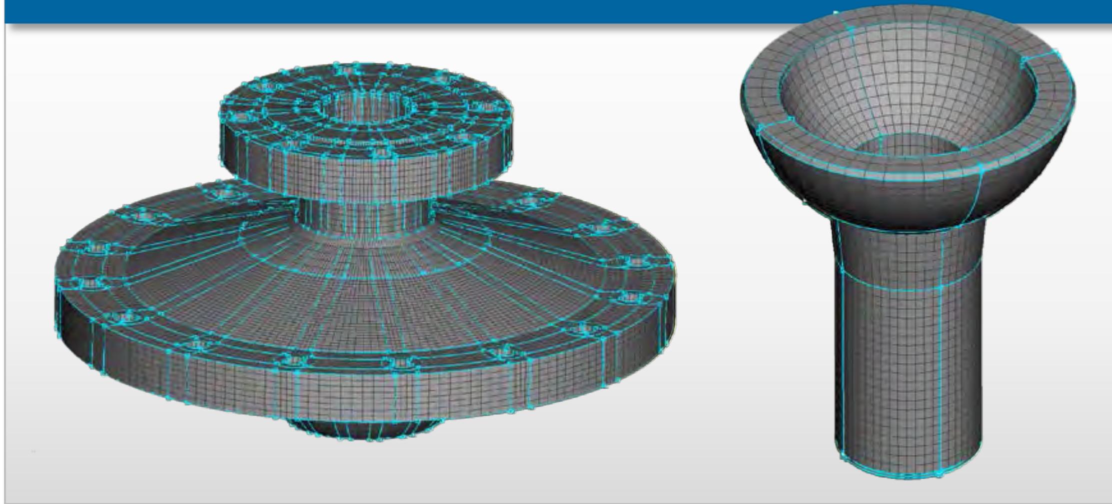
- ✓ **12.5% Maximum pressure reduction**
- ✓ **7.98% Mass reduction**



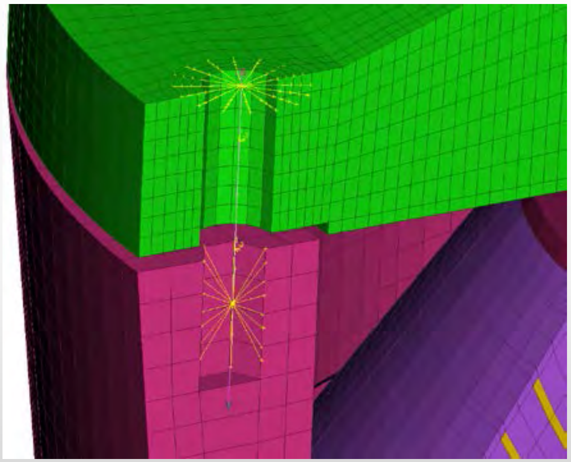
Flex Joint Contact analysis



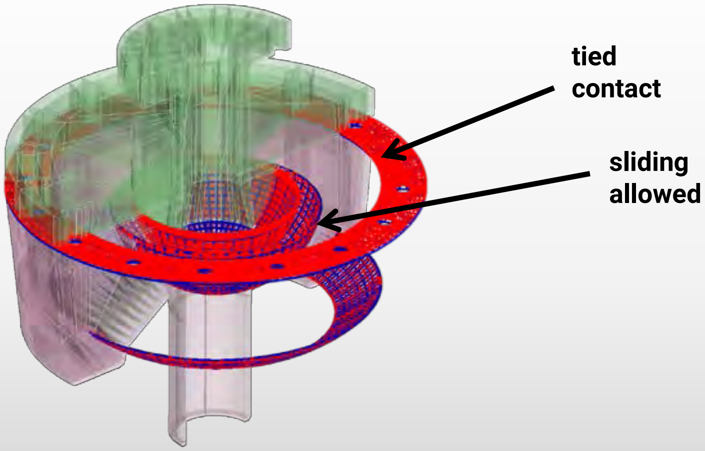
Pure Hexahedral Mesh Creation



Automated Bolts recognition

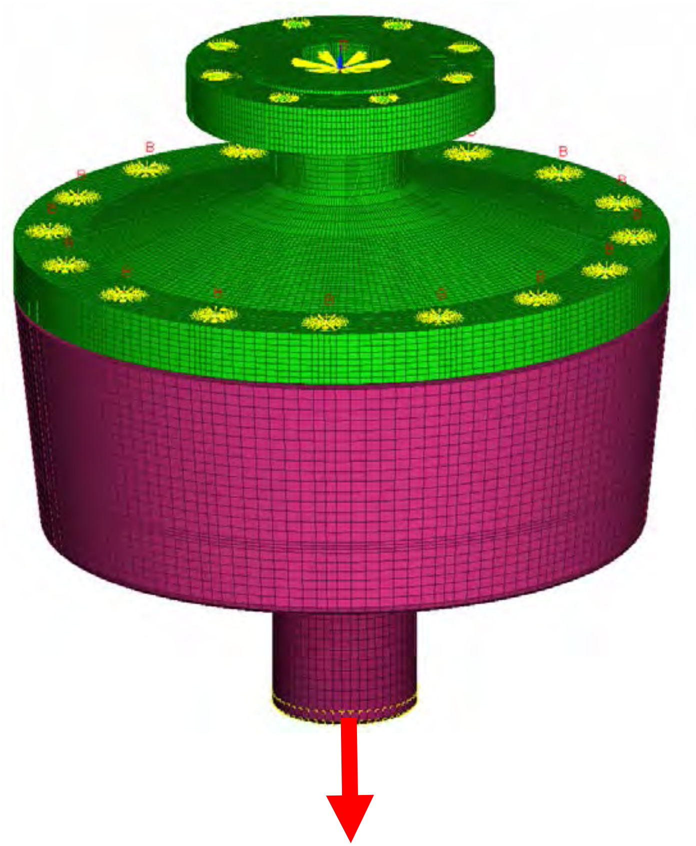


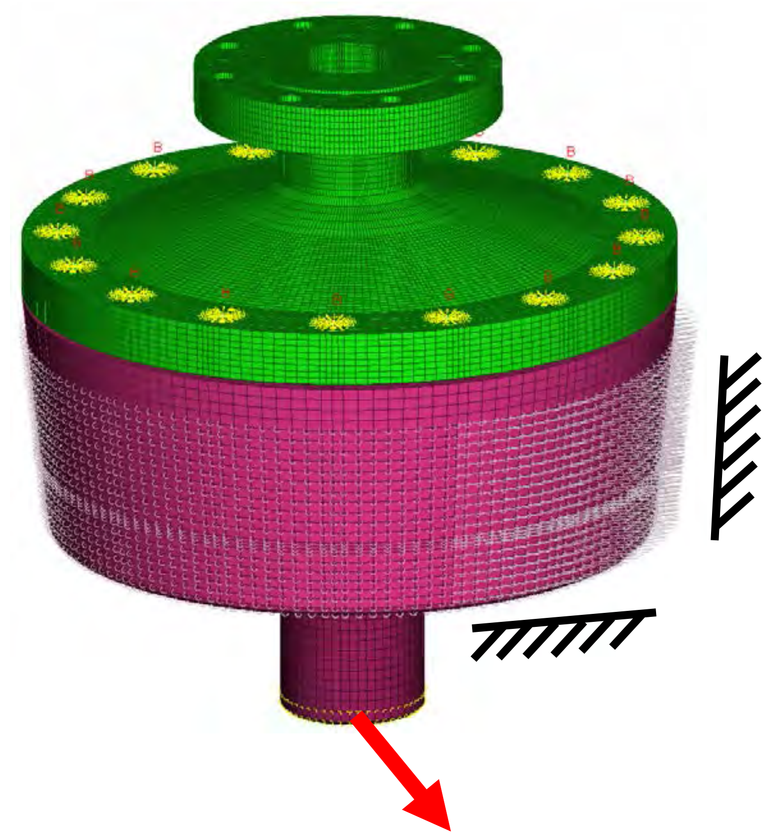
Automated Contact Detection



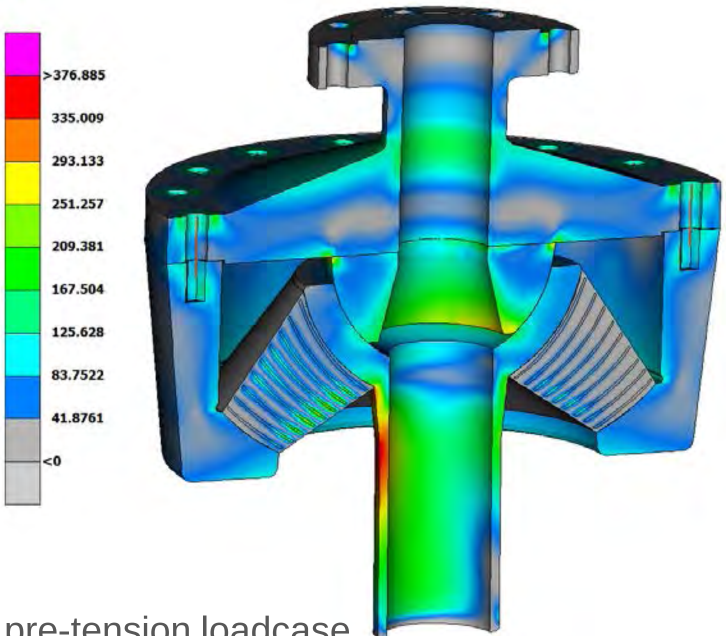
Boundary conditions

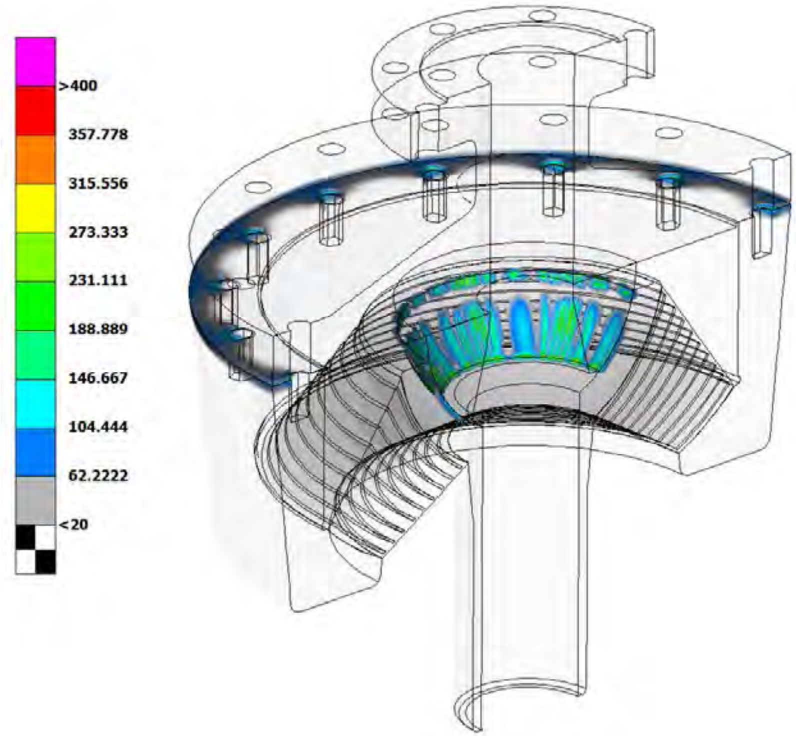
- 1st load case: axial riser force
- 2nd load case: bending riser force



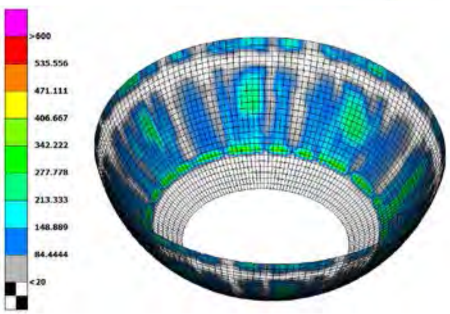


Flex Joint Contact analysis

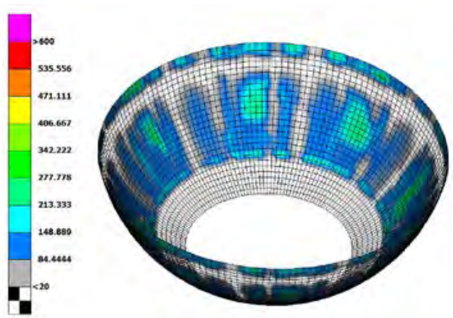




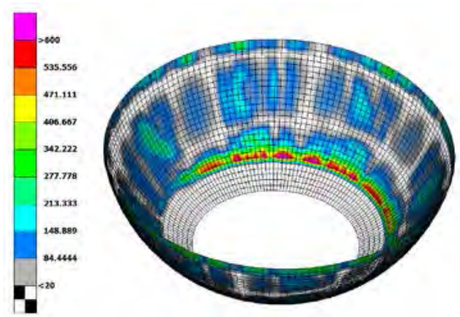
pre-tension loadcase



axial force loadcase

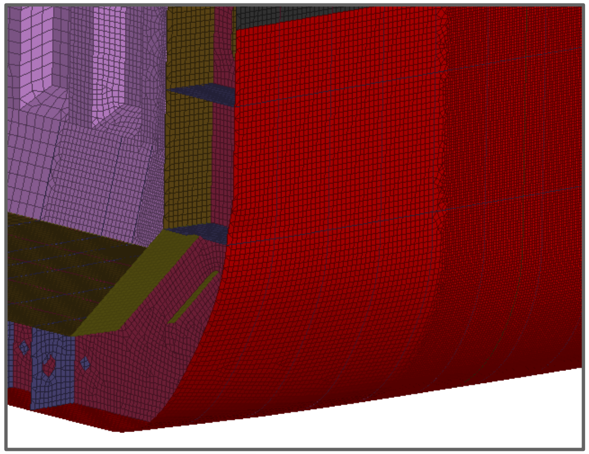


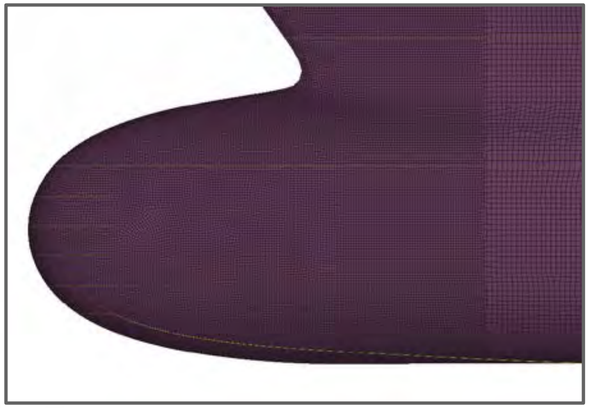
bending force loadcase

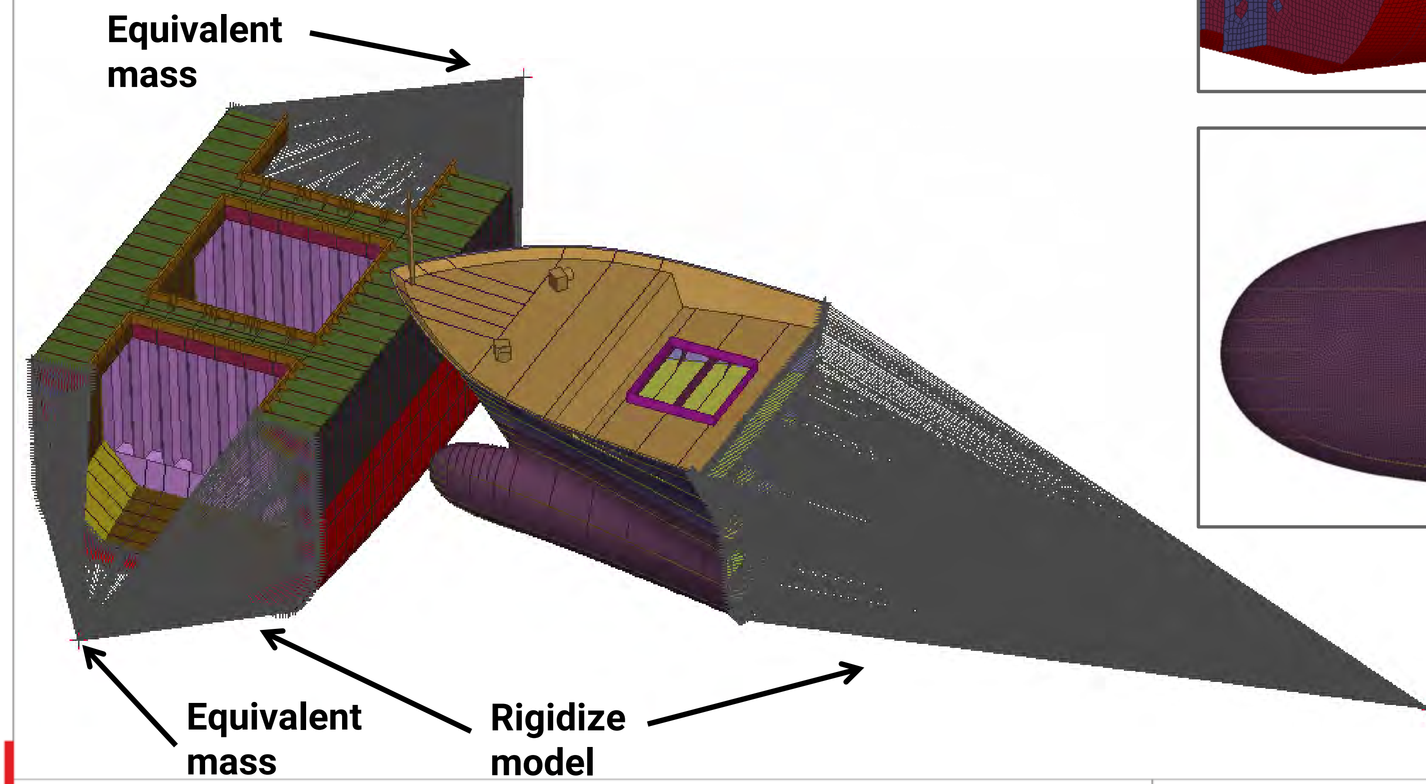


Ship collision analysis

- Replacing part of the model with rigid body and equivalent mass
- Defining boundary conditions and contacts
- Local refinement at the collision area

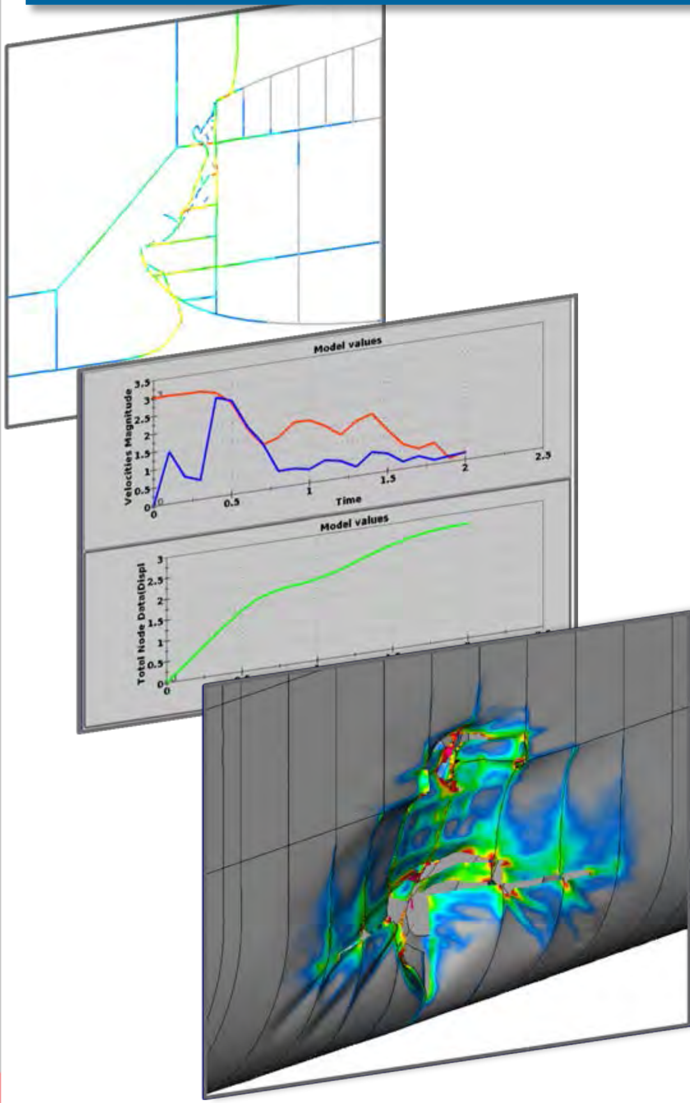


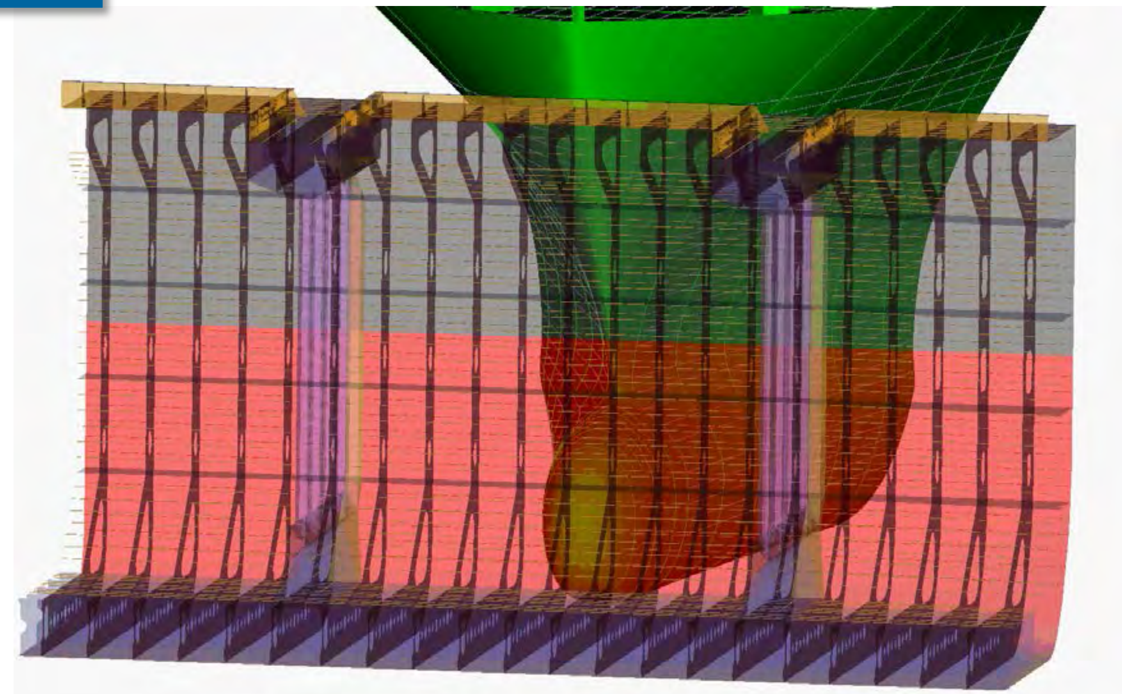




Ship collision analysis

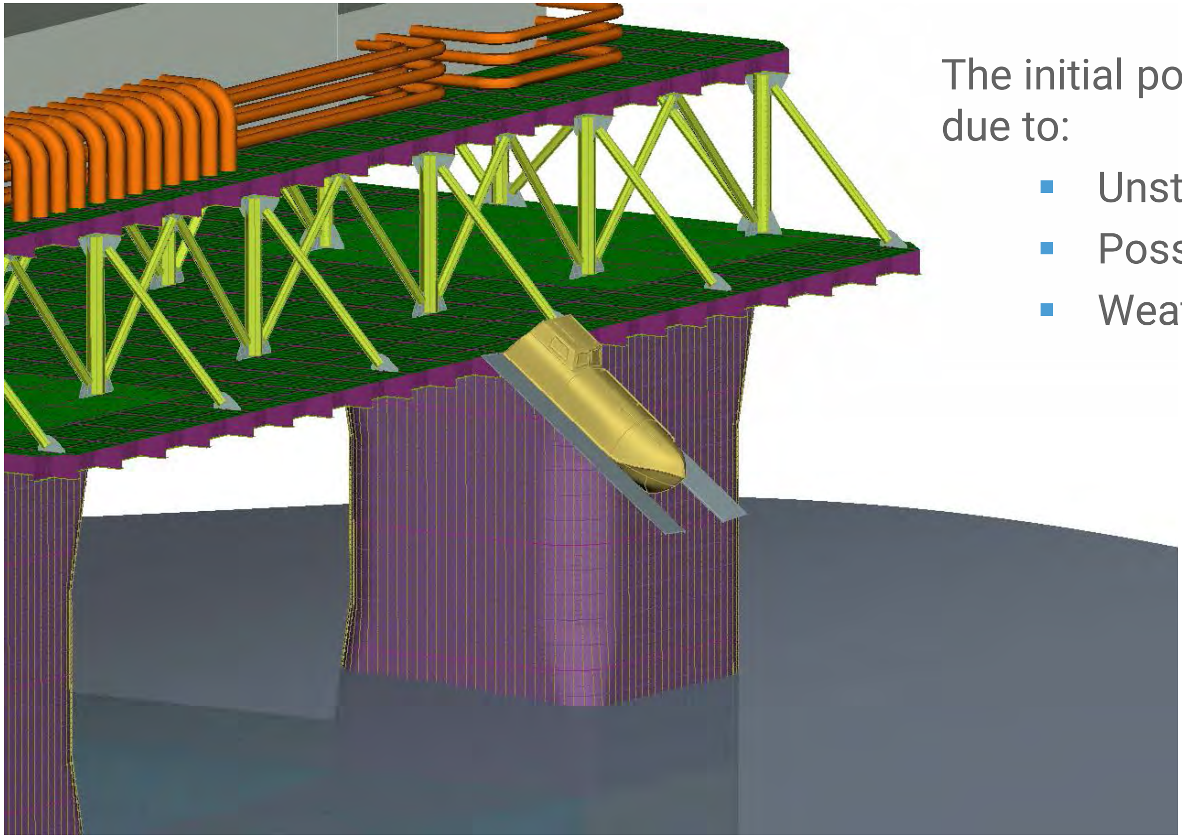
Viewing results with META





Introduction

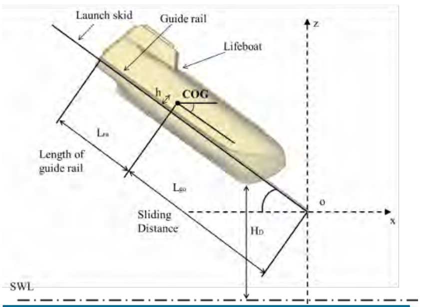
- Free fall lifeboats are found in oil platforms and large transport vessels.
- Carry up to 70 passengers
- Free fall to evacuate as fast as possible
- Safely submerge and surface away from the host structure



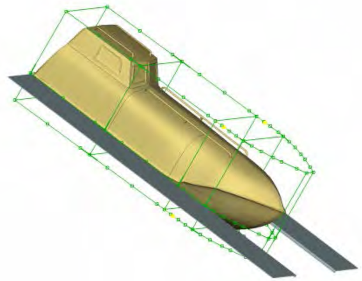
The initial position of the lifeboat is not fixed due to:

- Unstable host structure
- Possible damage in the structure
- Weather conditions variation

Aim Of Optimization

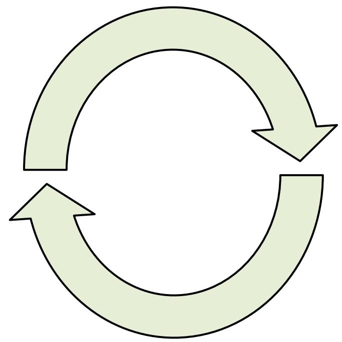


Initial Position



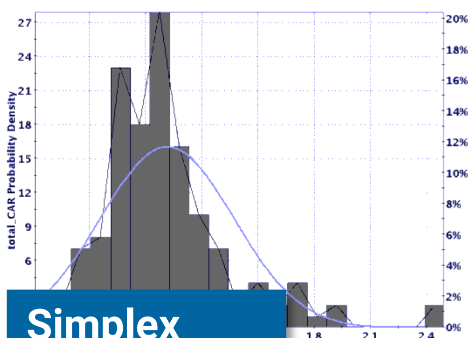
Shape modification

Kinematics Solution
Free-fall, Output



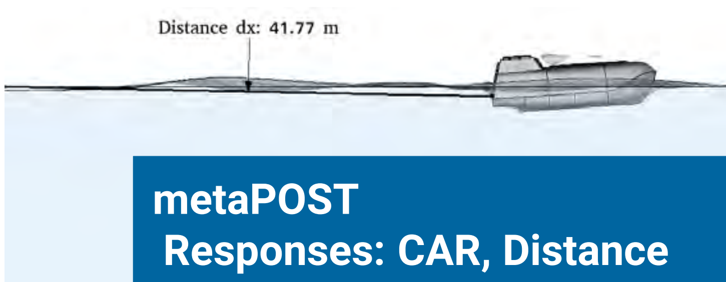
*.key

LS-Dyna analysis



Simplex Algorithm

-CAR
-Distance



metaPOST
Responses: CAR, Distance

Aim Of Optimization

The aim is to achieve a robust trajectory for the lifeboat that at any circumstances must evacuate the passengers safely

To achieve that, it was needed to:

✓ Reduce the accelerations on the passengers

✓ Surface as far from the structure as possible (>40m)

Constraints

- Minimum distance from the host structure (40m)
- Maximum CAR* Index value (1)

Objectives

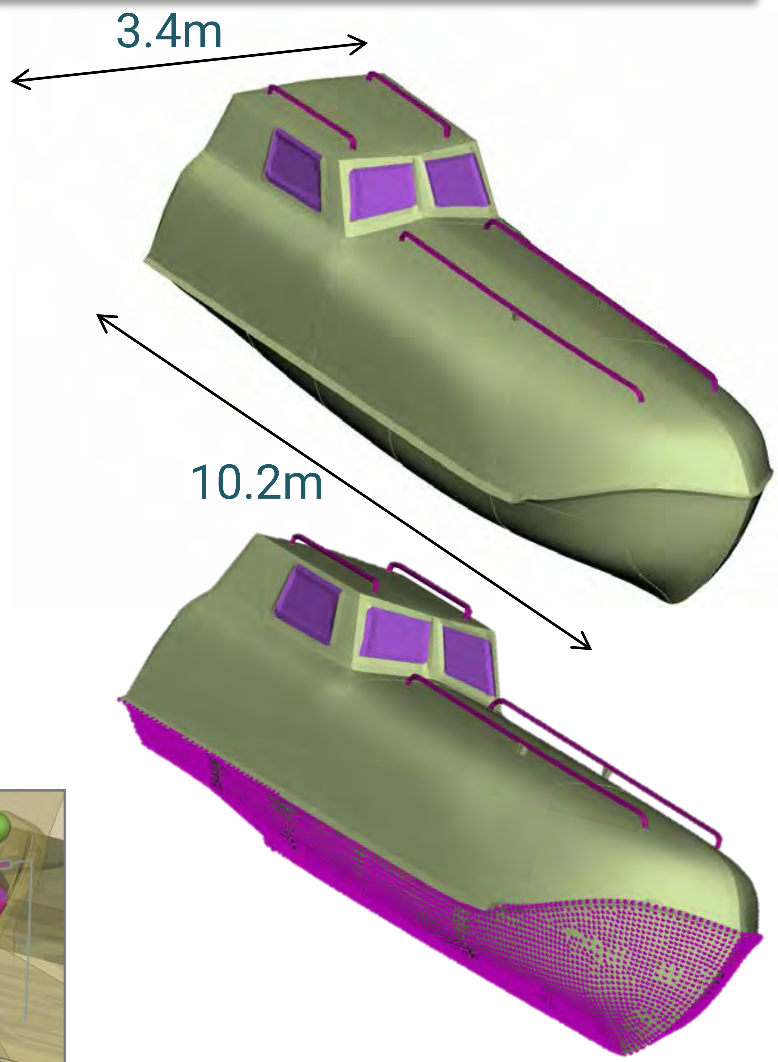
- Minimize the CAR Index value

*CAR: Combined Acceleration Ratio

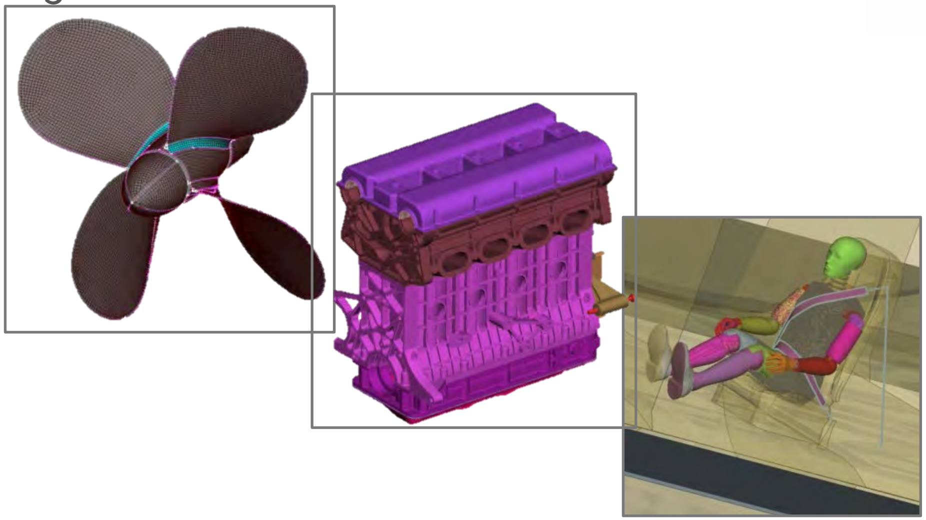
Pre-Processing

FE Model

Lifeboat weight: 9517kg
Capacity: 30 Persons
Material: Glass Fiber Reinforced Plastic (GFRP)
Length: 10.2m
Width: 3.4m



Added weight of passengers and equipment: 3750kg

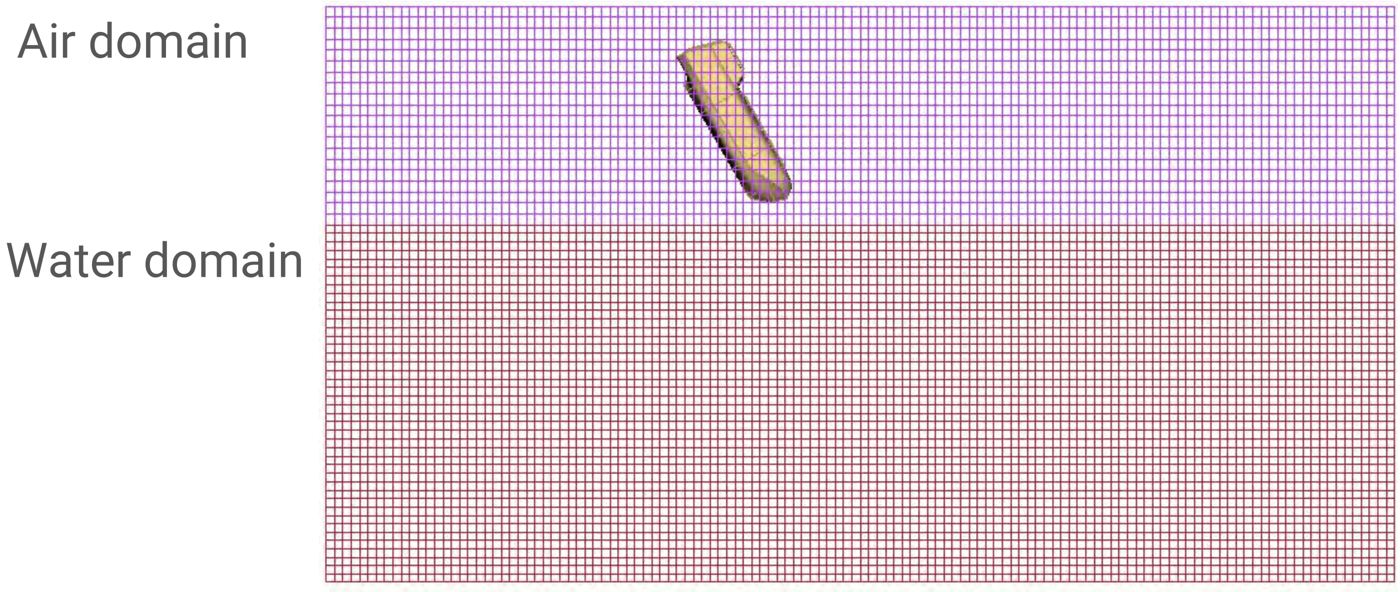


Pre-Processing

ALE method

The Arbitrary Langragian Eulerian method was used to simulate the air and seawater couple using solid HEXA elements

✓ The ALE interaction is defined through an LS-DYNA constrained entity that defines the settings of the interaction between the two bodies

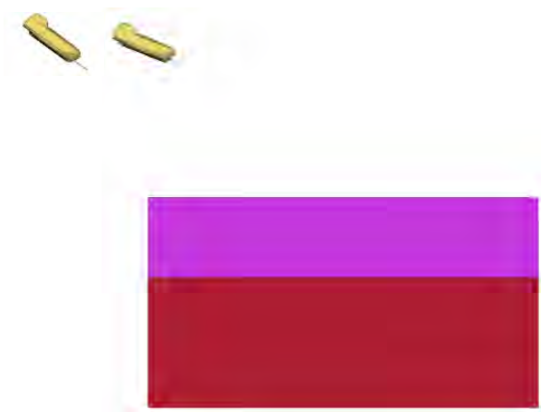


Pre-Processing

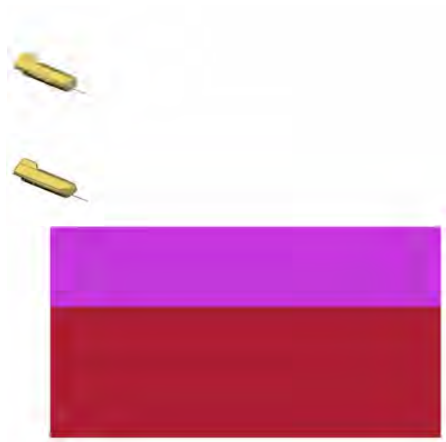
Position Parameters

Taking into account the instability of the host structure, three position parameters were defined using morphing functionality and defined as Stochastic variables for:

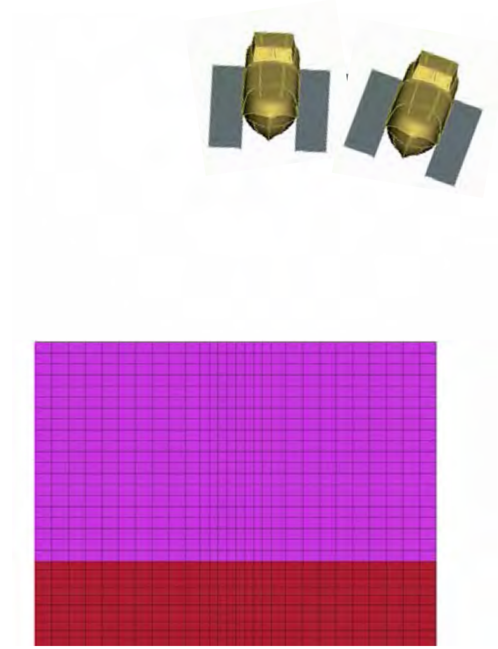
- ✓ Trim rotation



- ✓ Height



- ✓ List rotation

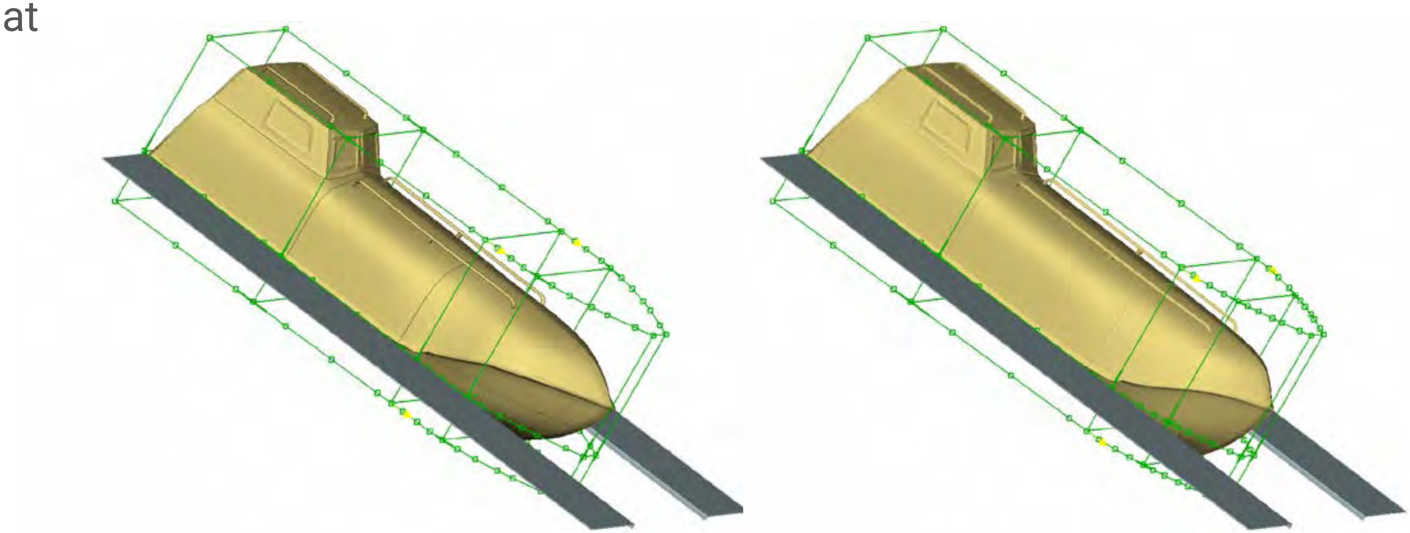


Pre-Processing

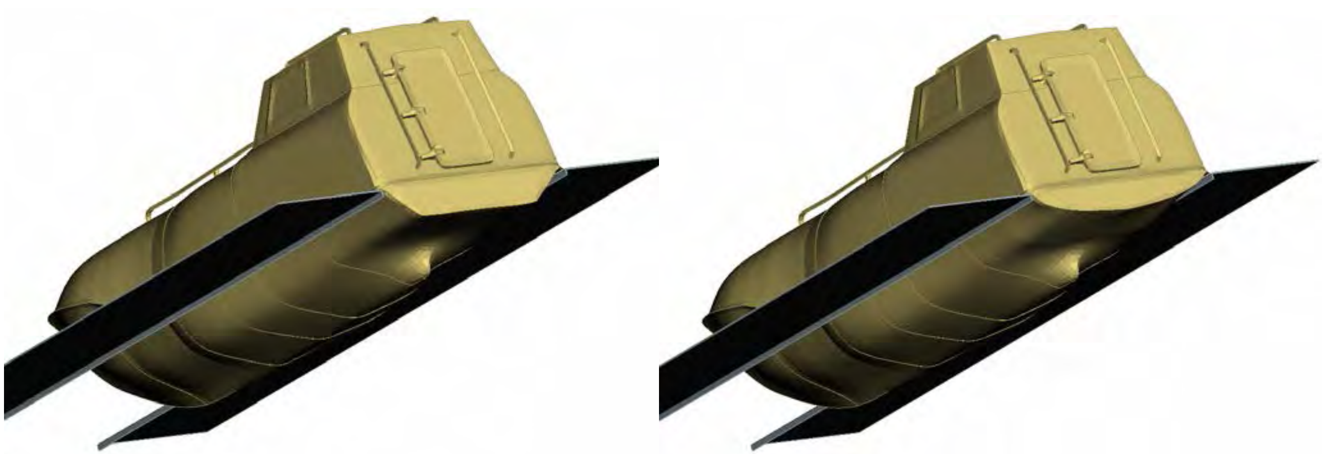
Shape Parameters

Two shape parameters were also defined using morphing functionality, modifying the shape of the lifeboat

- ✓ Nose Shape



- ✓ Rear Shape

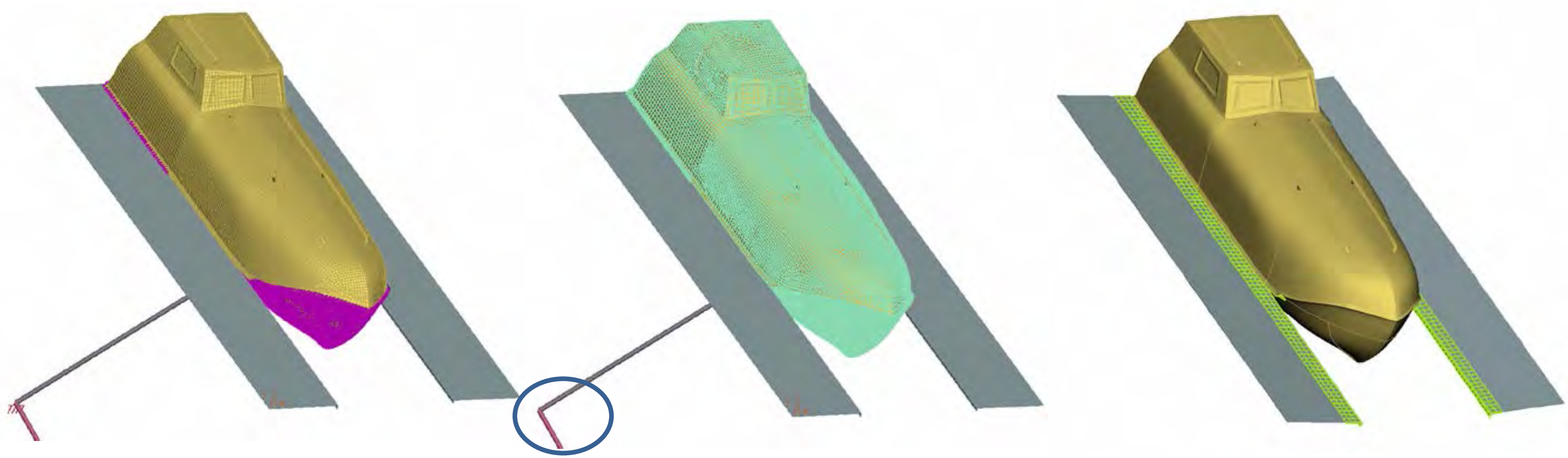


Pre-Processing

Kinematics

A build in Kinematic solver was used for the calculation of the sliding and free fall step of the process

- ✓ Two Kinematic rigid bodies were defined. One for the life boat and one for the launch platform.
- ✓ One Ground point was also necessary to define Kinematic Joints
- ✓ A Kinematic contact pair was defined between the two rigid bodies
- ✓ Friction of 0.15 consistent with nylon blocks use

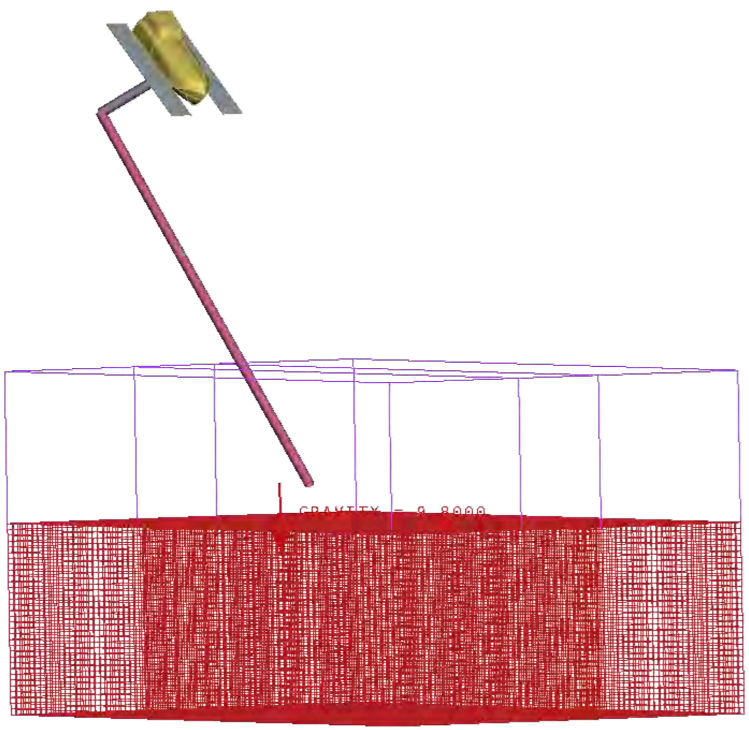


Pre-Processing

Kinematics

A build in Kinematic solver was used for the calculation of the sliding and free fall step of the process

- ✓ With Gravity as the load, the solver calculated the slide and the free fall
- ✓ A Kinematic sensor identifies the distance from the sea level and stops the free fall calculation
- ✓ The calculated velocity vectors are applied as initial conditions



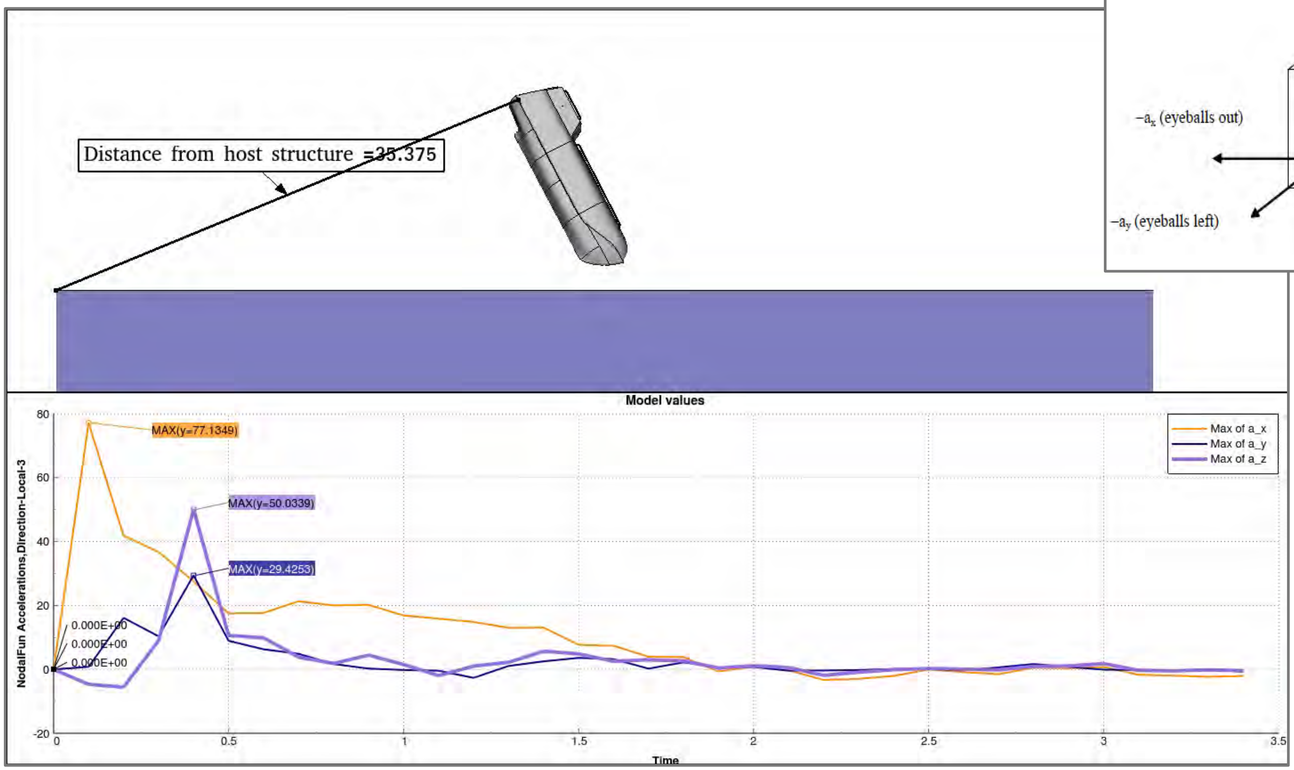
Post Processing

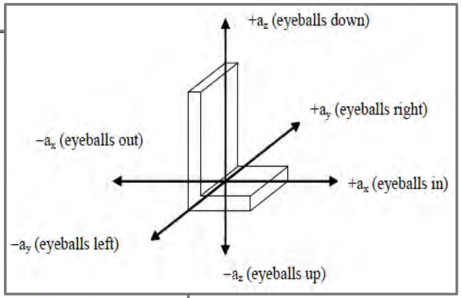
Combined Acceleration Ratio-CAR

The first response acquired at each iteration was the CAR index value, calculated by the nodal accelerations at selected measurement points

$$CAR = \max\sqrt{\left(\frac{a_x}{18g}\right)^2 + \left(\frac{a_y}{7g}\right)^2 + \left(\frac{a_z}{7g}\right)^2}$$

Where ax, ay, and az are the in-to-seat accelerations and g is the gravity

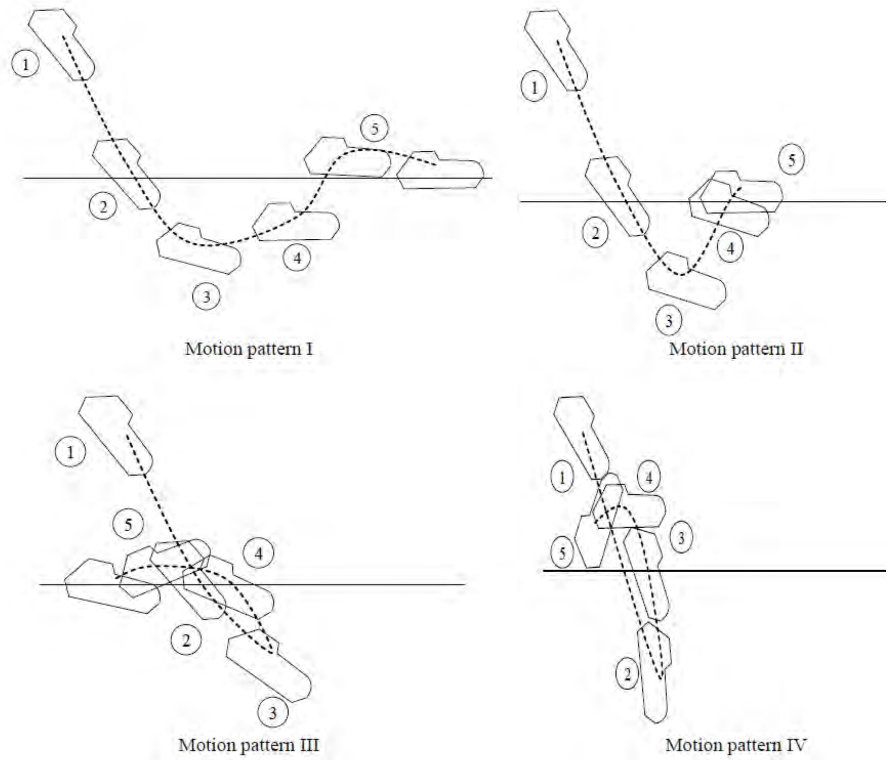


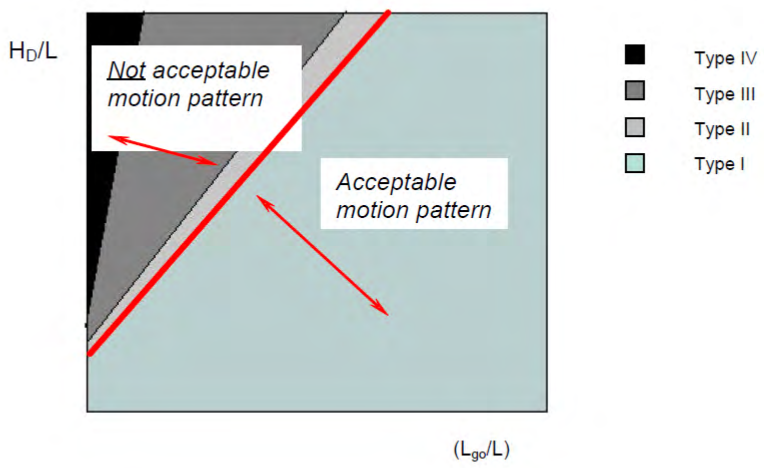


Post Processing

Distance from host structure- Motion Pattern

The second response acquired at each iteration was the distance between the host structure and the rear most point of the lifeboat. This measurement was directly dependent on the Motion pattern

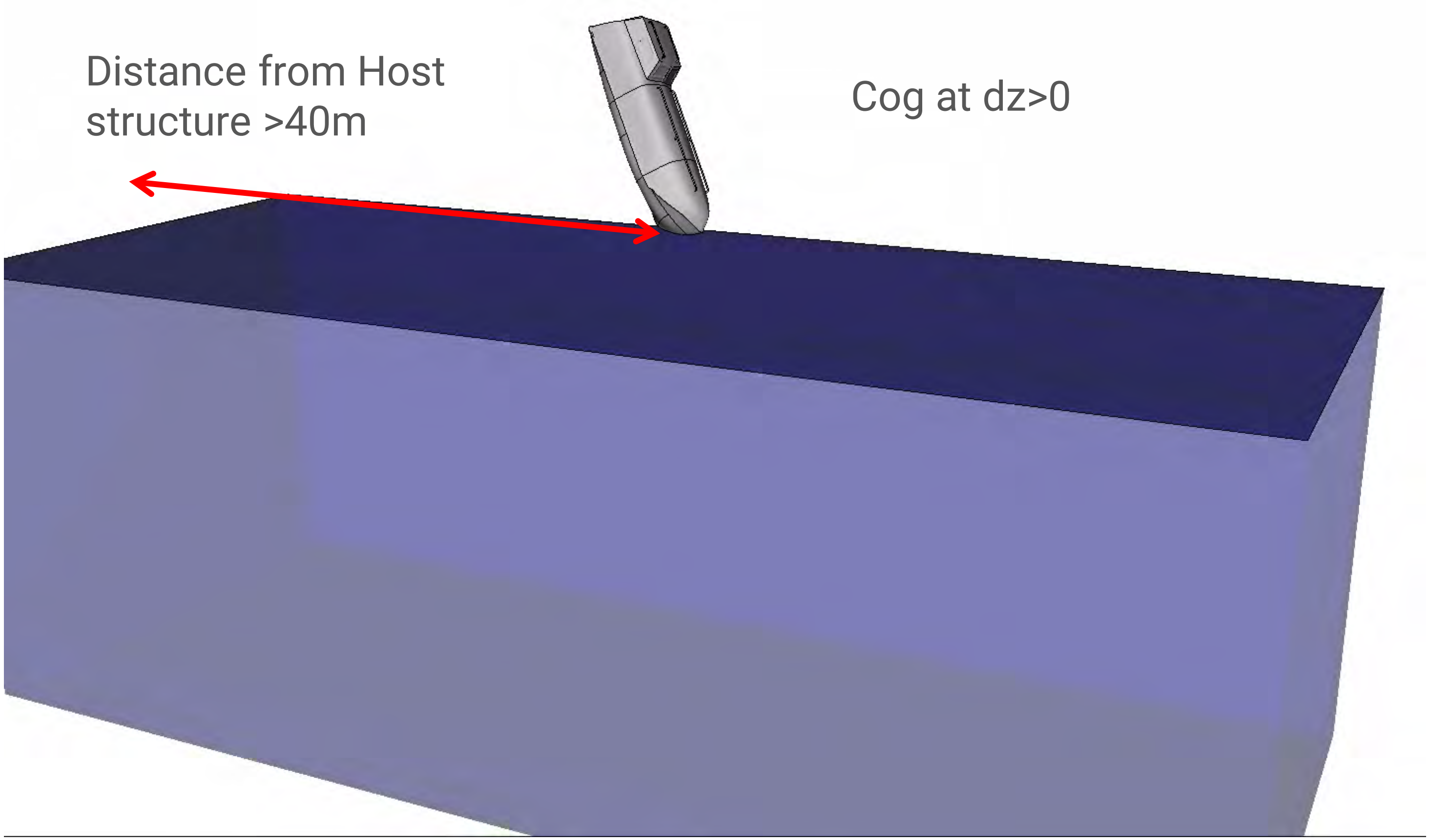




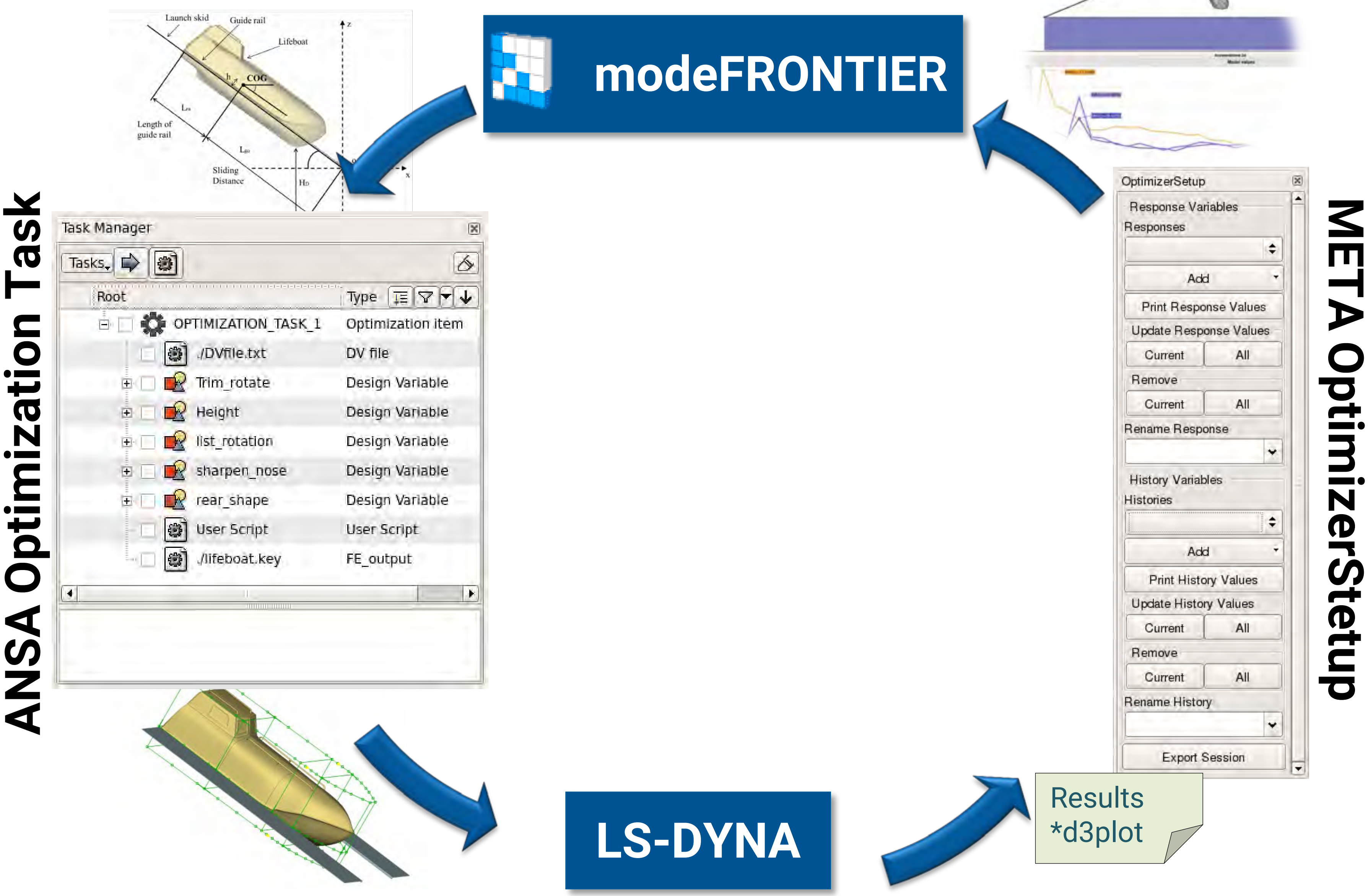
Post Processing

Distance from host structure

The second response acquired at each iteration was the distance between the host structure and the rear most point of the lifeboat



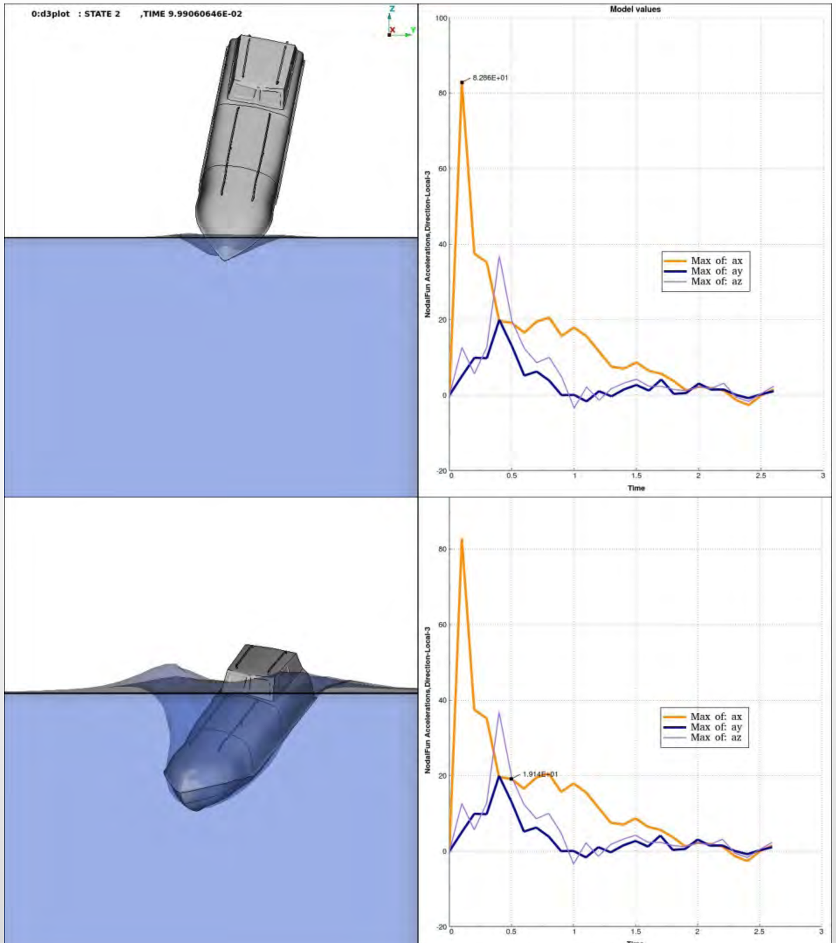
Optimization

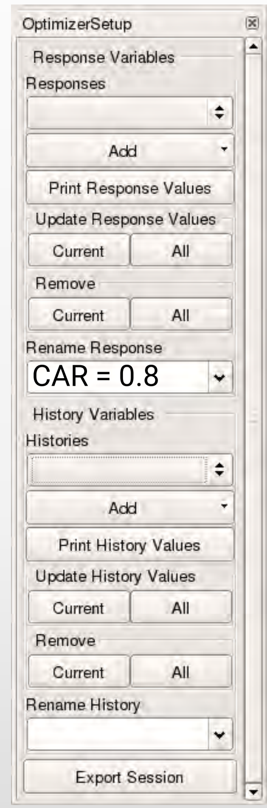


Response Extraction

Repeated Response acquirement

Using an automated post-processing process, the two responses are acquired at each iteration and the results are fed to the optimizer software





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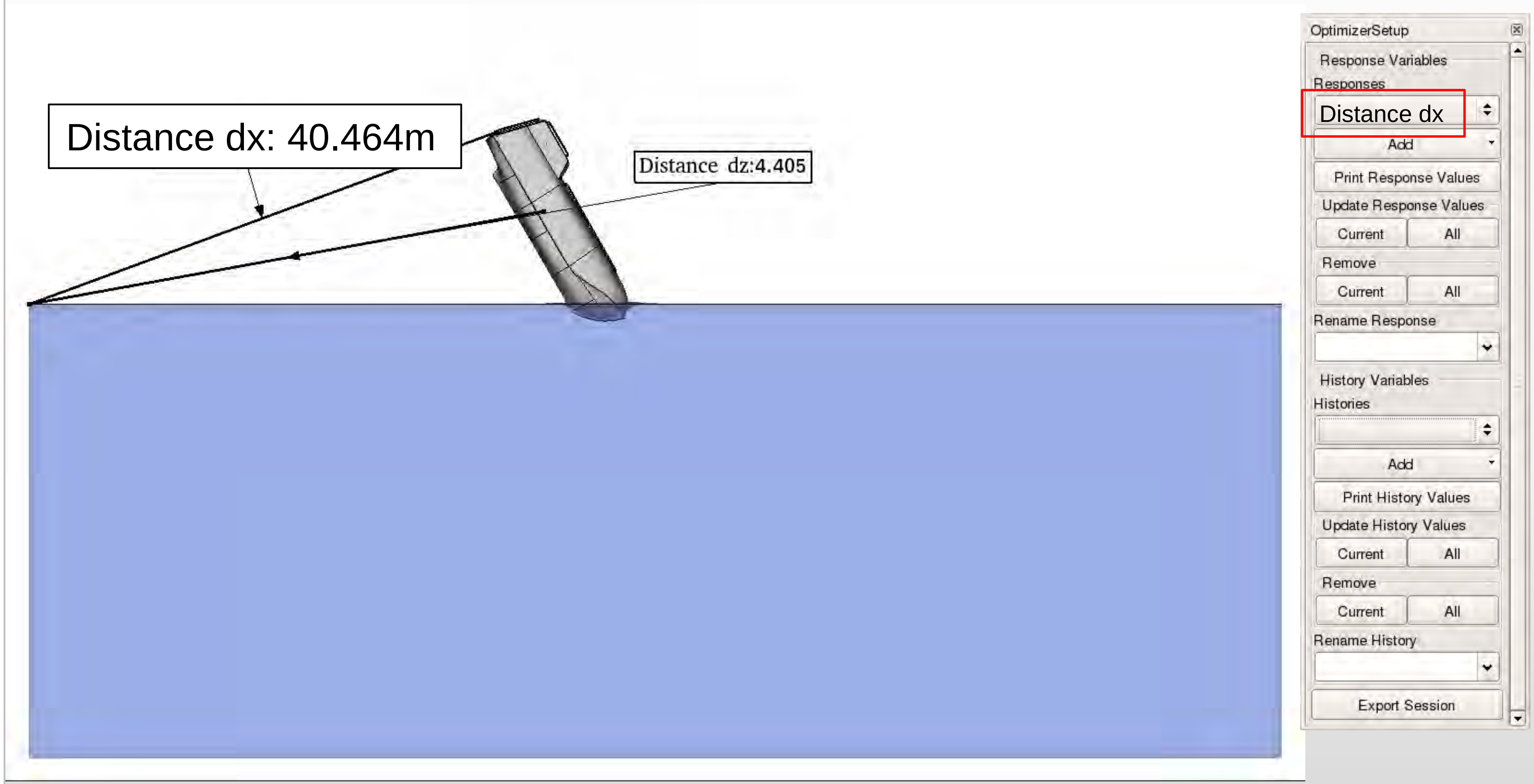
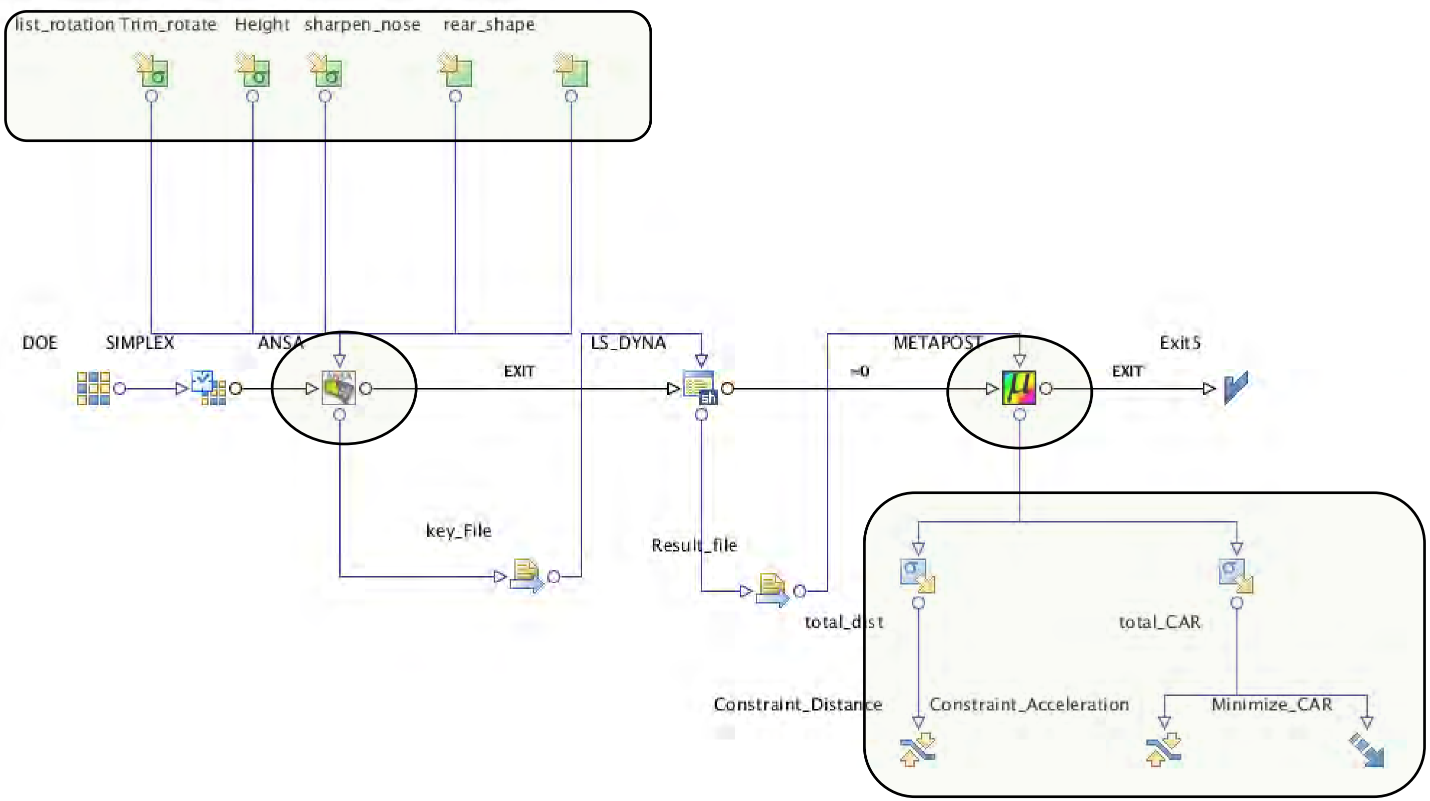


Optimization process

Robustness Optimization

modeFRONTIER was used in this study, to couple ANSA, Meta and the FSI solver.

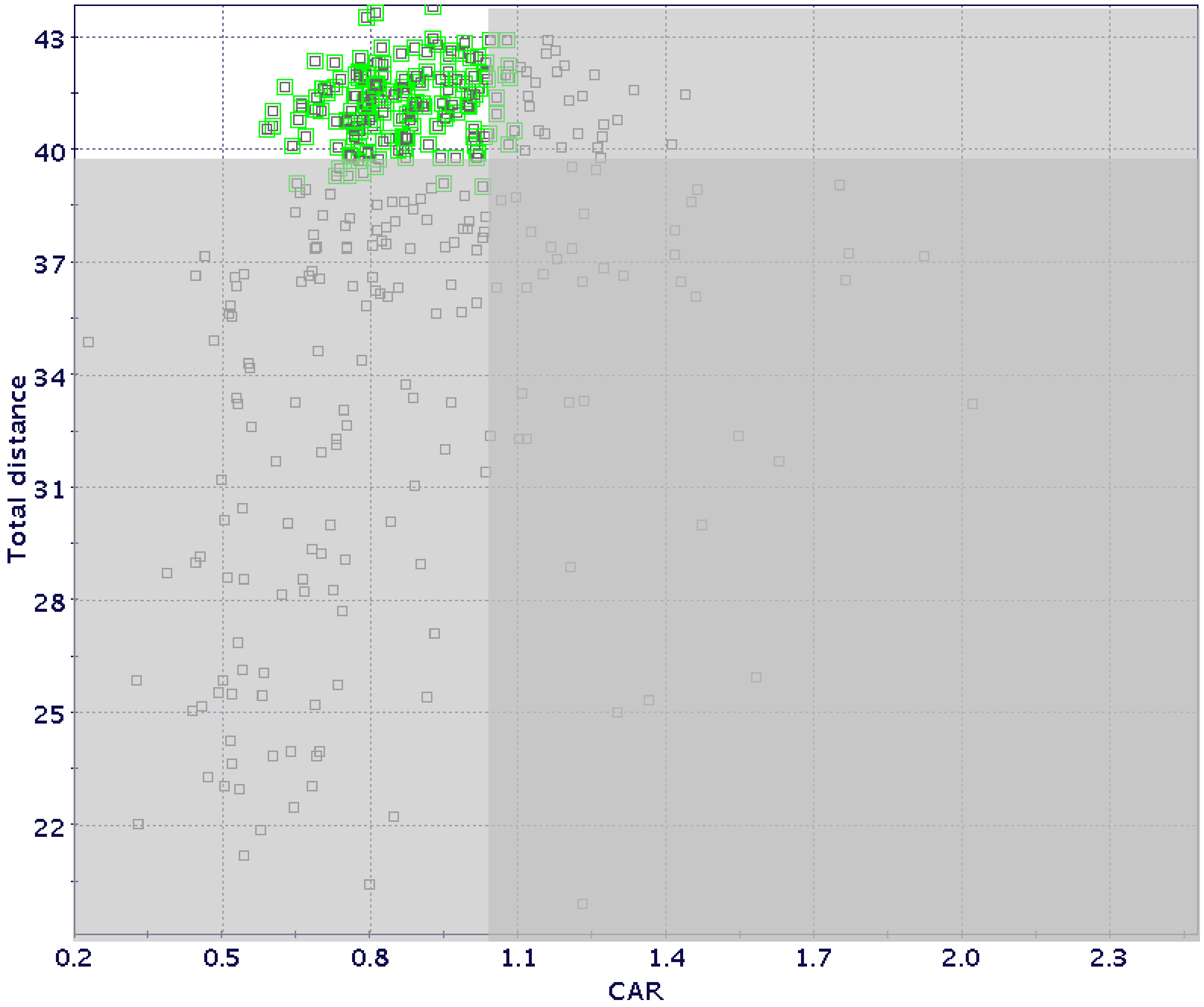
- ✓ Built-in ANSA & mETA Nodes
- ✓ Stochastic values for the three position input variables
- ✓ Constraint and Objective Stochastic responses



Results

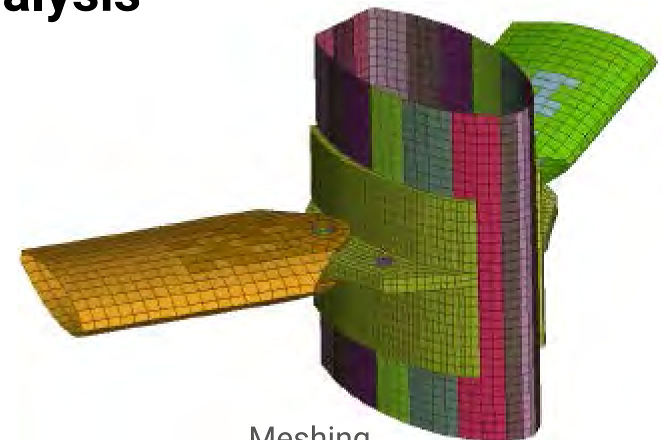
Scatter Chart – Feasible designs

Feasible designs were close to 50% of the total of 400

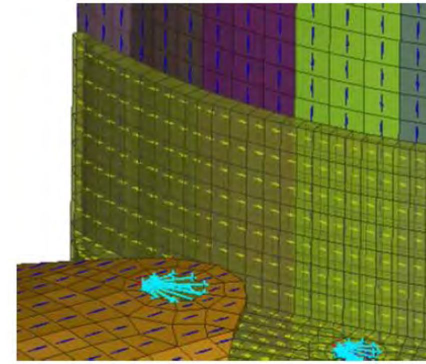


Safran Open 60’ race yacht composite mast modelling for crashworthiness analysis

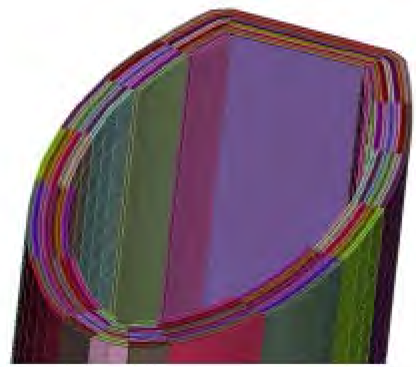
Mast modelling



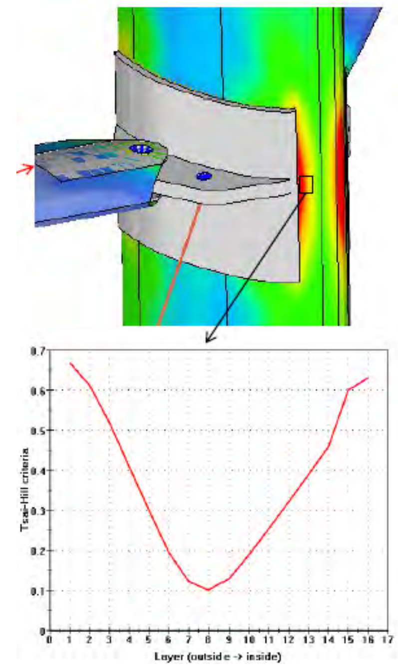
Meshing



Elements orientation



Composite materials

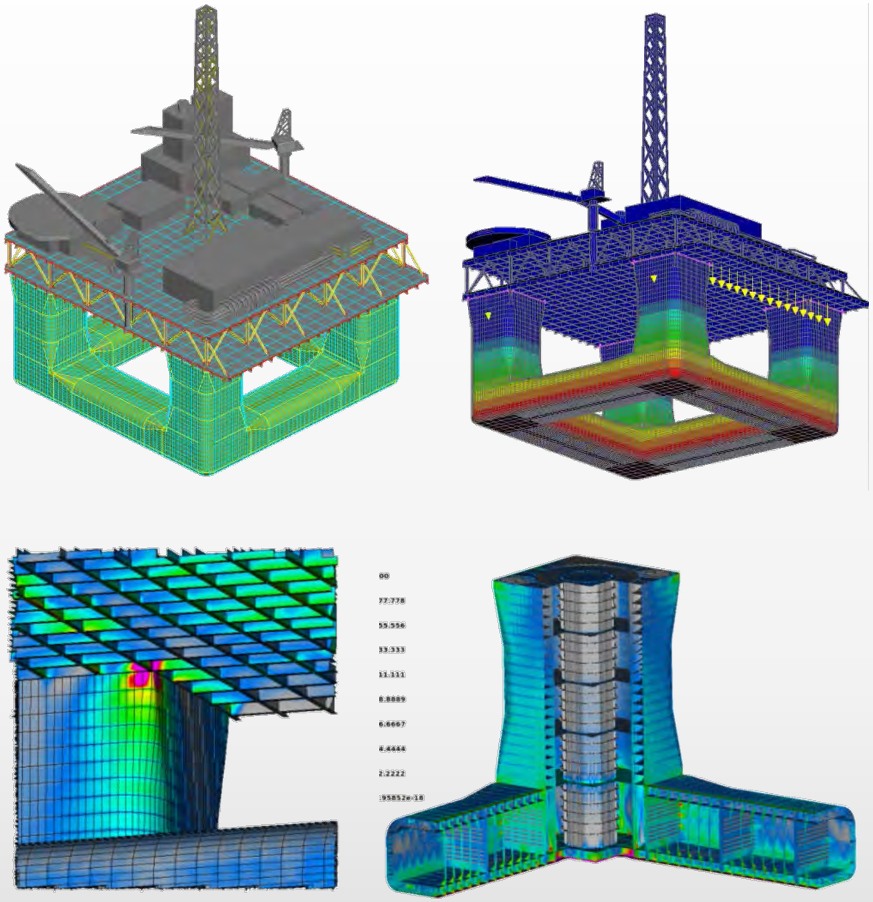


ANSA and META contribution to the study of Safran Open 60’ race yacht crashworthiness
Philippe Biagi, Safran Engineering Services, 4th ANSA & META International Conference, 2011

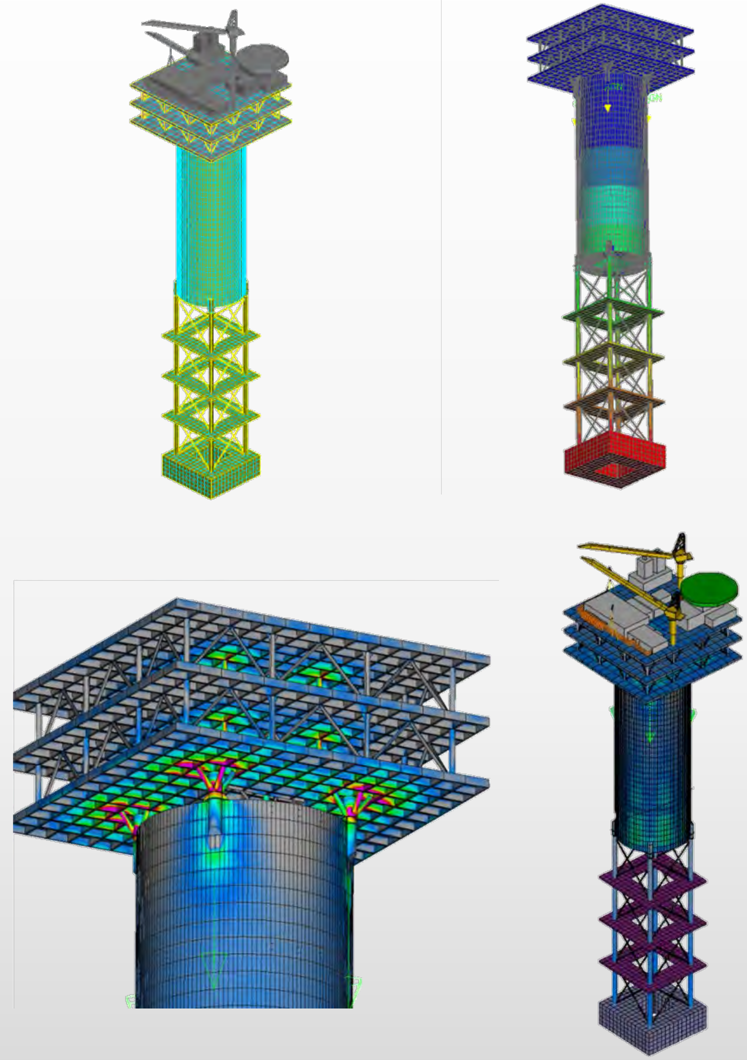
Safran Engineering Services
SAFRAN Group

Static Analysis for Offshore Models

Semi Submersible Platform

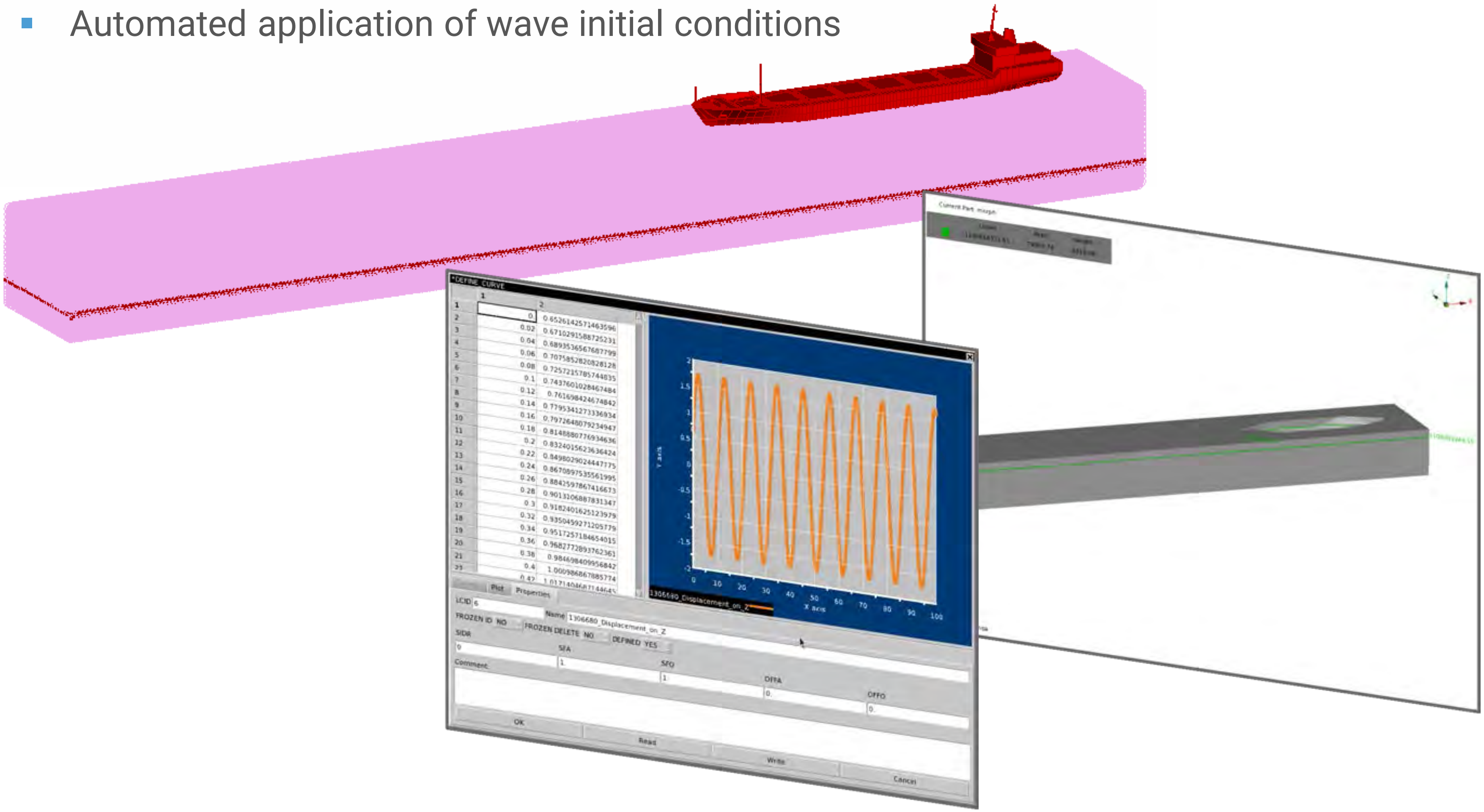


Spar Platform

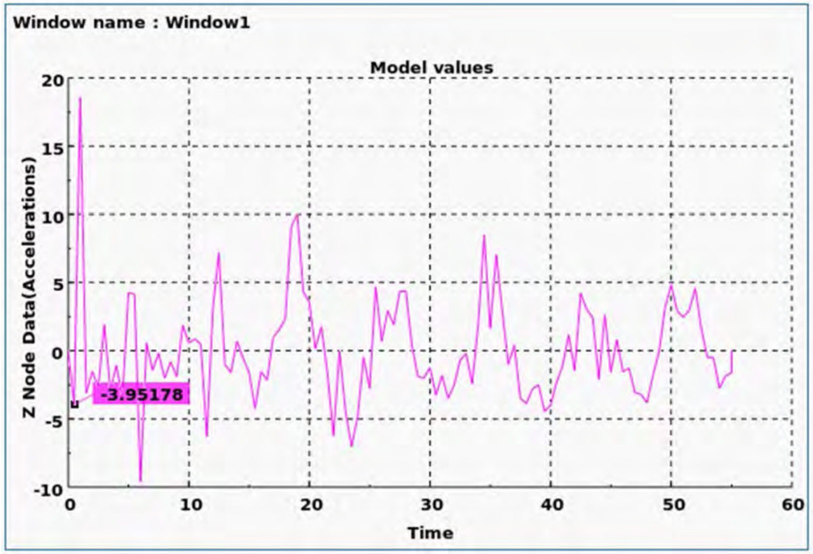


Wave on SPH case study

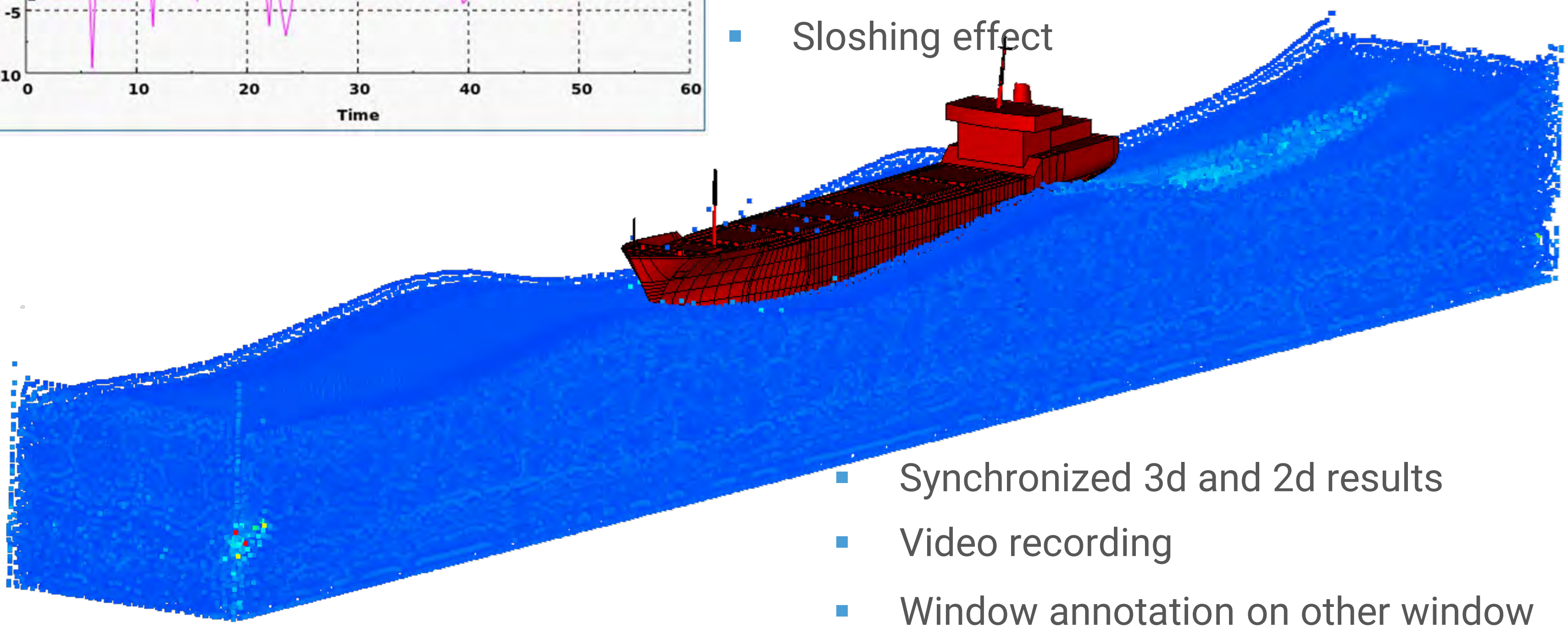
- Volume detection
- Automated SPH creation
- Automated application of wave initial conditions



Results in META



- Accelerations
- Vessels Stability
- Contact pressure and forces
- Hydrodynamic drag
- Stresses
- Sloshing effect



- Synchronized 3d and 2d results
- Video recording
- Window annotation on other window

Thank you

Stay connected

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social media