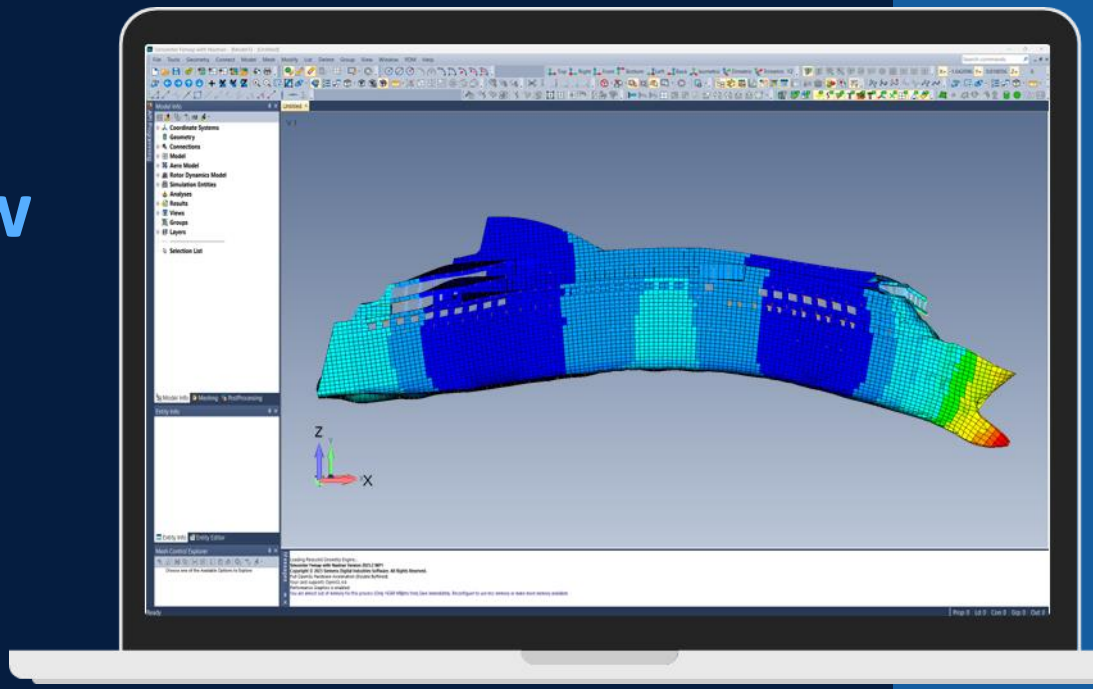
Rapid Structural design

The **OCX** Annual General Meeting (AGM), October 29-31, 2024. Ancona, Italy

OCX in Action: Simplify your FE-analysis workflow



Presented by:
Michael Pudd, RSD
Jussi Puurula, RSD

“Vision is the art of seeing what is invisible to others” Jonathan Swift

“Wanderer above the Sea of Fog”, Caspar David Friedrich

RSD
RAPID STRUCTURAL DESIGN

AGENDA

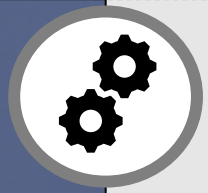
Technology Partner
Digital Industries Software

SIEMENS

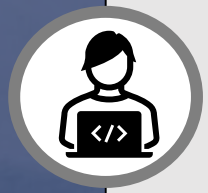
Introduction

Our background
Why do FEA
FEA **Problems**

Main topic



Solution:
OCX based FE-workflow in Ship Design
Why OCX



Implementation
RSD Tools
Global Model Case Study (Demo **Videos**)

Summary

WHO We Are

Technology Partner

Digital Industries Software

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Michael Pudd **Jussi Puurula**

CUSTOMER RELATIONS MANAGER

7 years of ship structural design

Various highly challenging ship projects, from **cargo ships to the world's largest cruise vessel**

FOUNDER

15 years of ship structural design, coordination and development

Involved in most Finnish shipbuilding projects, **icebreakers, Ropaxes, cruise and navy vessels**

Implementation of **Simulation driven design with Femap in Finnish shipbuilding.**

Rapid Structural Design Oy

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Developing next-generation Ship Structural FE-analysis

MEYER TURKU SHIPYARD 1737 · RAUMA MARINE CONSTRUCTIONS · bluetech

15 years of experience in

Strength analysis, design, coordination and development.

Cruise and passenger ships

Icebreakers and research vessels

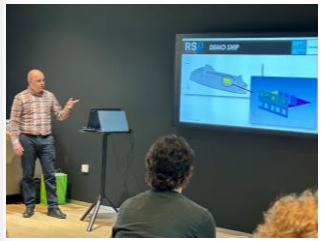
Bulk Carriers

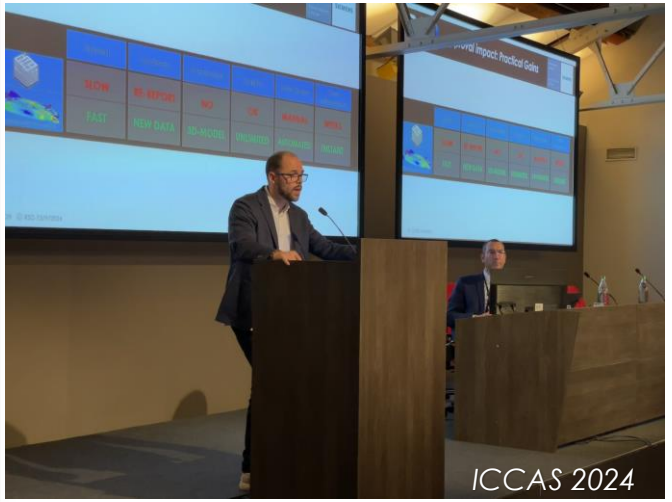
Presenter at

COMPIT 2023 OCX Standard and Structural Model Reuse in the Shipbuilding Design

AVEVA WORLD 2023 Structural modelling with AVEVA™ E3D Design for design collaboration and FEM

ICCAS 2024 – INTERNATIONAL CONFERENCE ON COMPUTER APPLICATIONS IN SHIPBUILDING

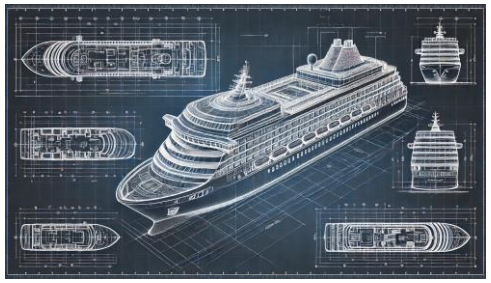




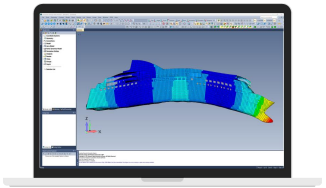
Why do FE-simulation?

Validation of hull in extreme Sea conditions

Enables us to develop amazing designs



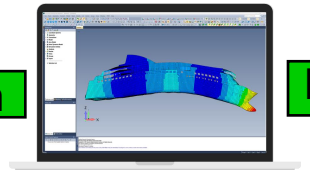
Novel Designs



FE-simulation

Flaws

UPD Design



Errors fixed

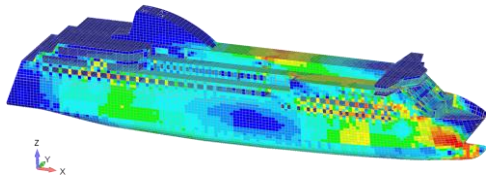
Final Product

Simulation of Real-life behavior of the vessel

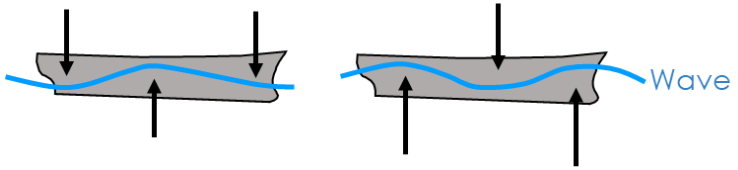
Value

Reporting
Structural Compliance

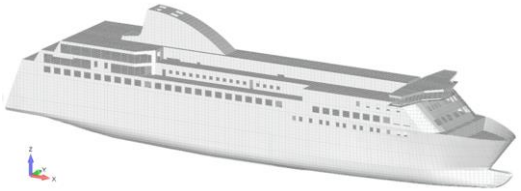
Analysis
Support design



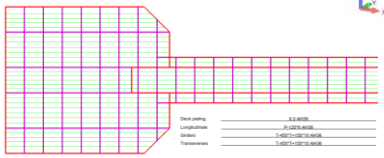
Loading
Rule Loads



Meshing
GEO into FE-mesh



GEOmetry Modeling
From drawings



Problems encountered

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AVEVAWORLD SAN FRANCISCO 2023

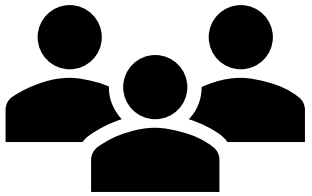
OCX

COMPIT

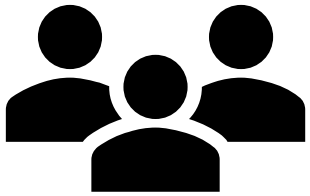
THE ROYAL INSTITUTION OF NAVAL ARCHITECTS

ICCAS 2024 – INTERNATIONAL CONFERENCE ON COMPUTER APPLICATIONS IN SHIPBUILDING

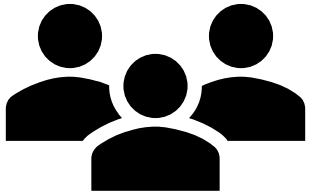
SMM

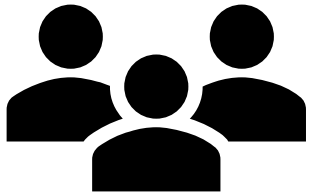


Managers

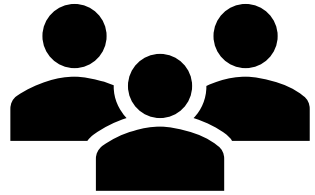


Designers





Class



What are **your** FE-problems?

Asking

FE-problems

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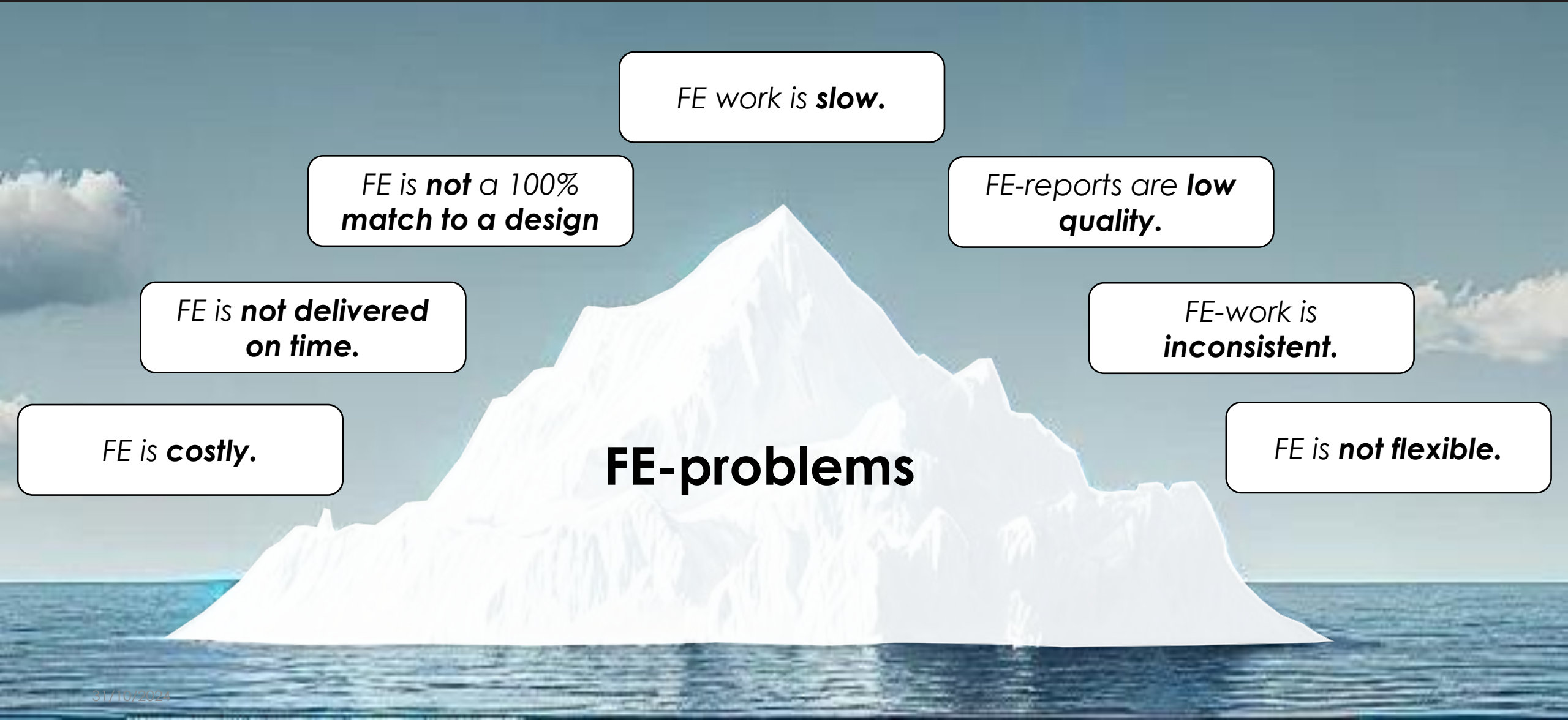

FE-problems

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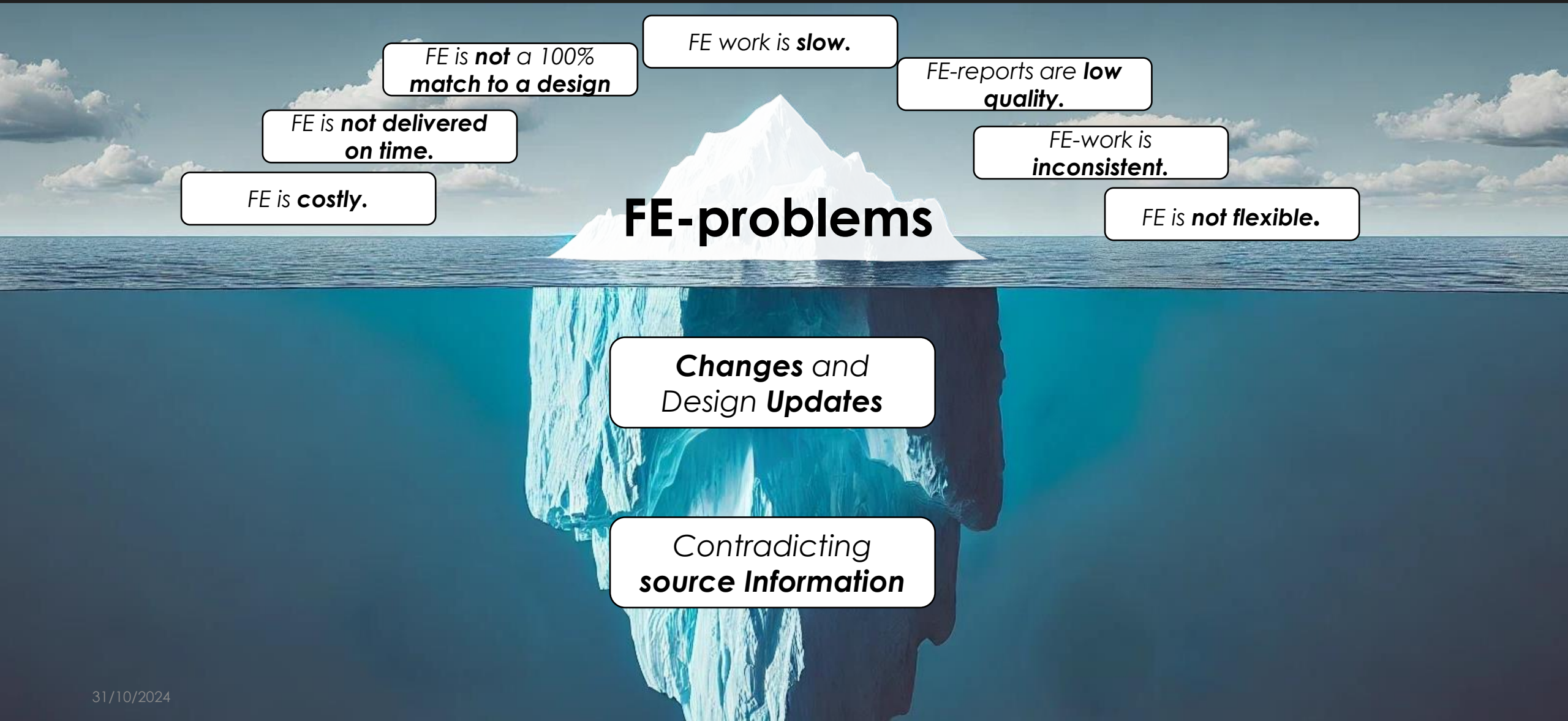

FE-workflow in Ship Design

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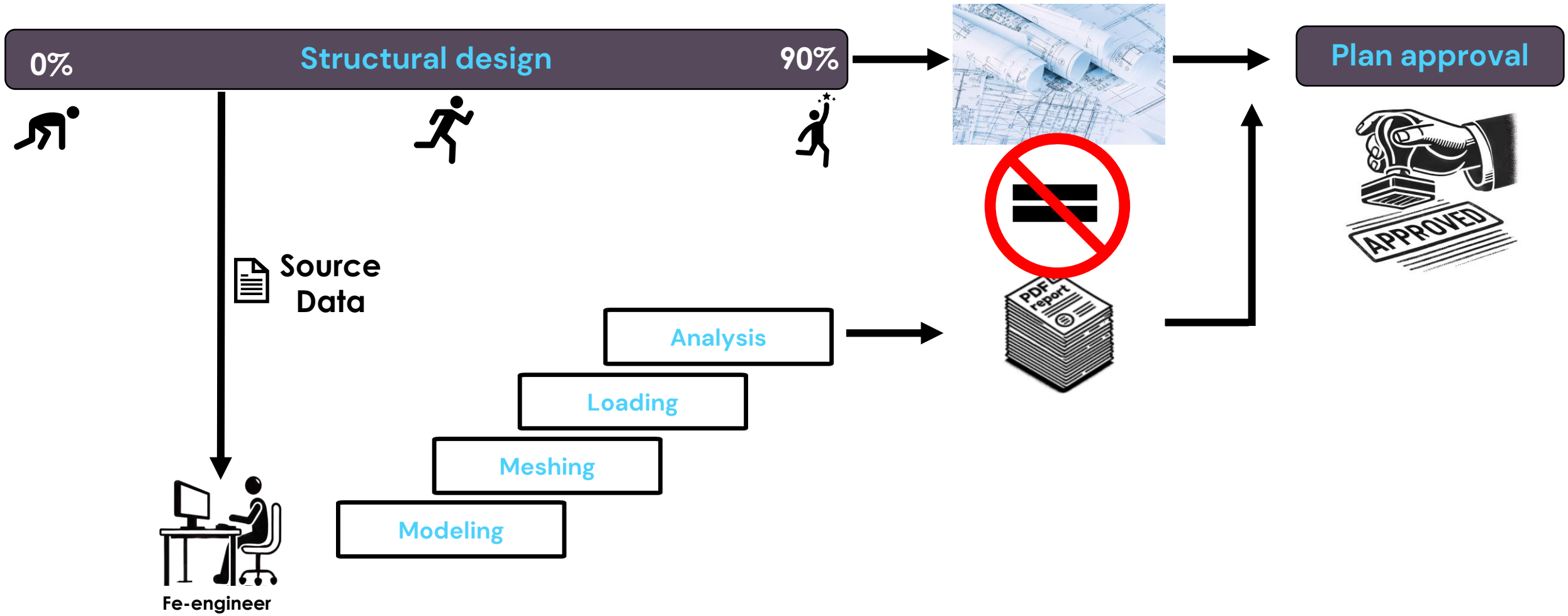

FE-workflow in Ship Design

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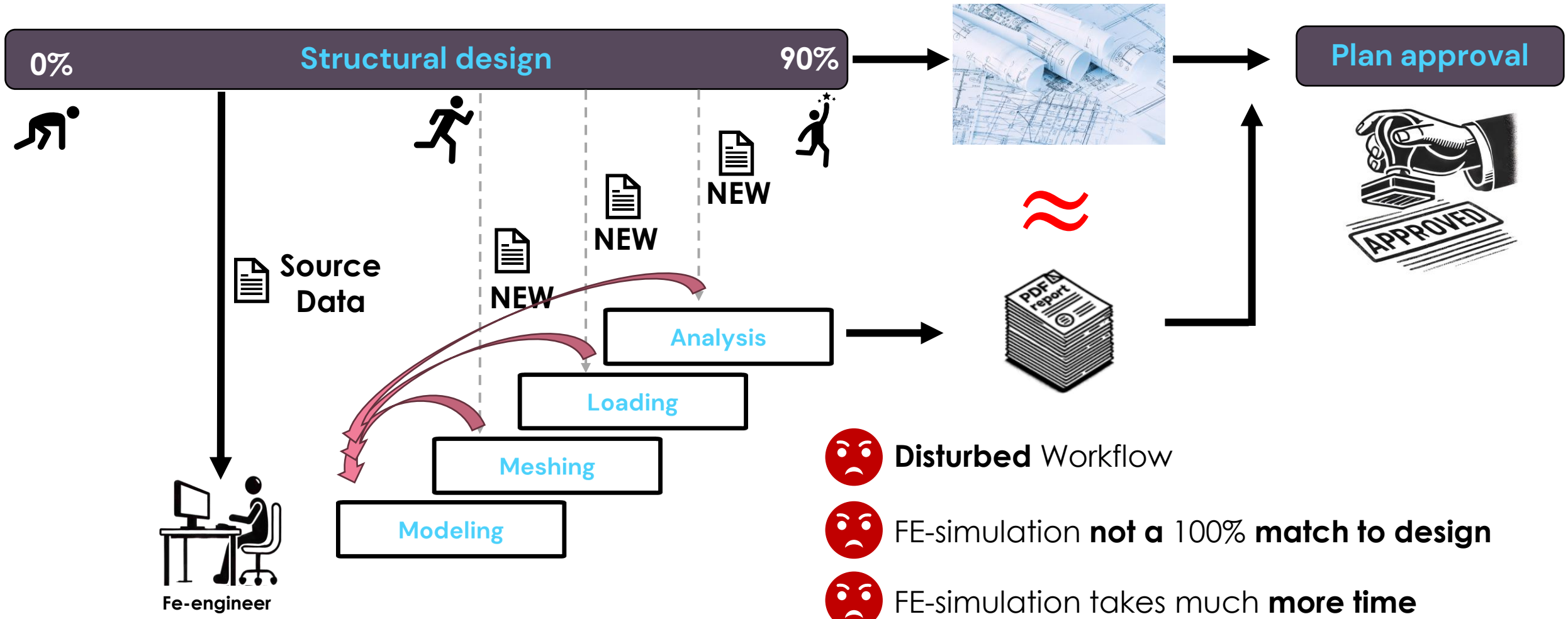
RSD RAPID STRUCTURAL DESIGN



Disturbed Workflow

FE-simulation **not a** 100% **match to design**

FE-simulation takes much **more time**

OCX-Powered FE-Workflow in Ship Design

RAPID STRUCTURAL DESIGN

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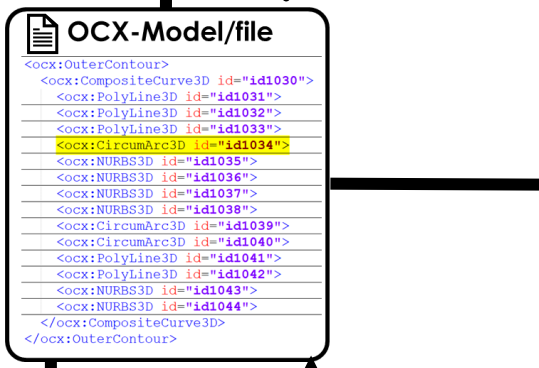
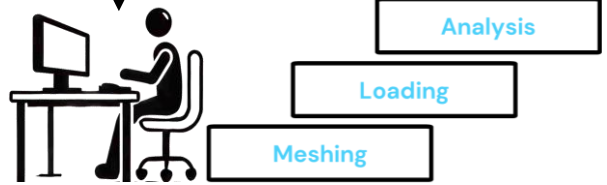
0% Structural design 90%

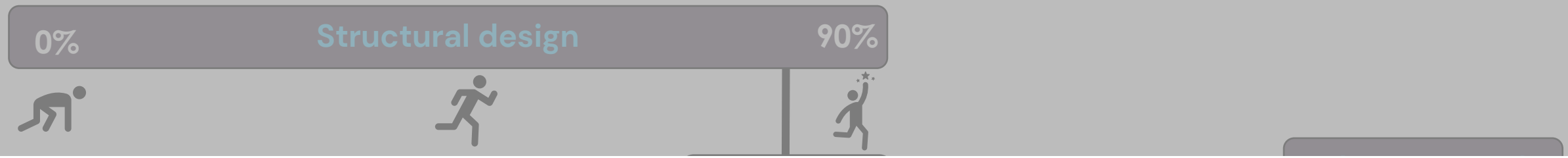


Plan approval

- **No** time-consuming **modelling**
- **On time**
- **On budget** € $

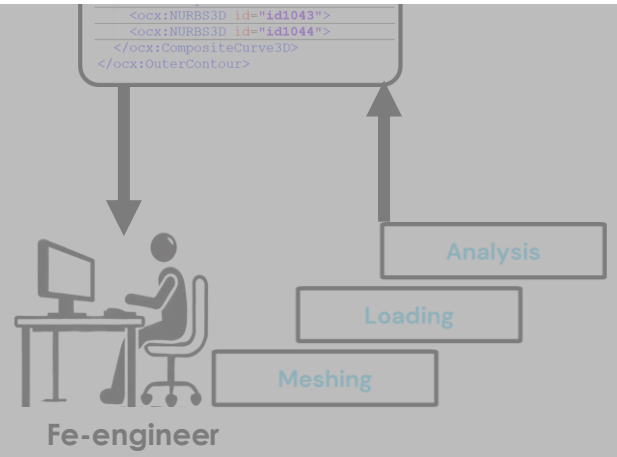


Fe-engineer



Why OCX?

- **No** time-consuming **modelling**
- On time
- On budget



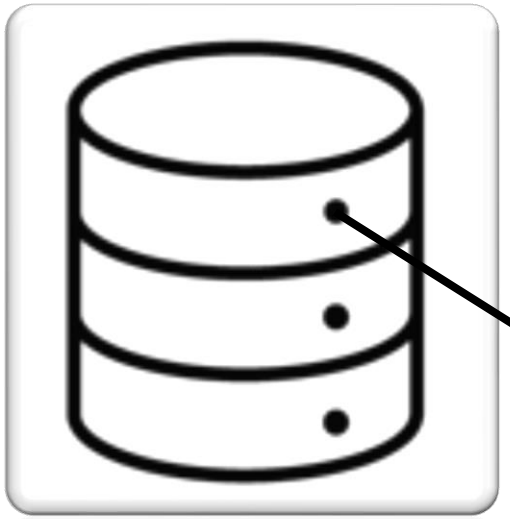
OCX = MODEL

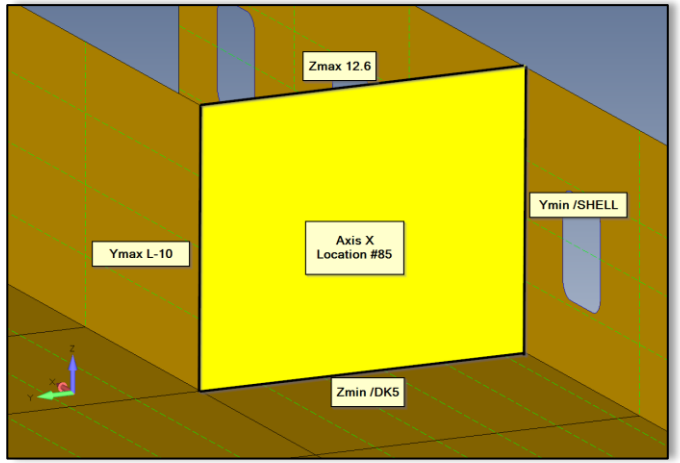
OCX ~ CAD-model

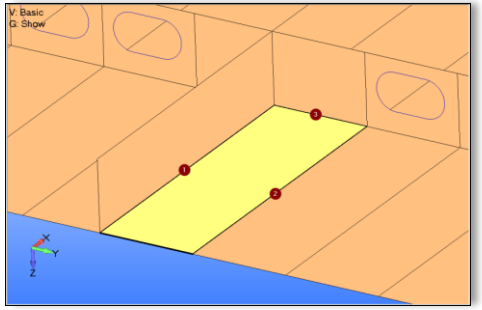
Build for purpose

FE-Meshing

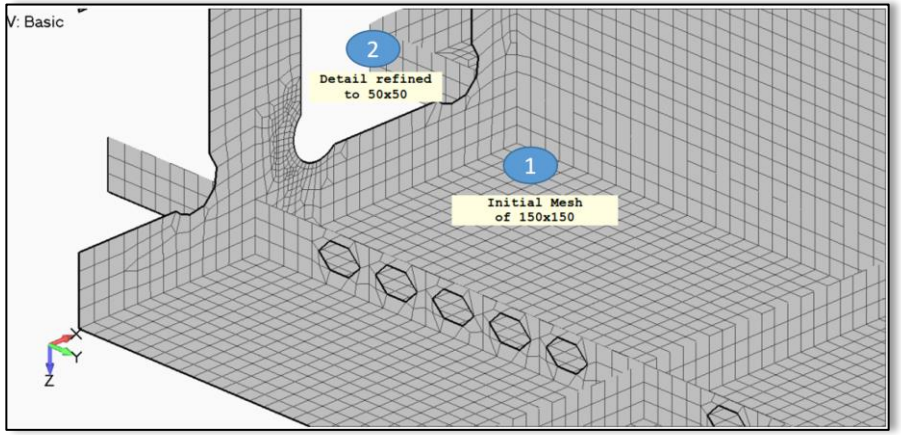
OCX:Vessel







Ocx:Panel
Location, Limits
Stiffeners, Holes



Comparison

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Source	Time spend	Value
2D DWG	Modeling → 40h → Meshing	**Takes time** FE use: start **from scratch**
3D STEP	Modeling → 20h → Meshing	**Overdetailed** **NOT** utilizable by FE FE use: as **a reference**
3D OCX	Modeling → 8h → Meshing	FE use: geometry and data **directly** **Require tools** for data extraction RSD

*the exact number of hours spent is project/model specific

Efficient Tools for OCX

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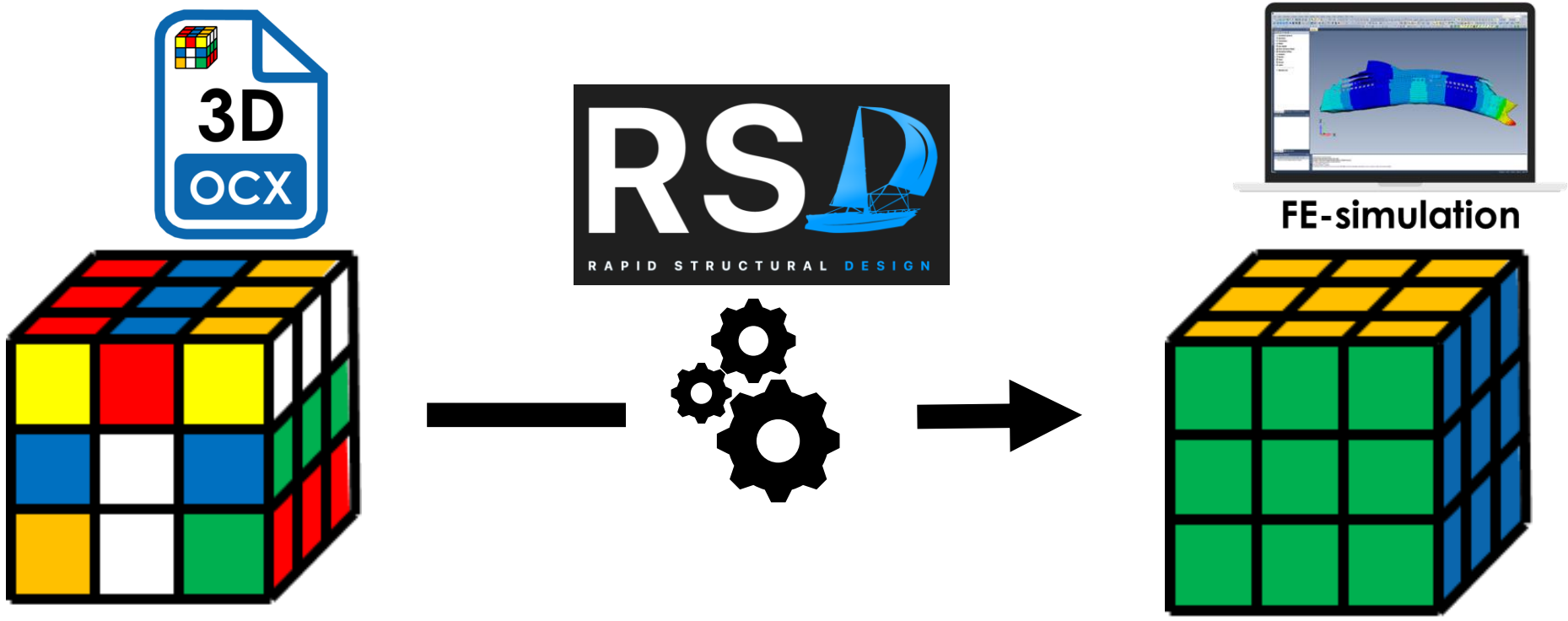


Efficient Tools for OCX

Efficient RSD OCX-tools

RSD OCX import

~~Modeling~~

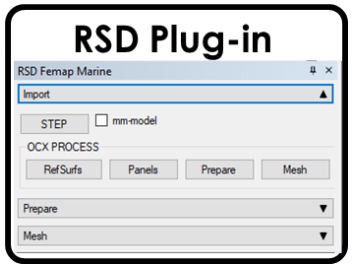
Meshing

Loading — RSD Tools, APIs

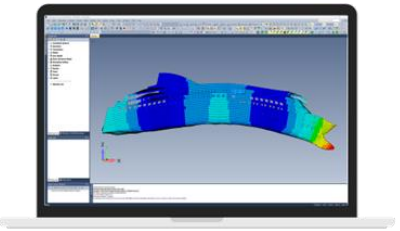
Analysis — RSD Experience

Reporting — RSD Tools, APIs

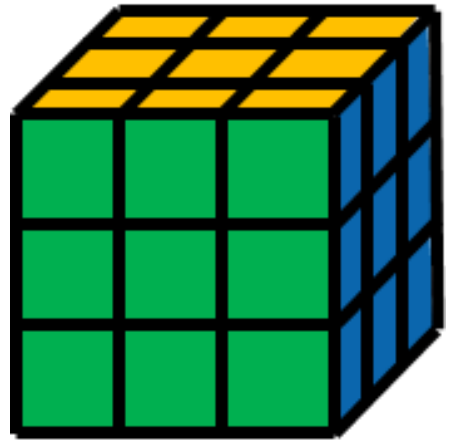
Communicate changes



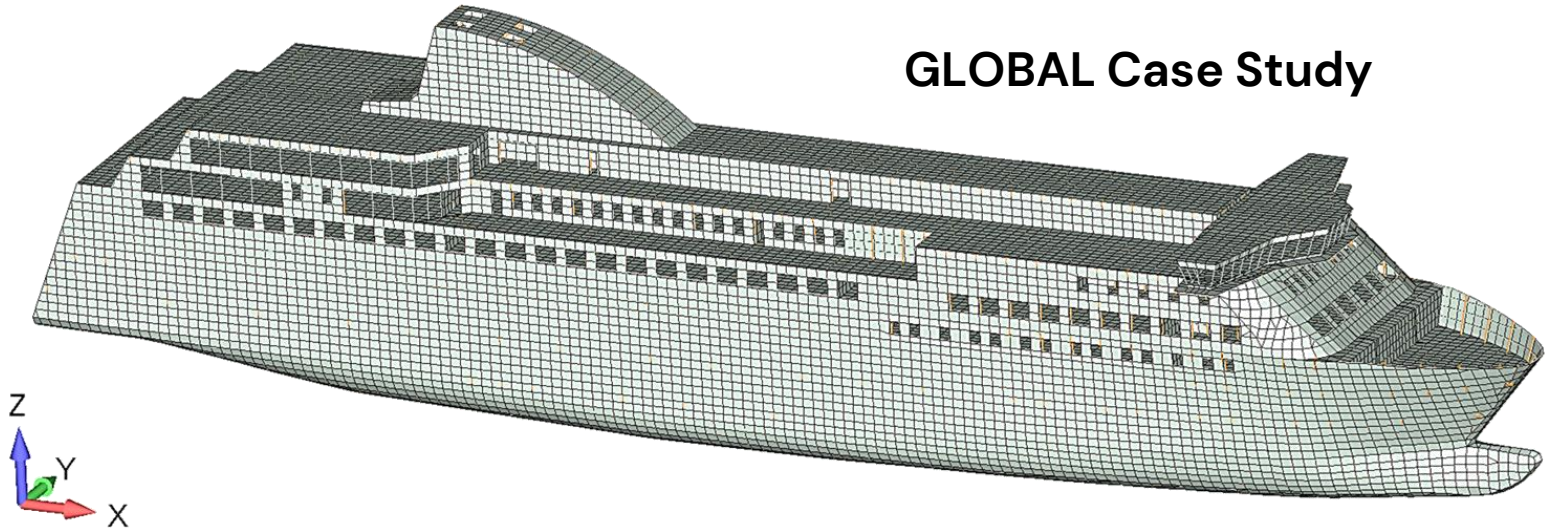
5x FASTER



FE-simulation



Global Case Study



RSD Pipeline

RAPID STRUCTURAL DESIGN

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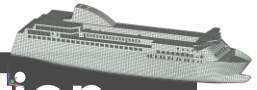
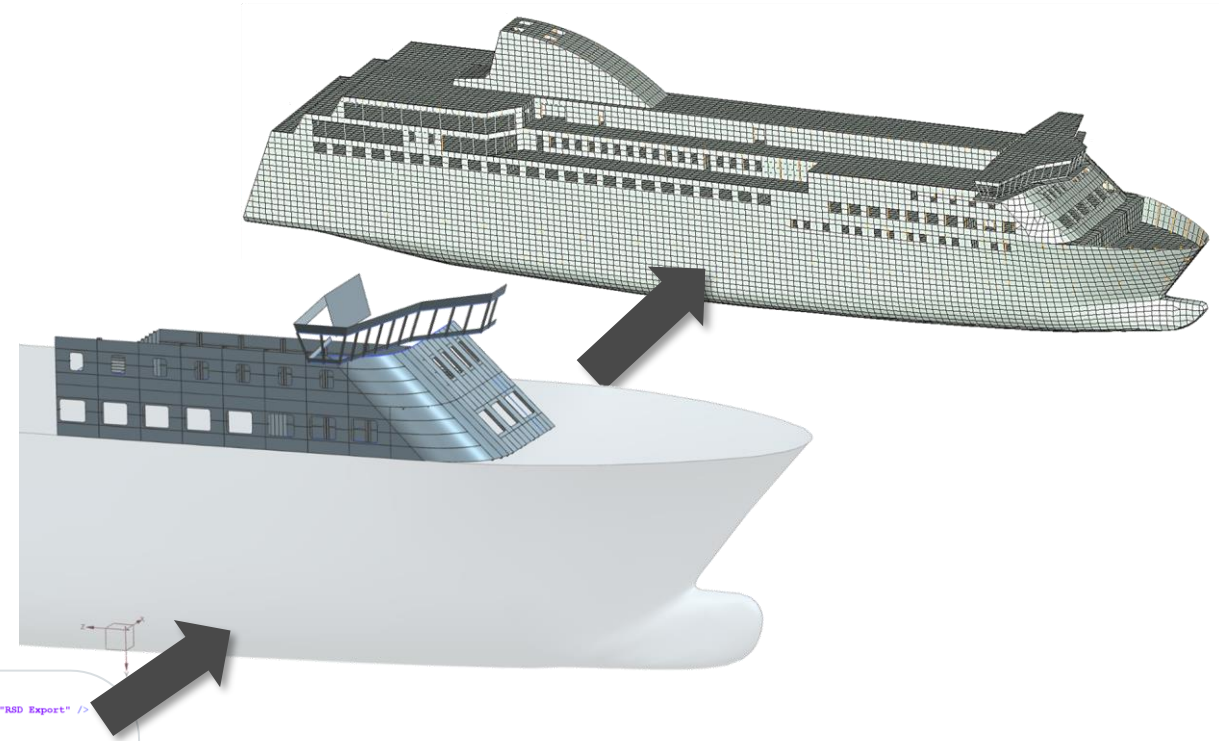
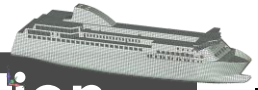


Model Creation

- Rule Loads
- Analysis
- Model Validation
- Report



RSD Pipeline



Model Creation

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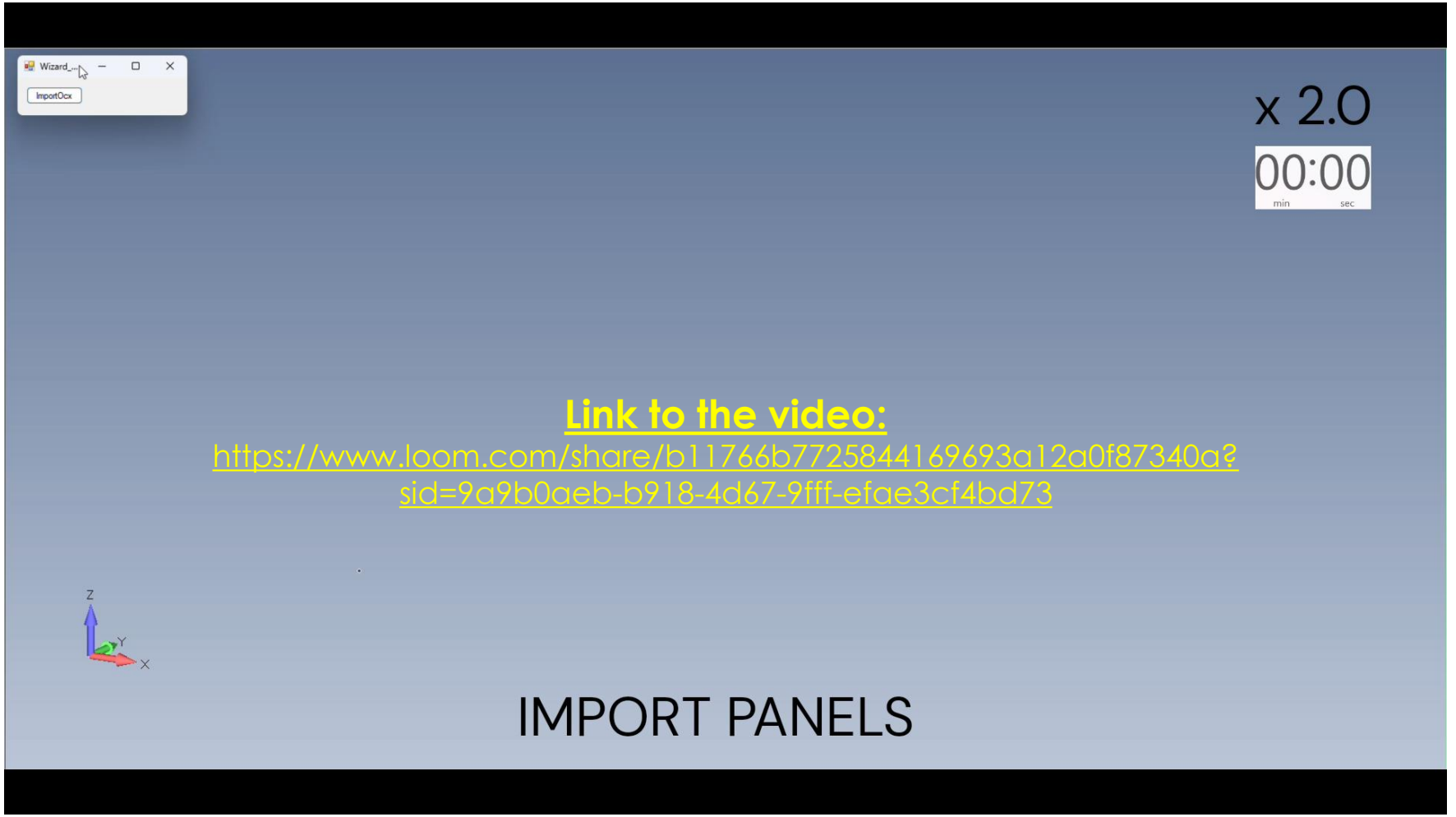

RSD Pipeline

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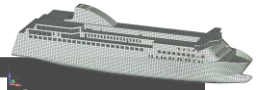
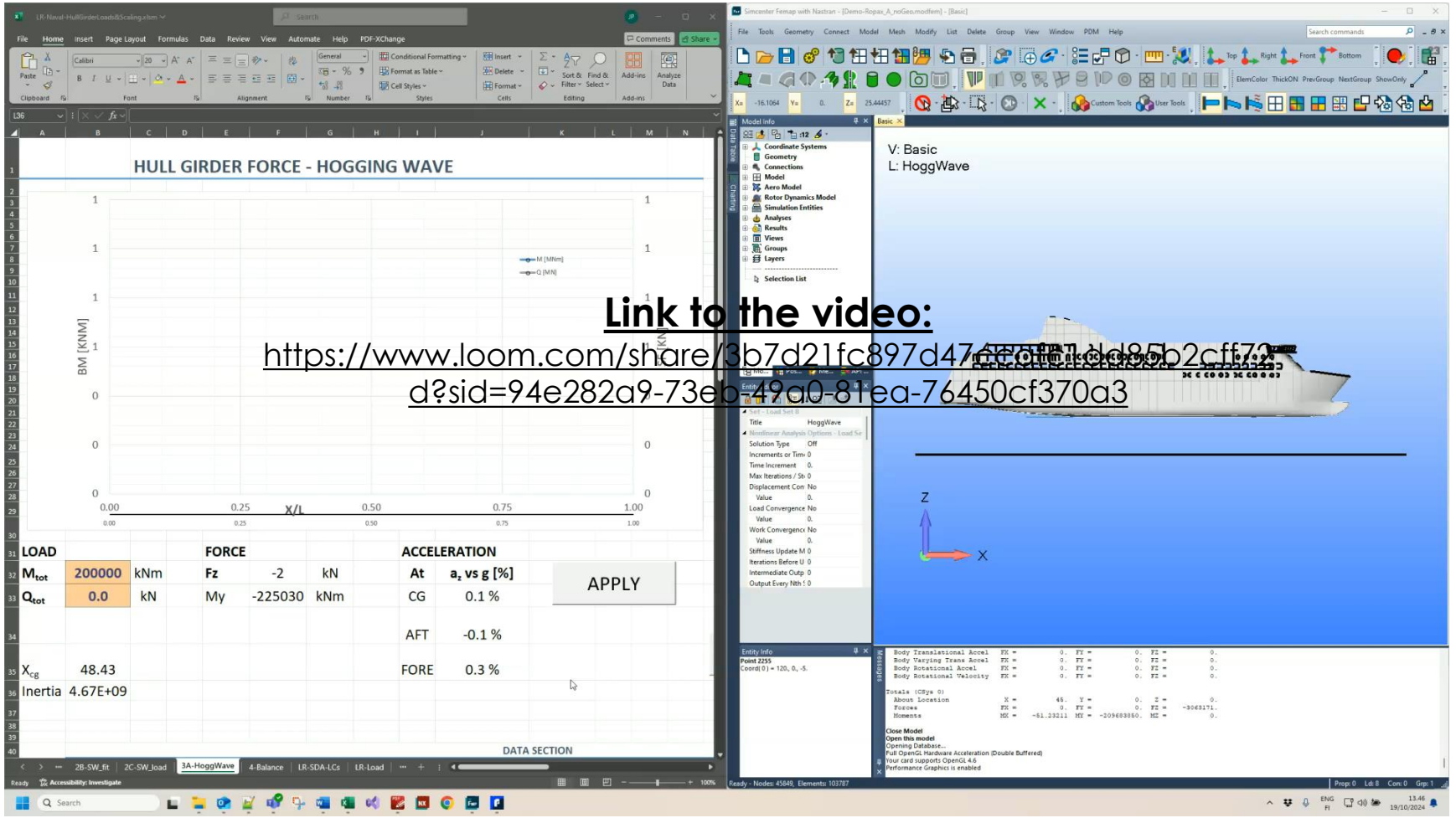
- Model Creation
- **Rule Loads**
- Analysis
- Model Validation
- Report





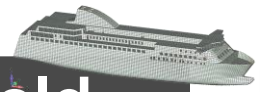
Link to the video:

https://www.loom.com/share/3b7d21fc897d47[illegible]d85b2cff73d?sid=94e282a9-73e6-49a0-81ea-76450cf370a3

RSD Pipeline

Model Creation

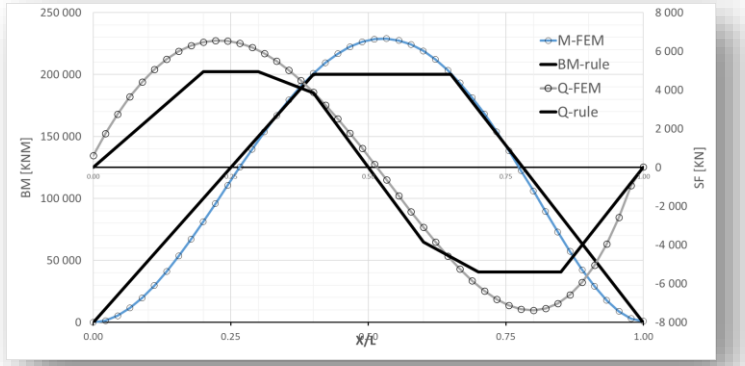
Rule Loads

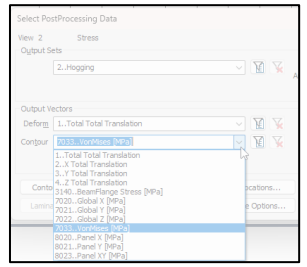


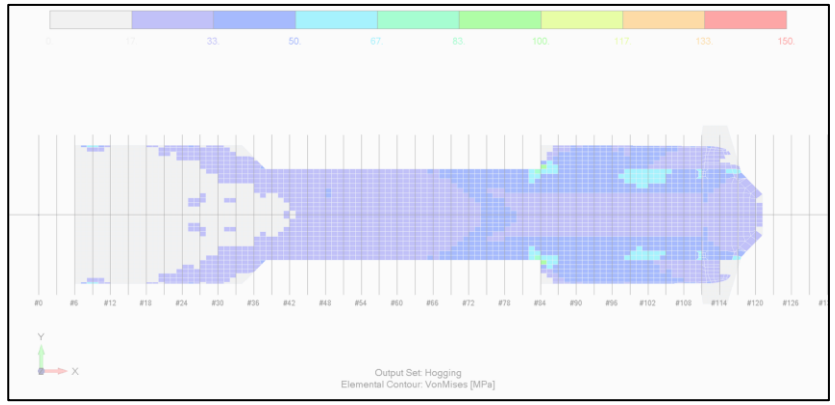
1/2 **Analysis - Yield**

Model Validation

Report







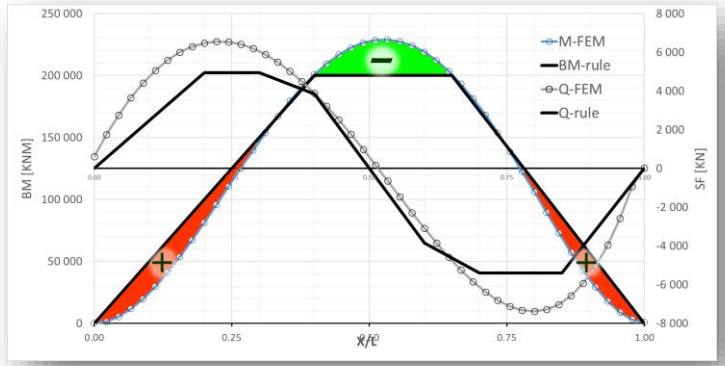
Model Creation

Rule Loads

1/2 **Analysis - Yield**

Model Validation

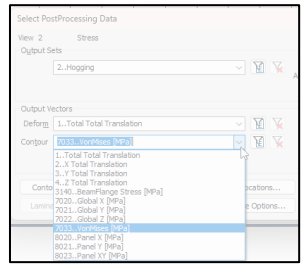
Report

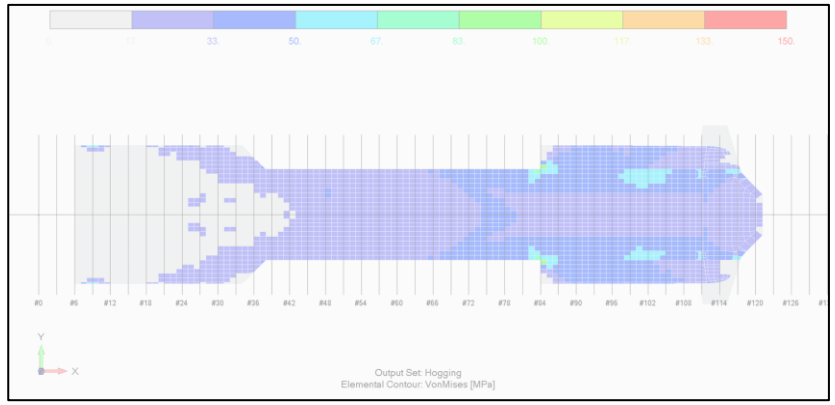


SDA for Primary Structure Naval Ships under Category NS_2

Adjustment of Global BM and SF

Lloyd's Register





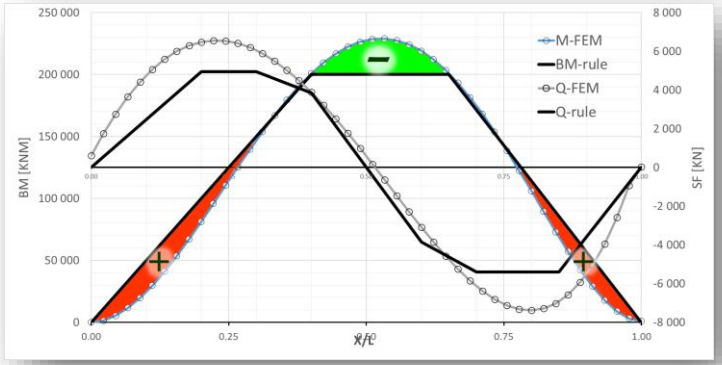
RSD Pipeline

Technology Partner

Digital Industries Software

SIEMENS

- Model Creation
- Rule Loads
- 1/2 **Analysis - Yield**
- Model Validation
- Report

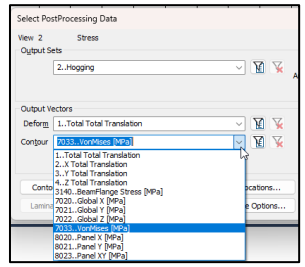


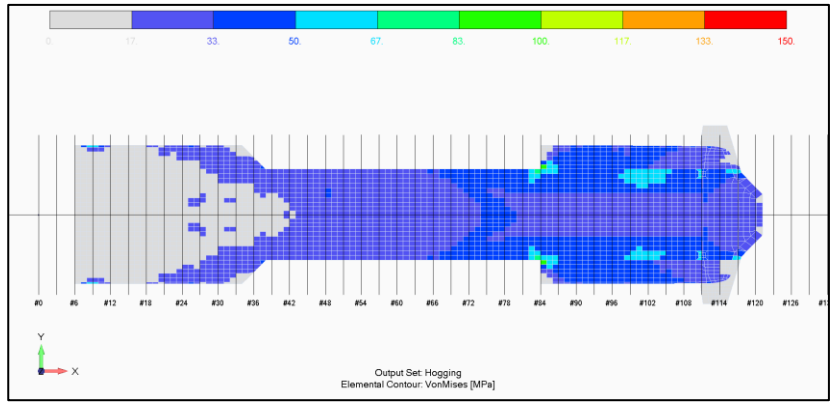
SDA for Primary Structure Naval Ships under Category NS_2

Adjustment of Global BM and SF

Lloyd's Register

Validated Rule Scaling





Stress assessment

Model Creation

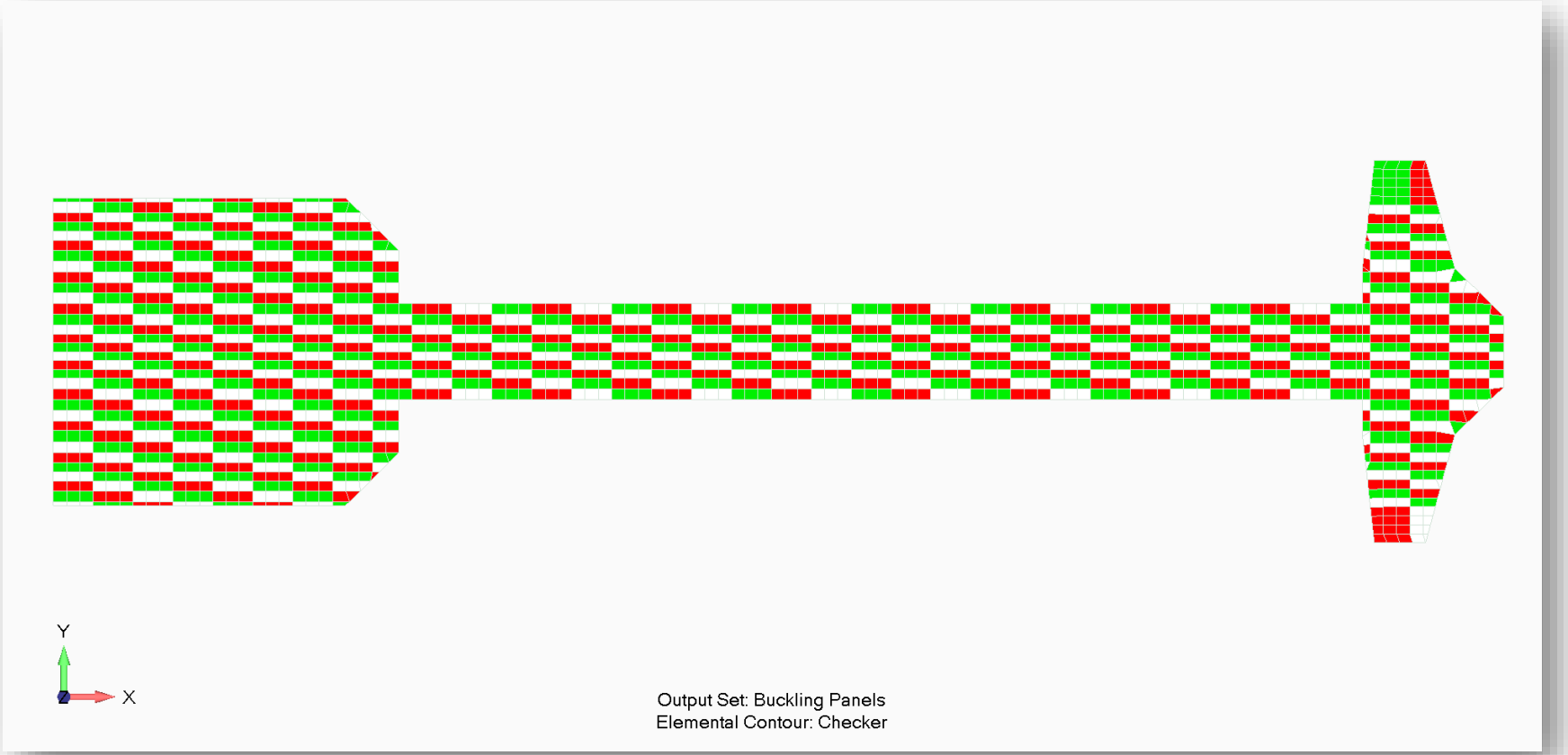
Rule Loads

2/2 Analysis - Buckling

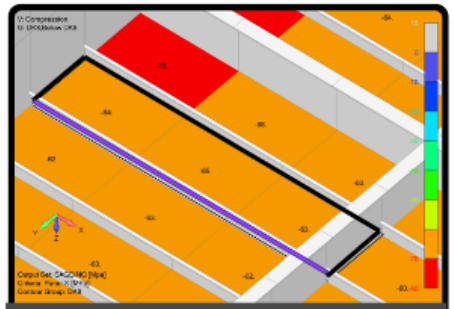
Model Validation

Report

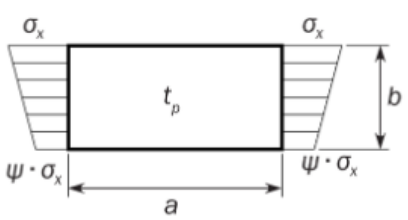
Identify the Panels



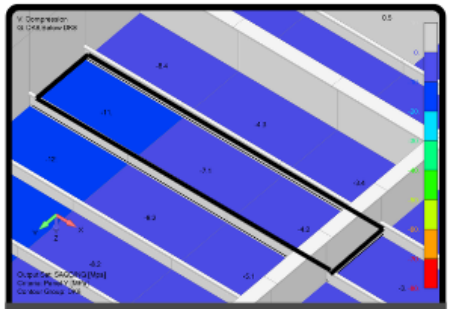
- Model Creation
- Rule Loads
- 2/2 **Analysis - Buckling**
- Model Validation
- Report



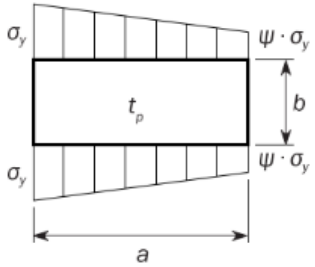
Compression X



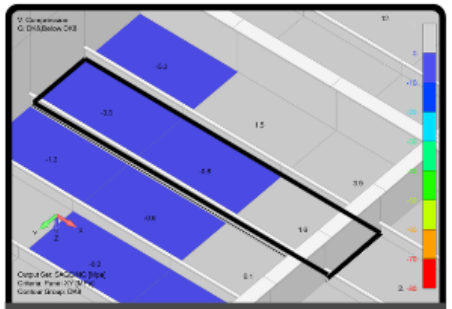
$$\frac{\gamma_{c1}\sigma_x S}{\sigma_{cx}'} = 0.62$$



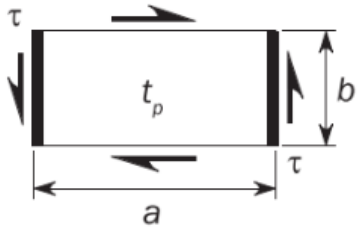
Compression Y



$$\frac{\gamma_{c1}\sigma_x S}{\sigma_{cx}'} = 0.11$$



Shear XY



$$\frac{\gamma_{c1}|\tau|S}{\tau_c'} = 0.02$$

Plate limit state

$$\frac{\gamma_{c1}\sigma_x S}{\sigma_{cx}'} = 0.62$$

$$\frac{\gamma_{c1}\sigma_x S}{\sigma_{cx}'} = 0.11$$

$$\frac{\gamma_{c1}|\tau|S}{\tau_c'} = 0.02$$

$$\left(\frac{\gamma_{c1}\sigma_x S}{\sigma_{cx}'}\right)^{e_0} - B\left(\frac{\gamma_{c1}\sigma_x S}{\sigma_{cx}'}\right)^{\frac{e_0}{2}}\left(\frac{\gamma_{c1}\sigma_y S}{\sigma_{cy}'}\right)^{\frac{e_0}{2}} + \left(\frac{\gamma_{c1}\sigma_y S}{\sigma_{cy}'}\right)^{e_0} + \left(\frac{\gamma_{c1}|\tau|S}{\tau_c'}\right)^{e_0} = 1$$

$$\left(\frac{\gamma_{c2}\sigma_x S}{\sigma_{cx}'}\right)^{\frac{2}{0.25}} + \left(\frac{\gamma_{c2}|\tau|S}{\tau_c'}\right)^{\frac{2}{0.25}} = 1 \quad \text{for } \sigma_x \geq 0$$

$$\left(\frac{\gamma_{c3}\sigma_y S}{\sigma_{cy}'}\right)^{\frac{2}{0.25}} + \left(\frac{\gamma_{c3}|\tau|S}{\tau_c'}\right)^{\frac{2}{0.25}} = 1 \quad \text{for } \sigma_y \geq 0$$

$$\frac{\gamma_{c4}|\tau|S}{\tau_c'} = 1$$

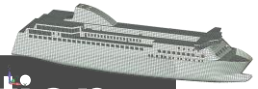
$$\gamma_c = \min(\gamma_{c1}, \gamma_{c2}, \gamma_{c3}, \gamma_{c4})$$

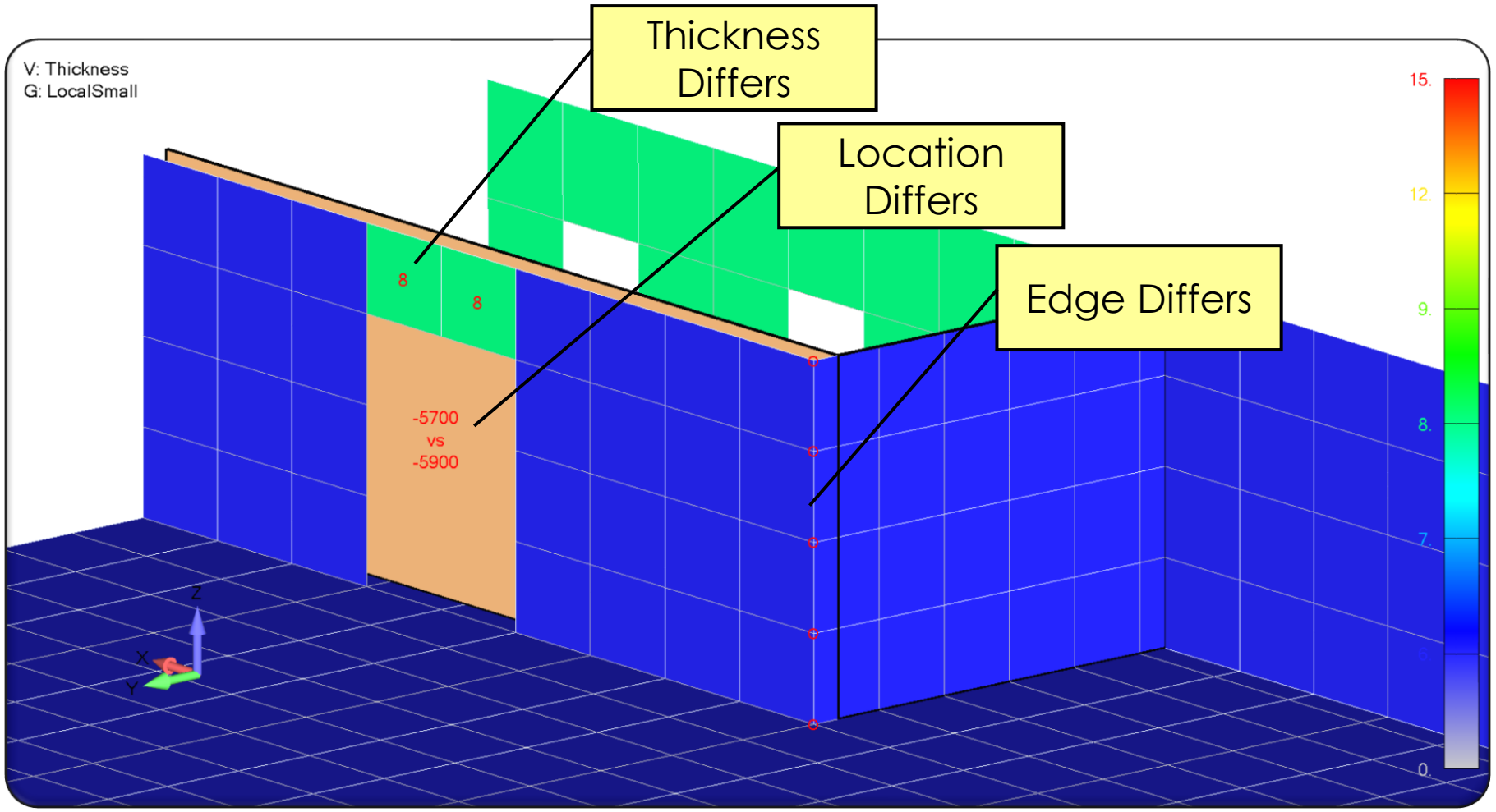
UF=63%

Automated buckling assessment

RSD Pipeline

- Model Creation
- Rule Loads
- Analysis
- **Model Validation**
- Report





Match OCX and FE-model

FE-reinforcements

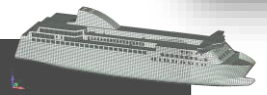
RSD Pipeline

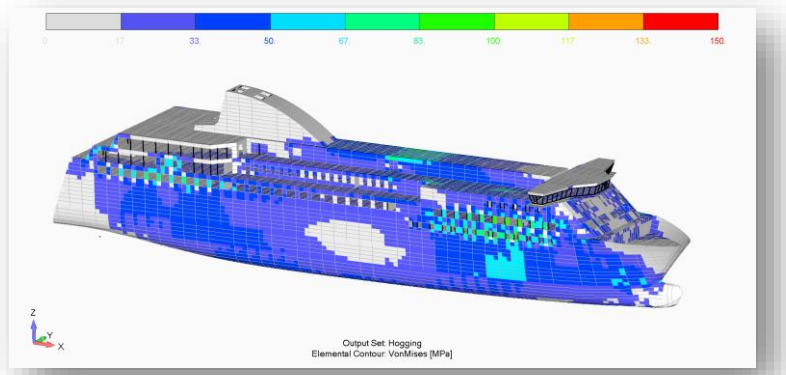
Technology Partner

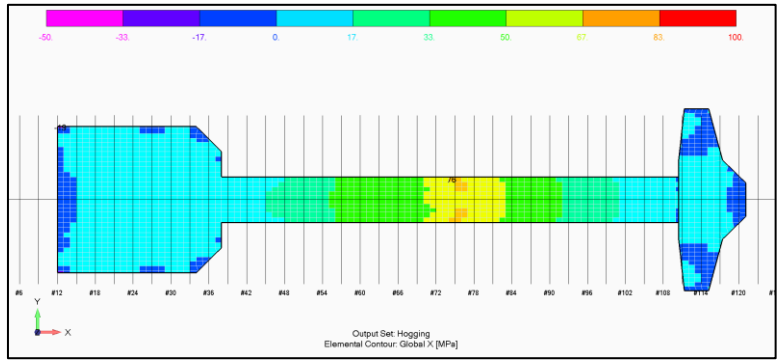
Digital Industries Software

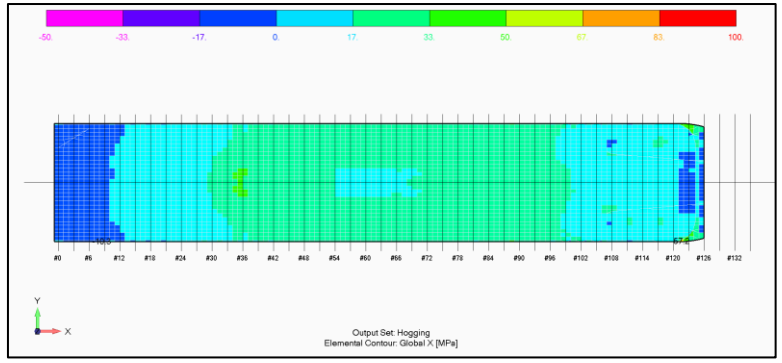
SIEMENS

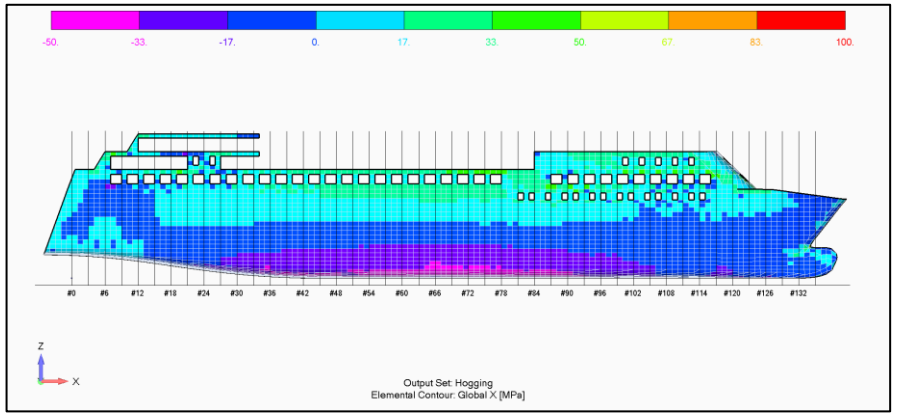
- Model Creation
- Rule Loads
- Analysis
- Model Validation
- **Report**

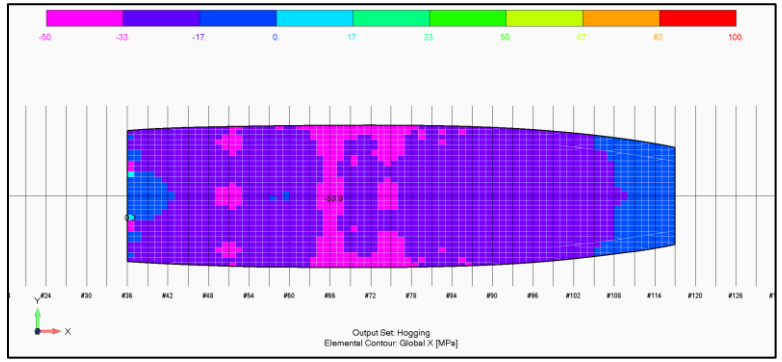












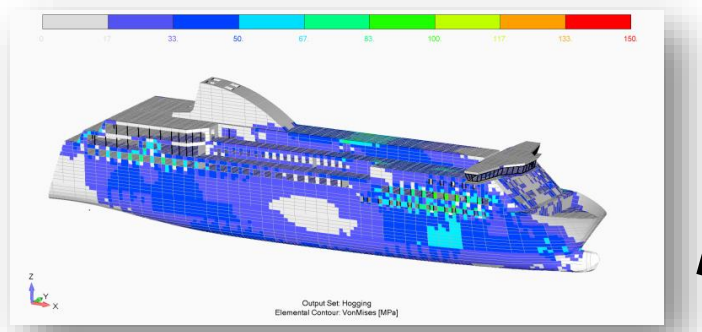
RSD Pipeline

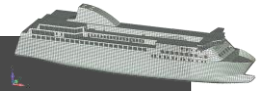
Technology Partner

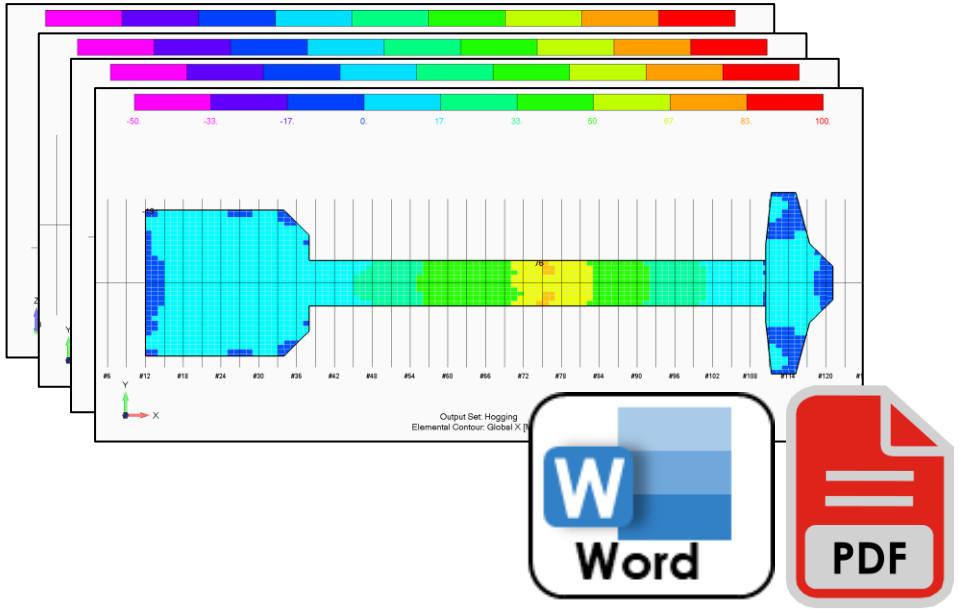
Digital Industries Software

SIEMENS

- Model Creation
- Rule Loads
- Analysis
- Model Validation
- **Report**





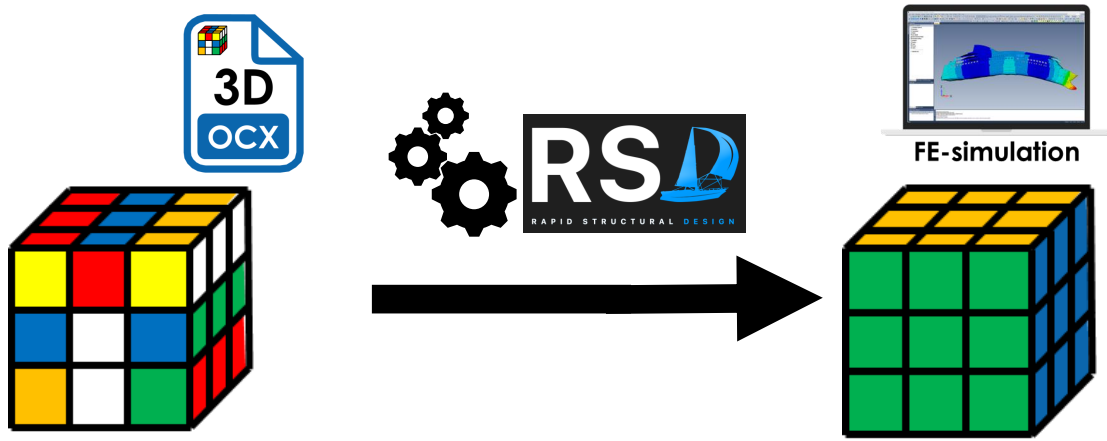


Word

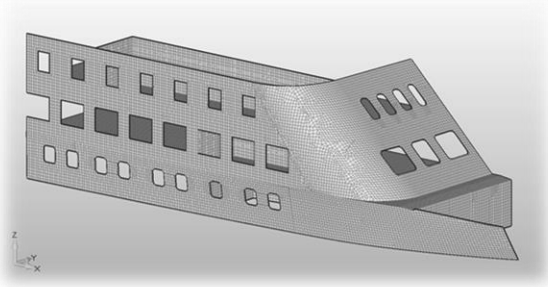
PDF

FE-report for Plan approval

Global Case Study

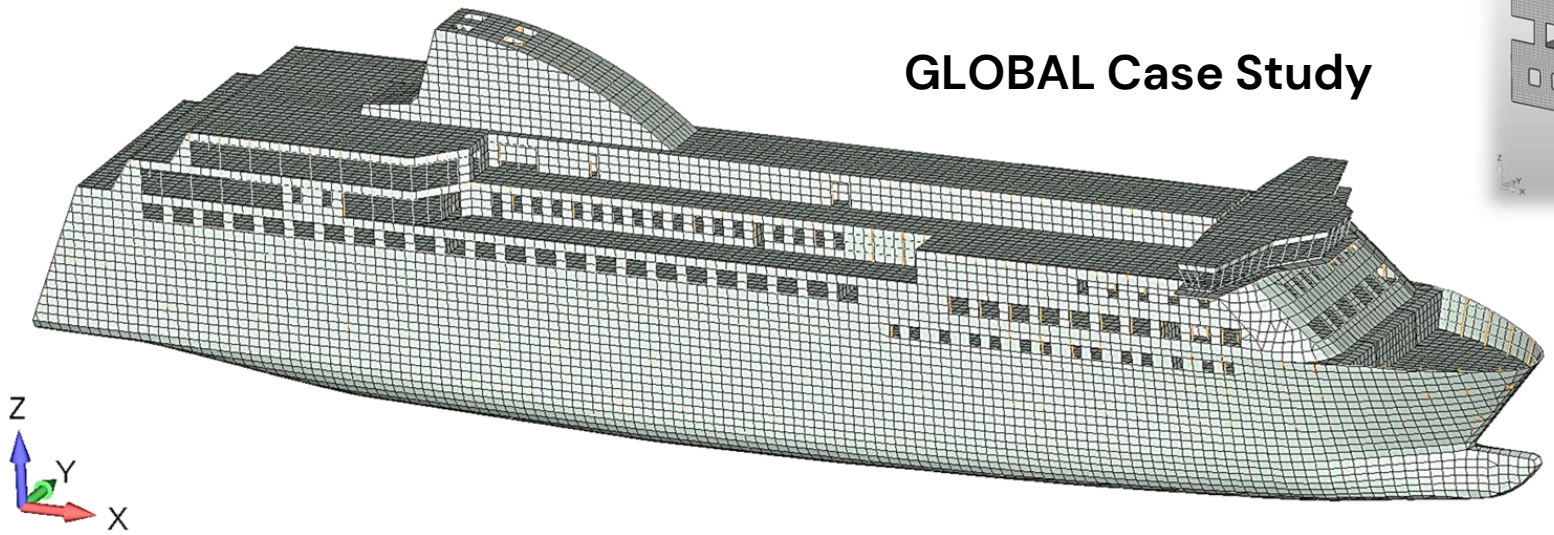


Local model



Same approach

GLOBAL Case Study



Perfect Tools for OCX

RAPID STRUCTURAL DESIGN

Technology Partner

Digital Industries Software

SIEMENS

Source

2D DWG

3D STEP

3D OCX

Efficient service

SC FMP

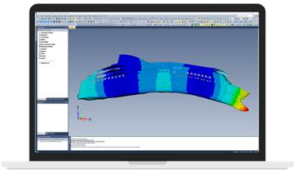
API

RS RAPID STRUCTURAL DESIGN

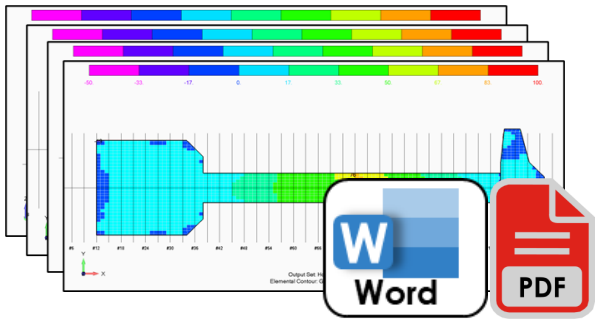
Macros

Excel

Output



FE-simulation



FE-report

Perfect Tools for OCX

Technology Partner

Digital Industries Software

SIEMENS

Source

3D OCX

Efficient service

RSD RAPID STRUCTURAL DESIGN

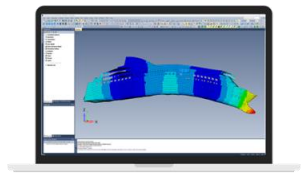
SC FMP

API

Macros

Excel

Output



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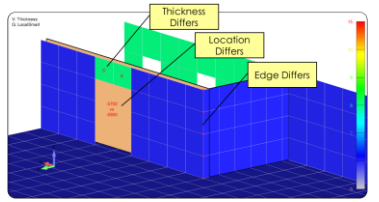
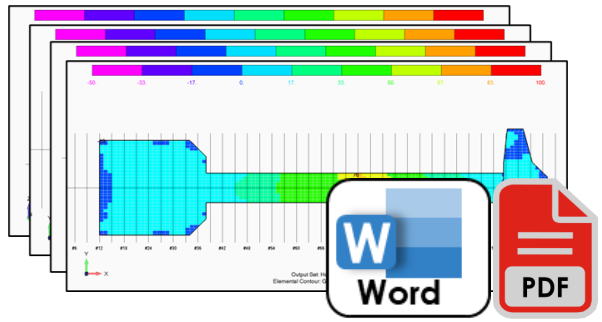


Model Validation



FE-report

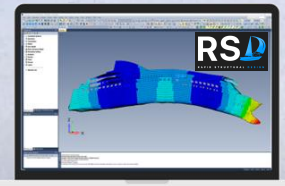
OCX

Plan Approval

On Budget

On Time

OCX



FE-simulation

3D OCX

3D OCX

Rapid Structural design

RAPID STRUCTURAL DESIGN

Thank you

Contact us.

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31 October 2024, Ancona, Italy