# Simcenter
## Engineering Innovation in the Marine Industry

Unrestricted © Siemens AG 2018

# The Marine Industry – time to Change?

SIEMENS
Ingenuity for life

## Stricter Regulations

## Increased Competition

## Global Recession

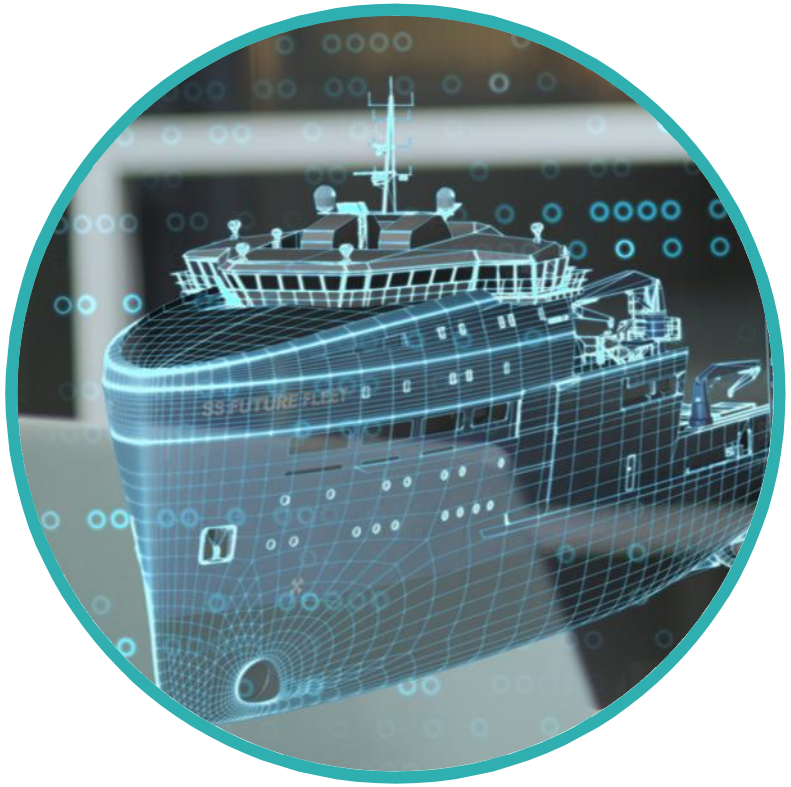
## Digitalisation and Smart operation

Unrestricted © Siemens AG 2018

# Digital Transformation with a Holistic Digital Twin

SIEMENS
Ingenuity for life

## Ideation



## Realization

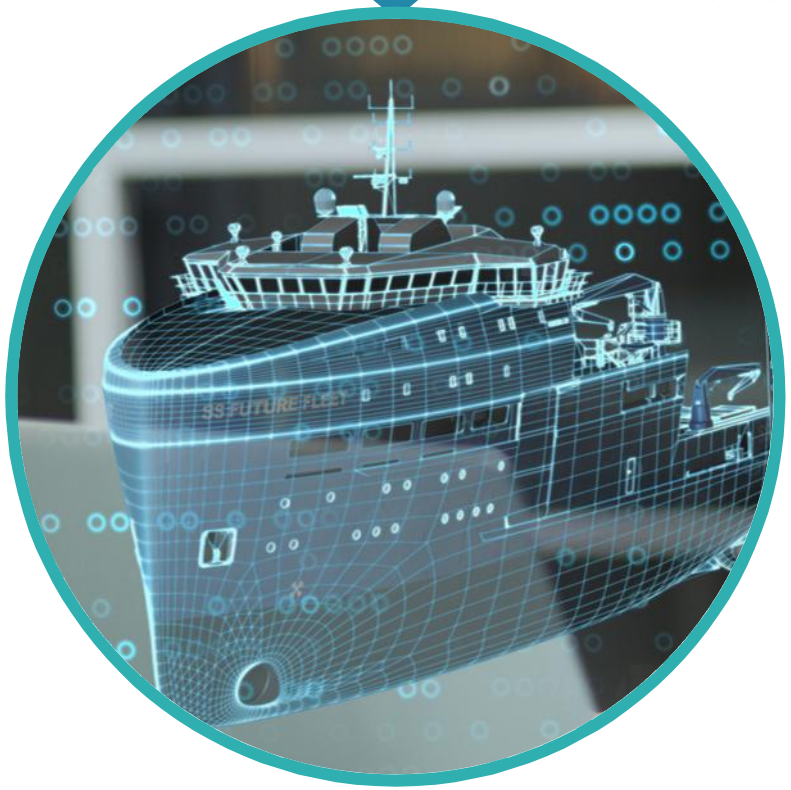
## Utilization

Unrestricted © Siemens AG 2018

# Closing the Loop with the Holistic Digital Twin

SIEMENS
Ingenuity for life

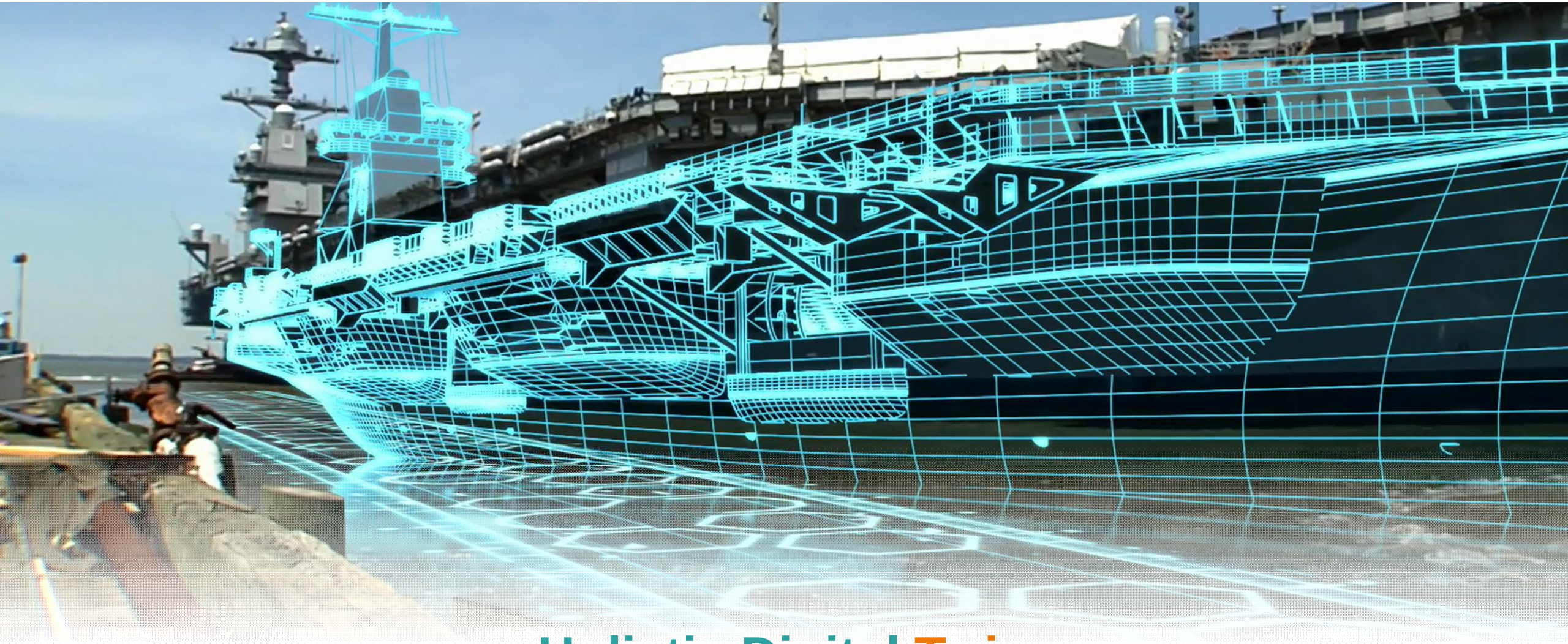
**Feed back insights to continuously improve product and production**



Unrestricted © Siemens AG 2018

# Digital Transformation with a Holistic Digital Twin

SIEMENS
Ingenuity for life

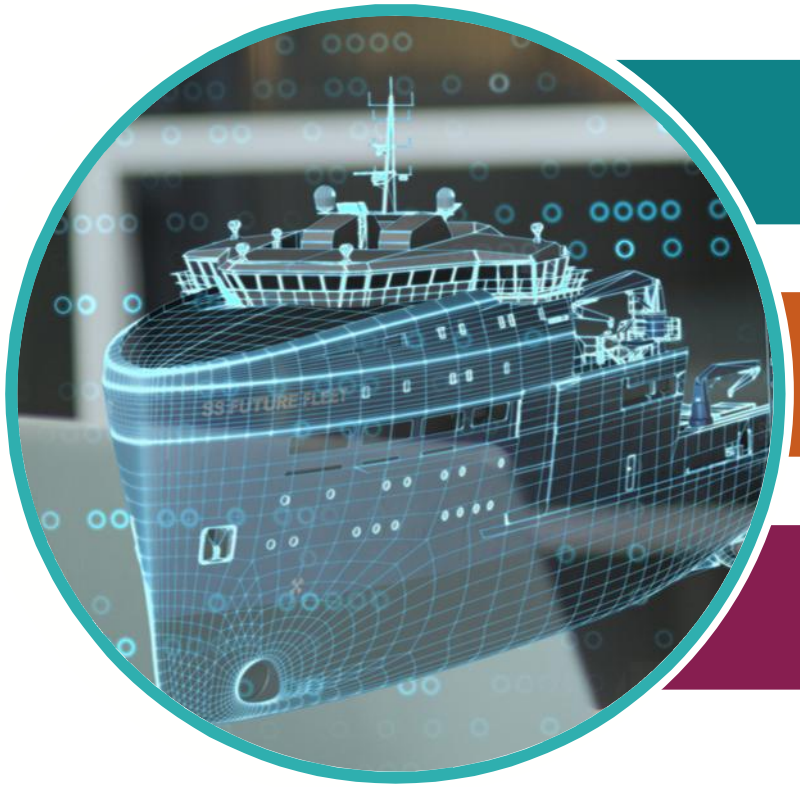


## Holistic Digital Twin

# Redefining Marine Performance Engineering for the Digital Twin

SIEMENS
Ingenuity for life

**Performance Engineering**



**Productivity**
Saving engineering time

**Realism**
Increasing confidence

**Continuity**
Enabling enterprise collaboration

**Exploration**
Delivering insight

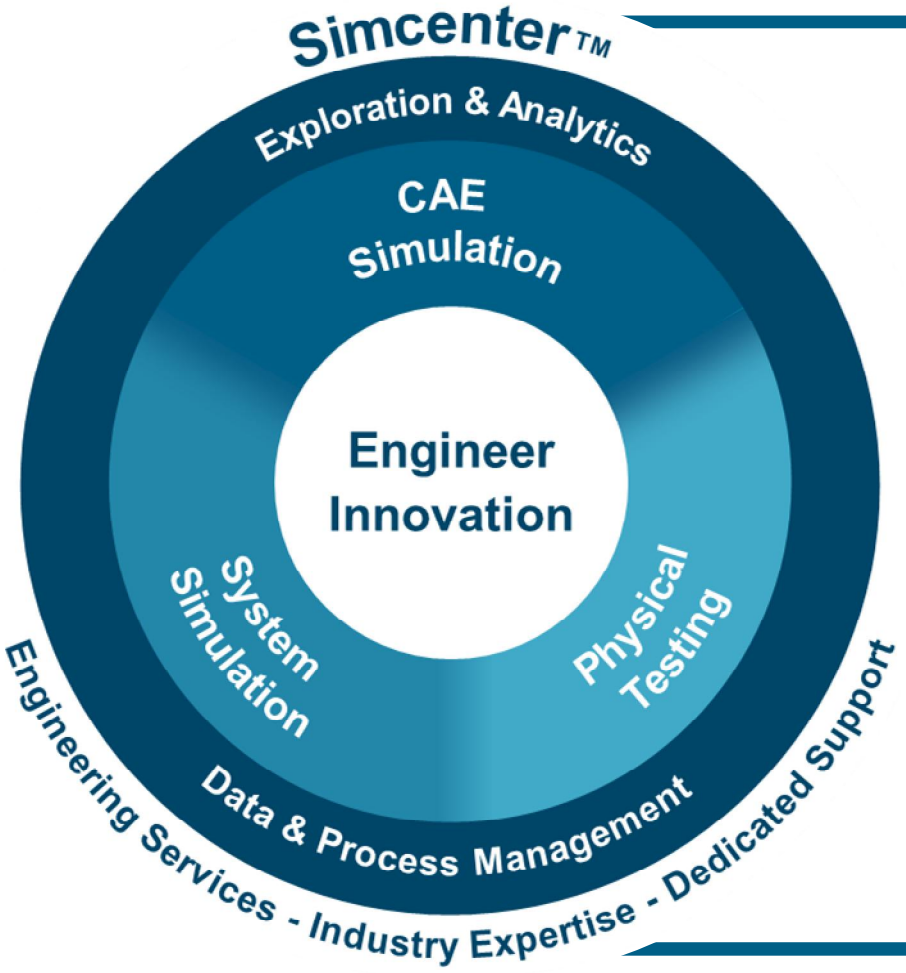
→ **Engineer Innovation**

Unrestricted © Siemens AG 2018

# Simcenter Portfolio

## Engineer innovation for marine performance

SIEMENS
Ingenuity for life




# Simcenter™

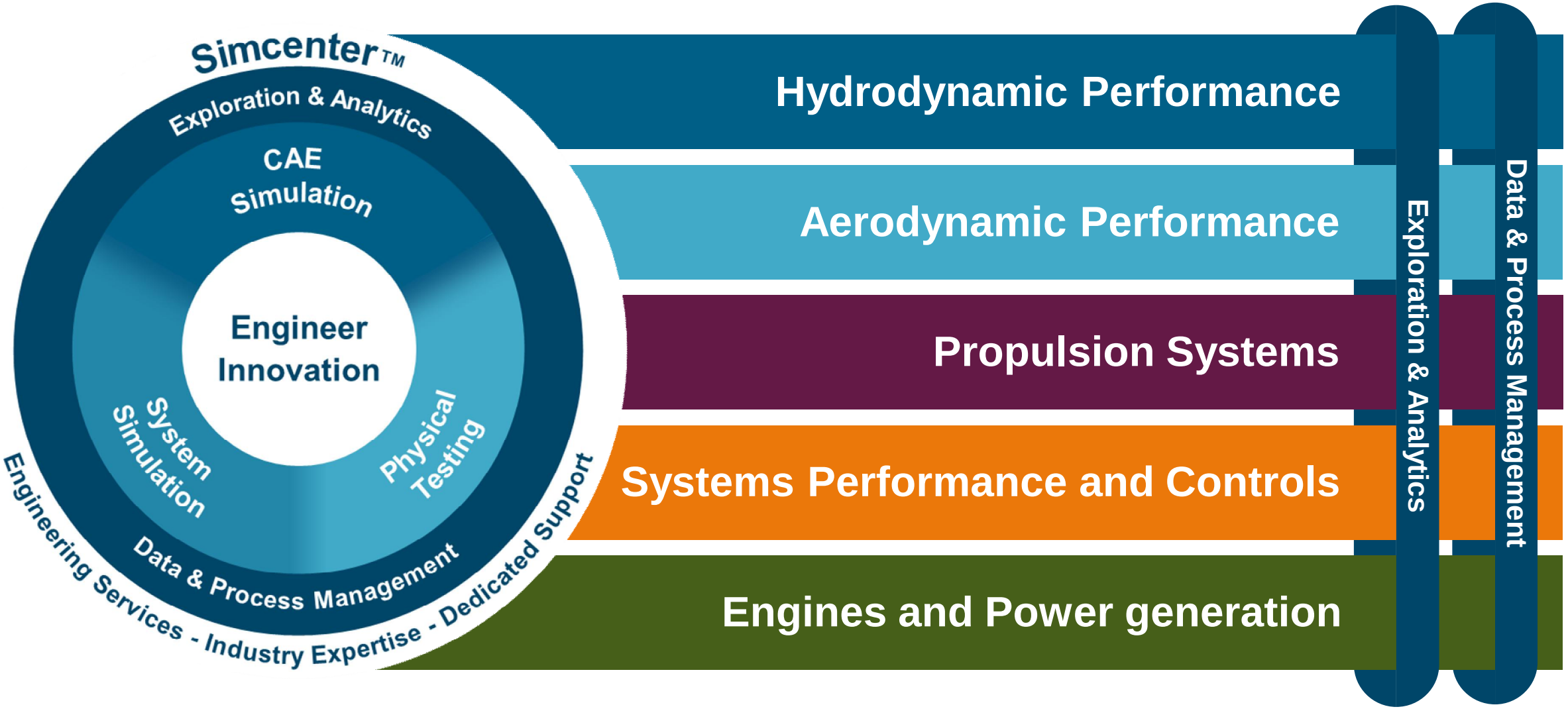
**Engineer innovation.**
**Simulate. Explore. Test.**

Unrestricted © Siemens AG 2018

# Simcenter Portfolio

## Engineer innovation for marine performance

SIEMENS
Ingenuity for life

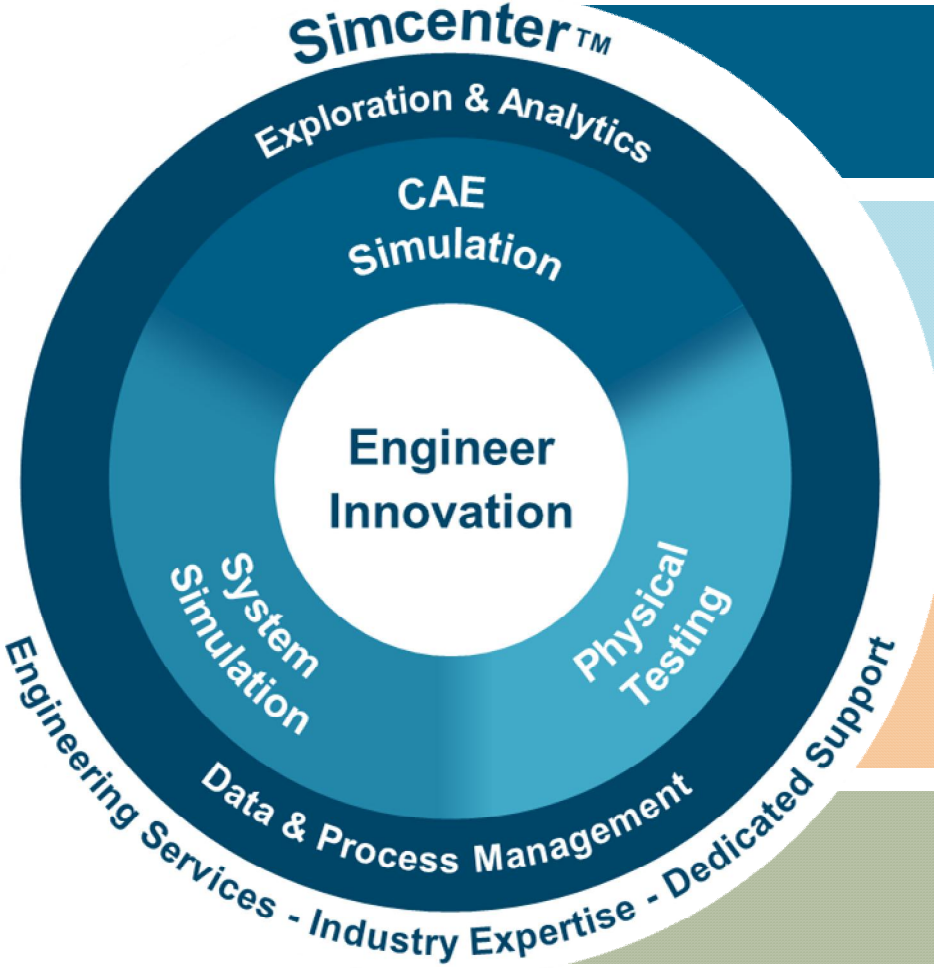



Unrestricted © Siemens AG 2018

# Simcenter Portfolio

## Engineer innovation for marine performance

SIEMENS
Ingenuity for life



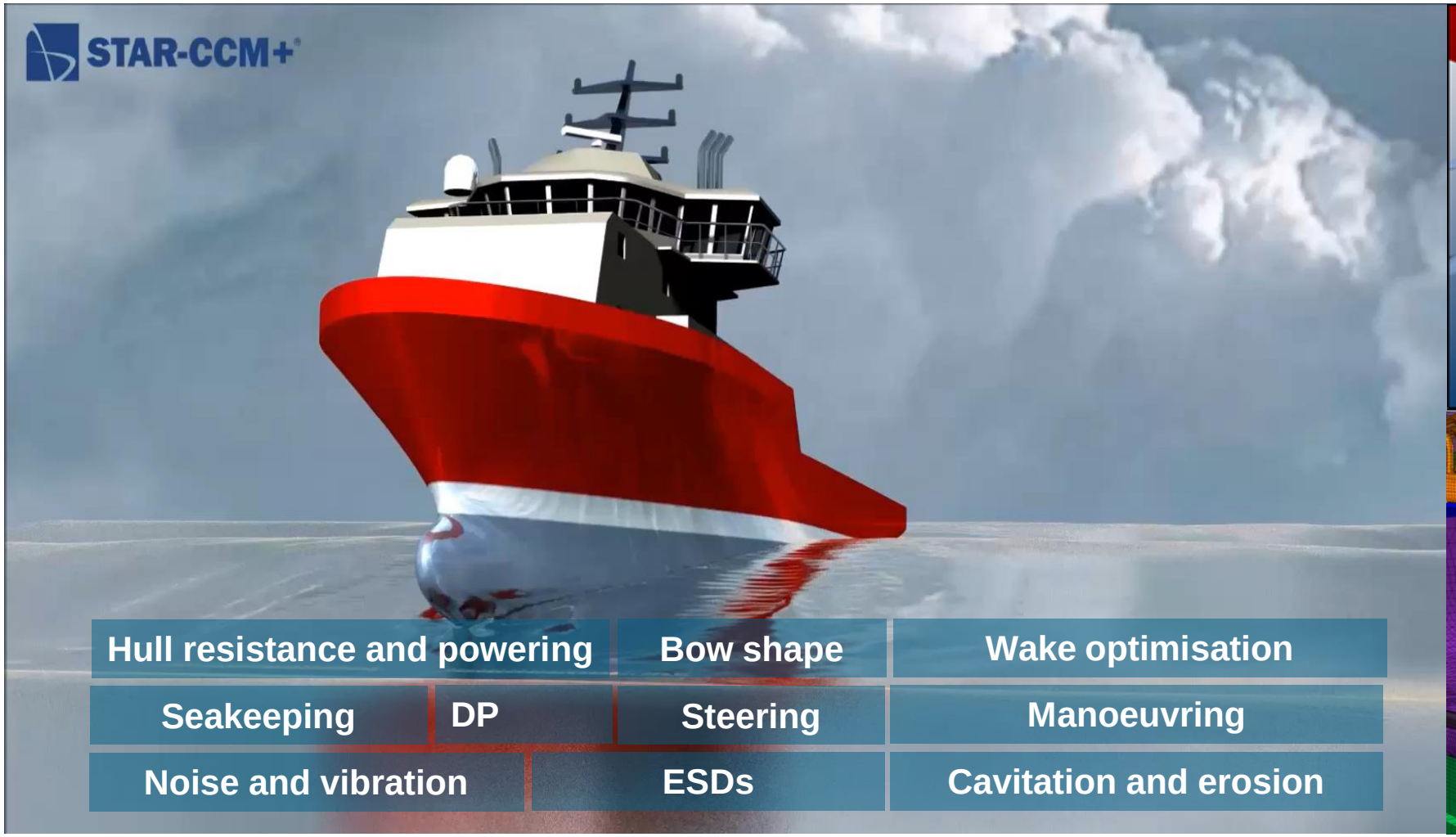

- Hydrodynamic Performance
- Aerodynamic Performance
- Propulsion Systems
- Systems Performance and Controls
- Engines and Power generation

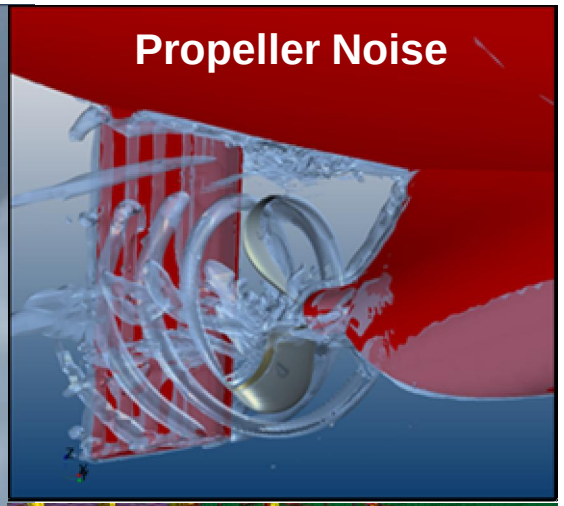
Unrestricted © Siemens AG 2018

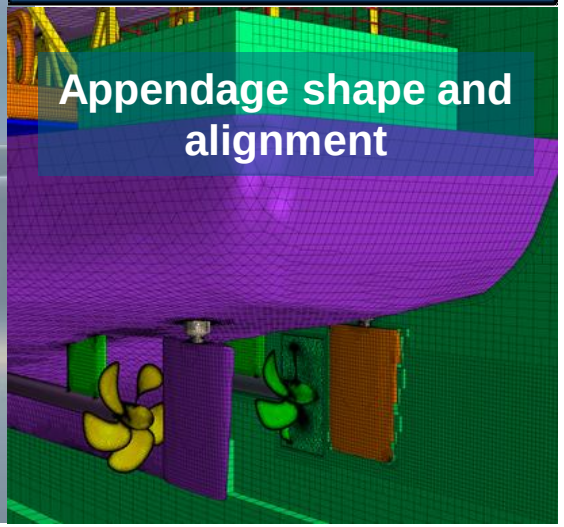
# Simcenter for Hydrodynamic Performance

## Covering a wide range of applications

SIEMENS
Ingenuity for life



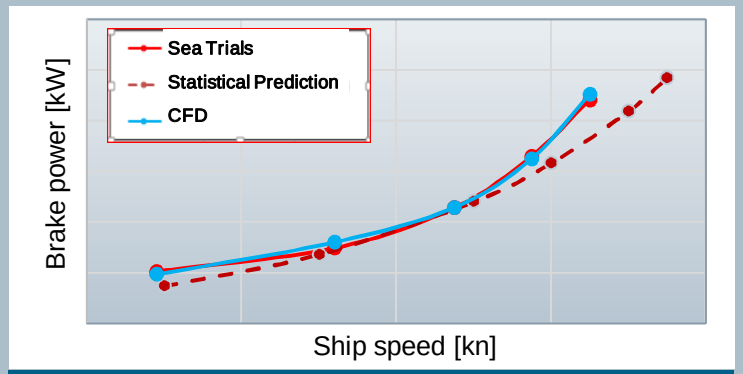

Unrestricted © Siemens AG 2018

# Wärtsilä
## Using Simcenter for VS 485 PSV change of use

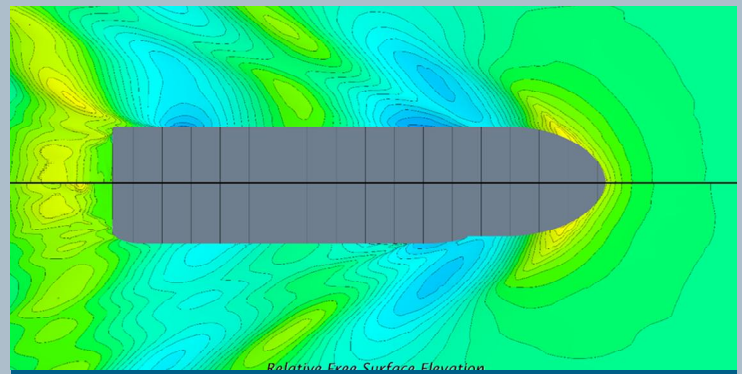
SIEMENS
Ingenuity for life

- **Optimized sponsons to mitigate impact on vessel performance**
- **Reduced high speed power requirement with minimal negative effect at low speed**
- **Reduced risk related to ship performance**

### Enabling change of vessel use through hull shape optimization




**Validation against sea trials**



**Full scale virtual towing tank**

- Explore alternative designs in a virtual environment
- Optimize hull design for alternative vessel use

**“STAR-CCM+ enabled us to mitigate the negative effect of sponsons on the vessel’s performance, thereby sustaining its original operational efficiency.”**

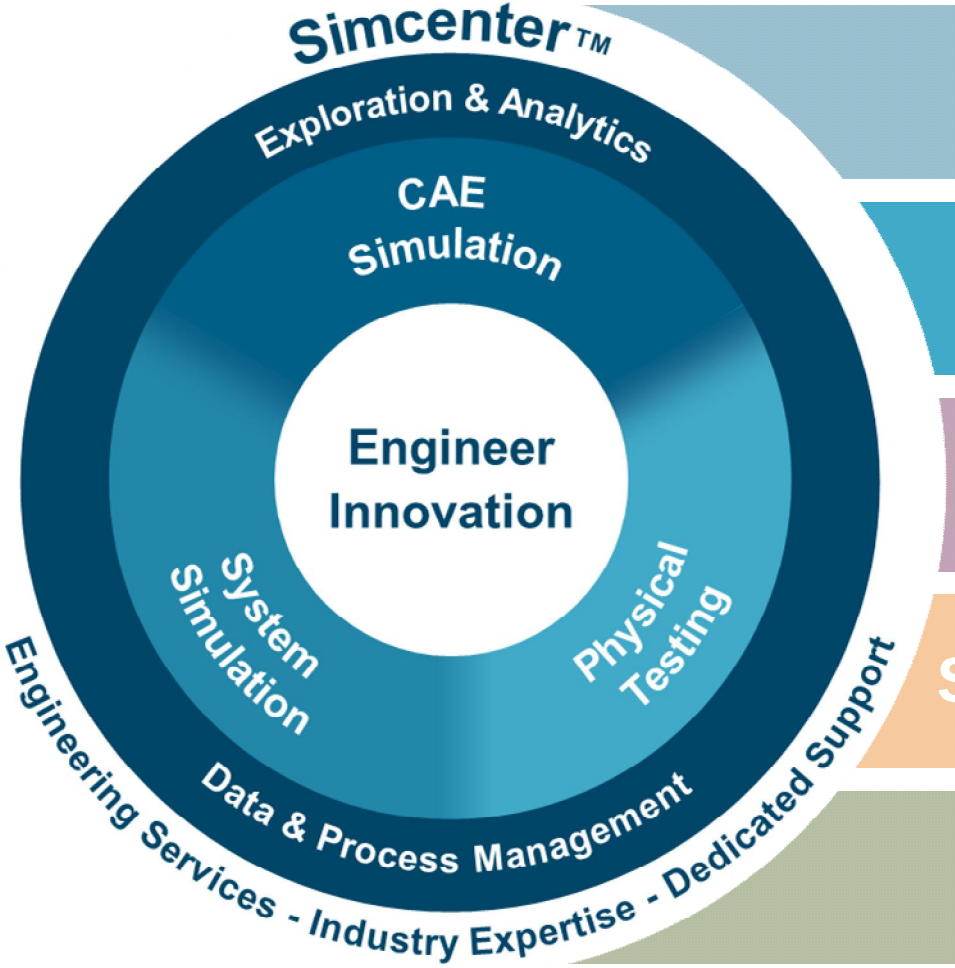
Inge Skaar, Director, Project Development and Naval Architecture

Unrestricted © Siemens AG 2018

# Simcenter Portfolio

## Engineer innovation for marine performance

SIEMENS
Ingenuity for life



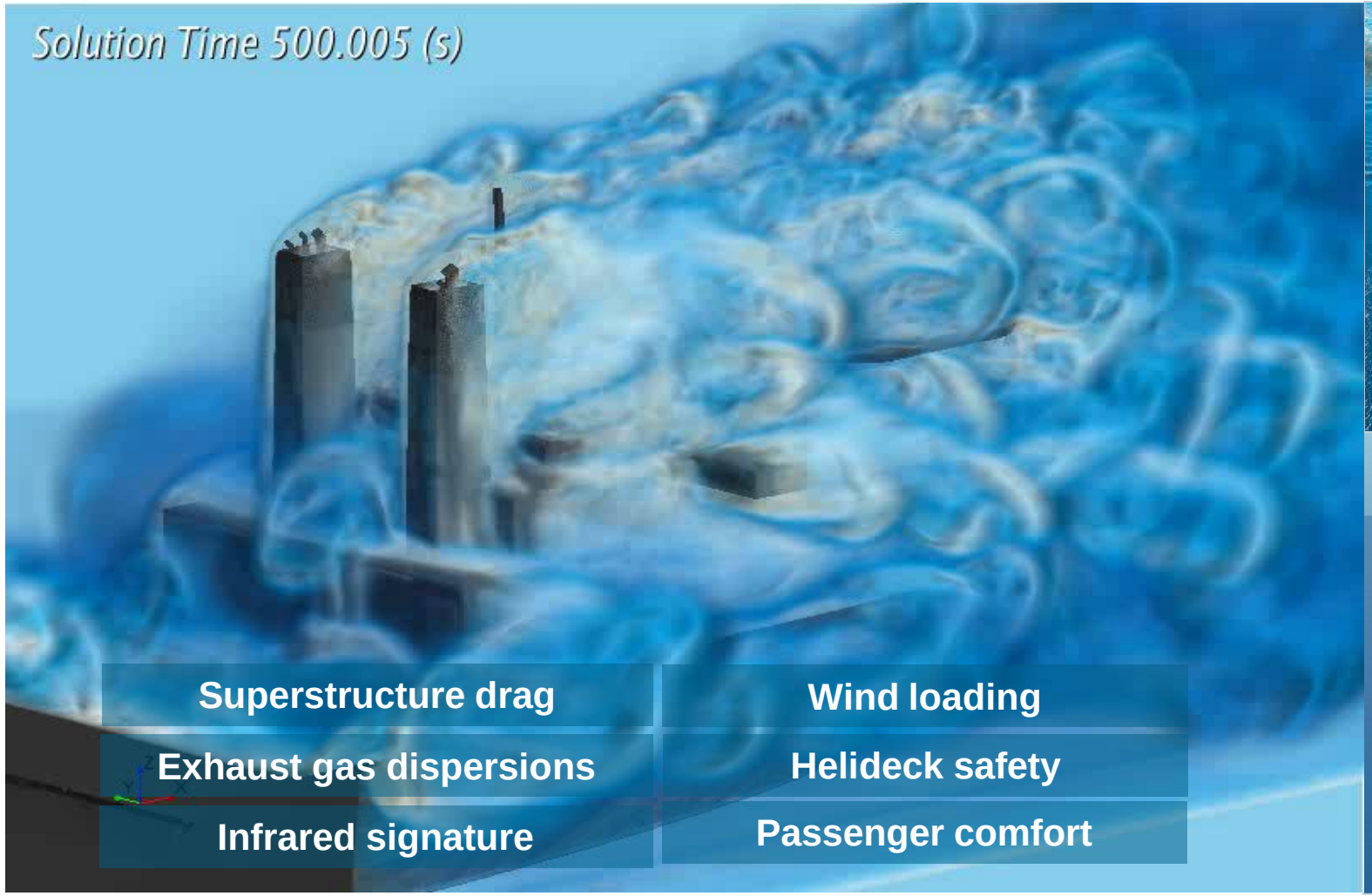

- Hydrodynamic Performance
- Aerodynamic Performance
- Propulsion Systems
- Systems Performance and Controls
- Engines and Power generation

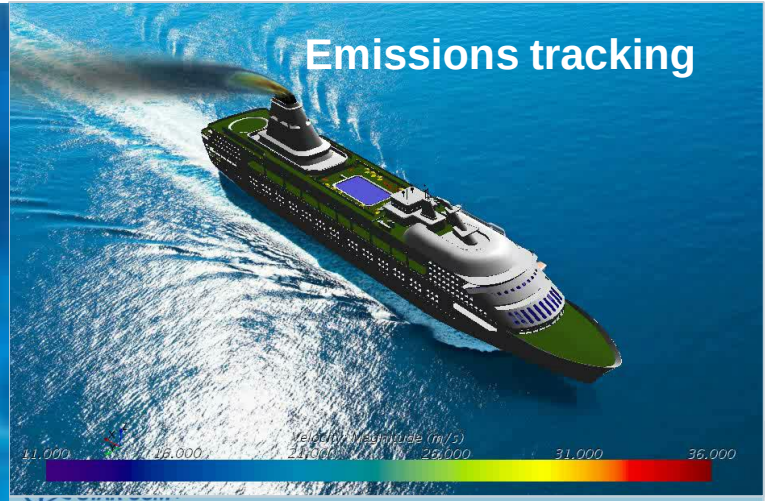
Unrestricted © Siemens AG 2018

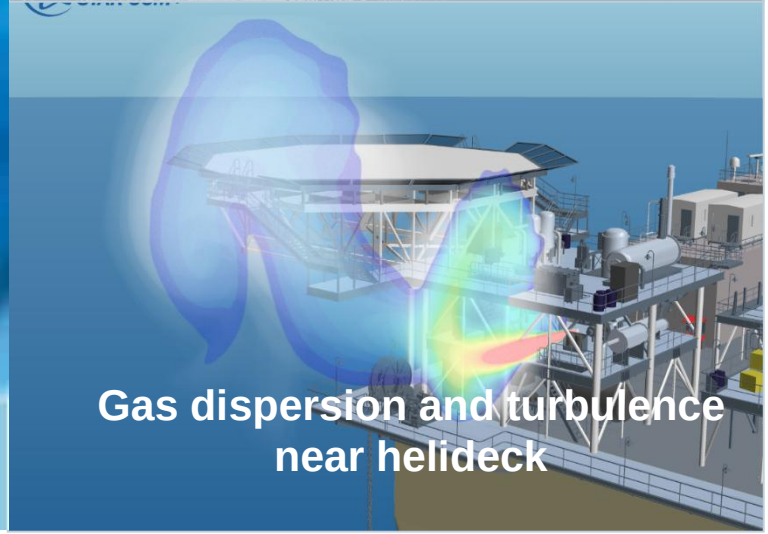
# Simcenter for Aerodynamic Performance

## Covering a wide range of applications

SIEMENS
Ingenuity for life




Unrestricted © Siemens AG 2018

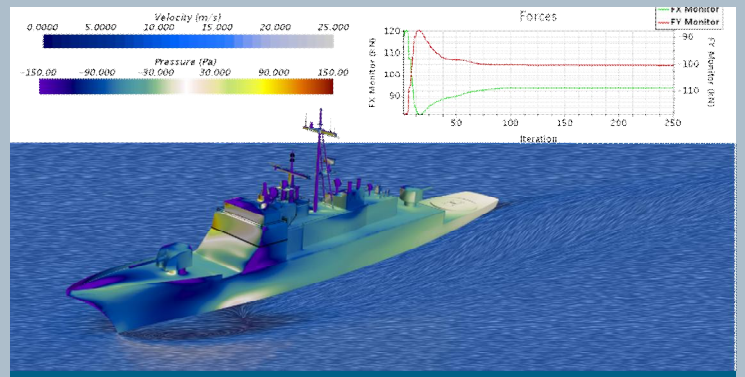
# Simcenter for Aerodynamic Performance

## Saving cost and time with the virtual wind tunnel

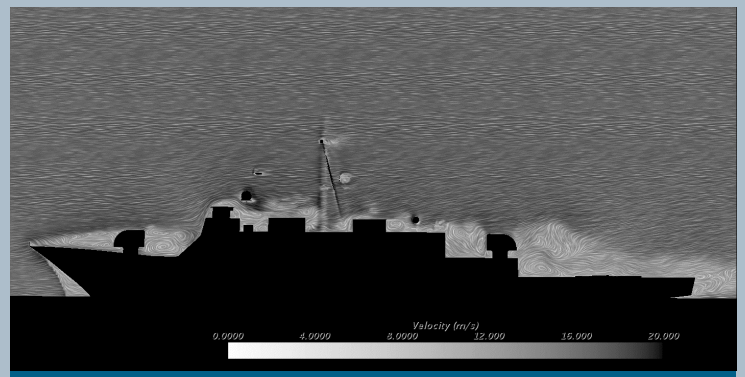
SIEMENS
Ingenuity for life

- **Use steady simulations with fast convergence to calculate aerodynamic loads**
- **High fidelity unsteady simulations provide valuable insight for identifying problems or troubleshooting**

### Predicting aerodynamic performance at full scale




**Steady State Analysis**




**Transient Analysis**

- Cut preparation time from weeks to hours using surface wrapping
- Understand the results with flow visualization, identify problem areas and see where to improve designs

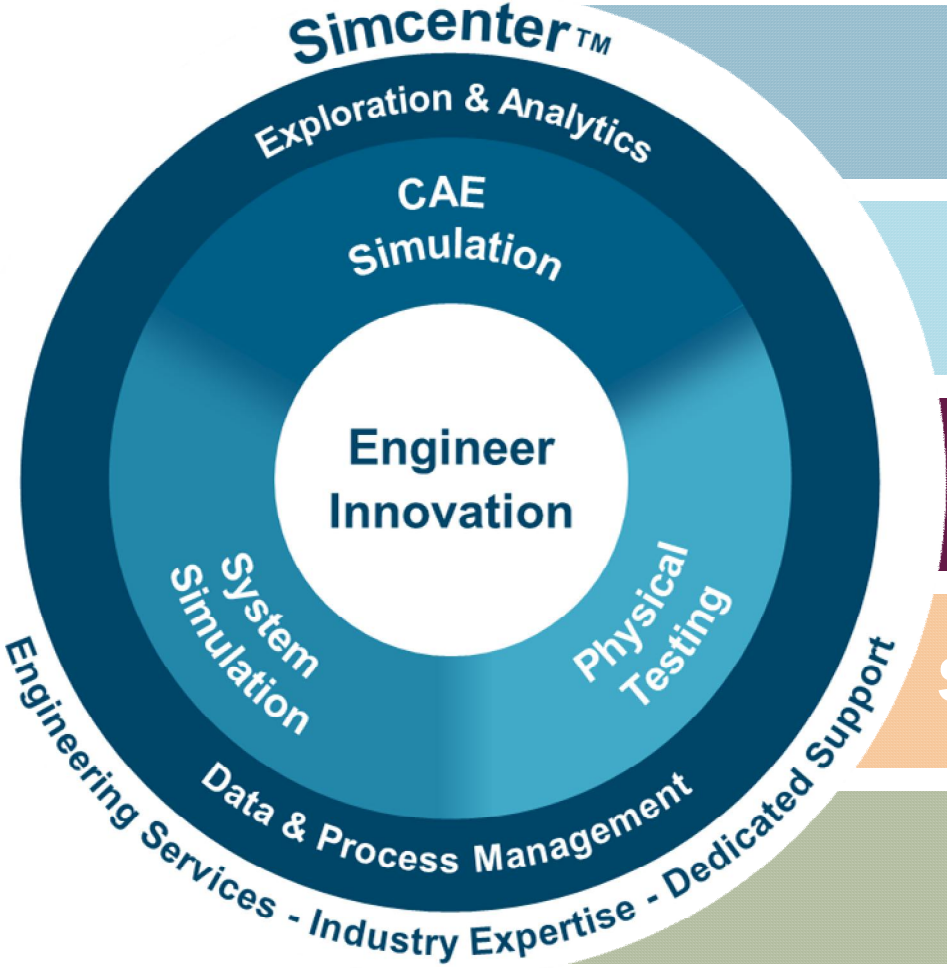
**The virtual wind tunnel saves costs and time over physical testing, whilst providing valuable insights that drive design changes with confidence**

Unrestricted © Siemens AG 2018

# Simcenter Portfolio

## Engineer innovation for marine performance

SIEMENS
Ingenuity for life




- Hydrodynamic Performance
- Aerodynamic Performance
- Propulsion Systems
- Systems Performance and Controls
- Engines and Power generation

Unrestricted © Siemens AG 2018

# Simcenter for Propulsion System Performance

## Covering a wide range of applications

SIEMENS
Ingenuity for life

Propeller performance

Propeller-hull interaction

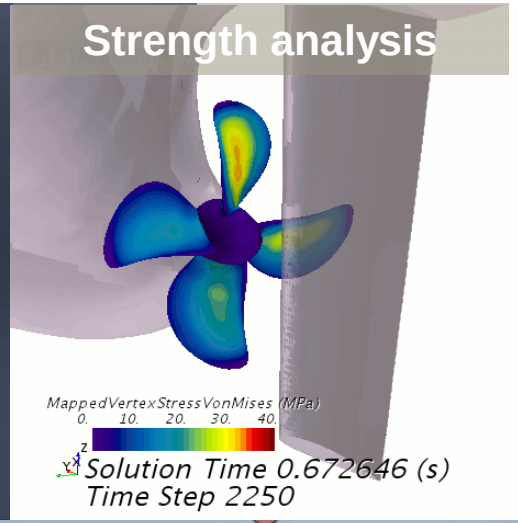
Crash stop/bollard pull

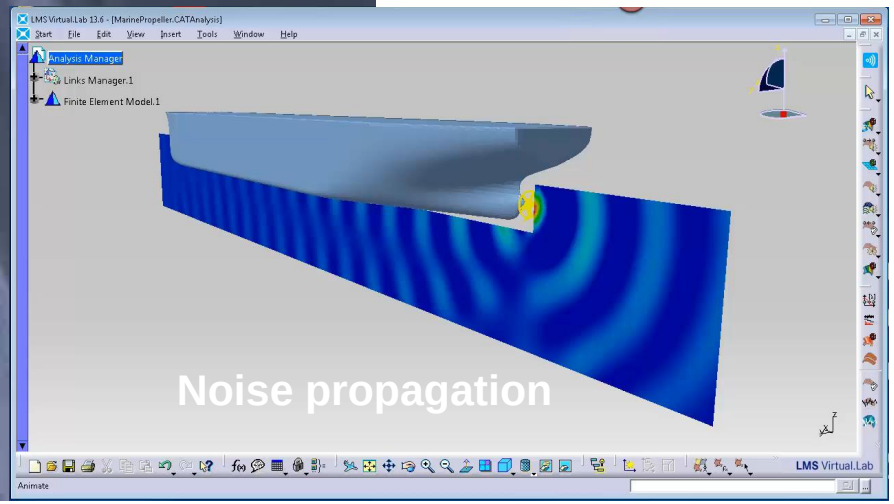
Cavitation and erosion

Torsional vibration

Power management and control

Strength analysis




Unrestricted © Siemens AG 2018

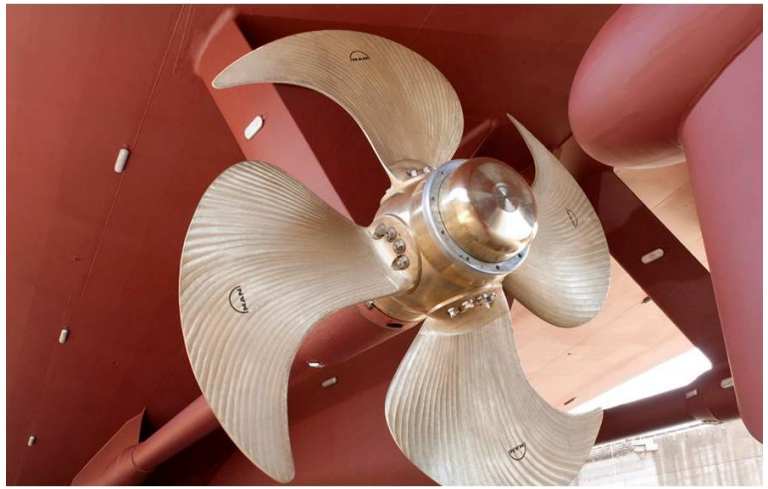


Go back

# MAN Diesel & Turbo

## Reducing cloud cavitation on tip-modified propellers with Simcenter

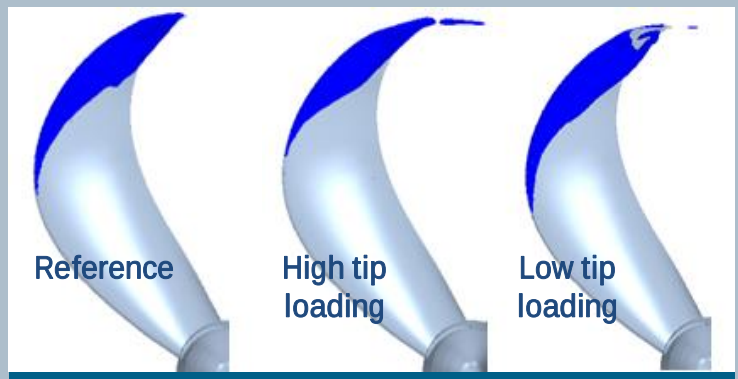
SIEMENS
Ingenuity for life



- **Reduced cloud cavitation**
- **Reduced noise and risk of erosion**
- **Reduced propulsive efficiency loss due to tip vortex**

### Multidisciplinary simulation and design exploration

**Full scale simulation**




**Multiple design analysis**

- Simulate complete flow field including ship wake and rudder interaction
- Optimize blade loading by varying blade pitch and vertical inclination

**“The cavitation prediction in STAR-CCM+ matched well with experimental data and enabled us to optimize the blade tip loading on the propeller.”**

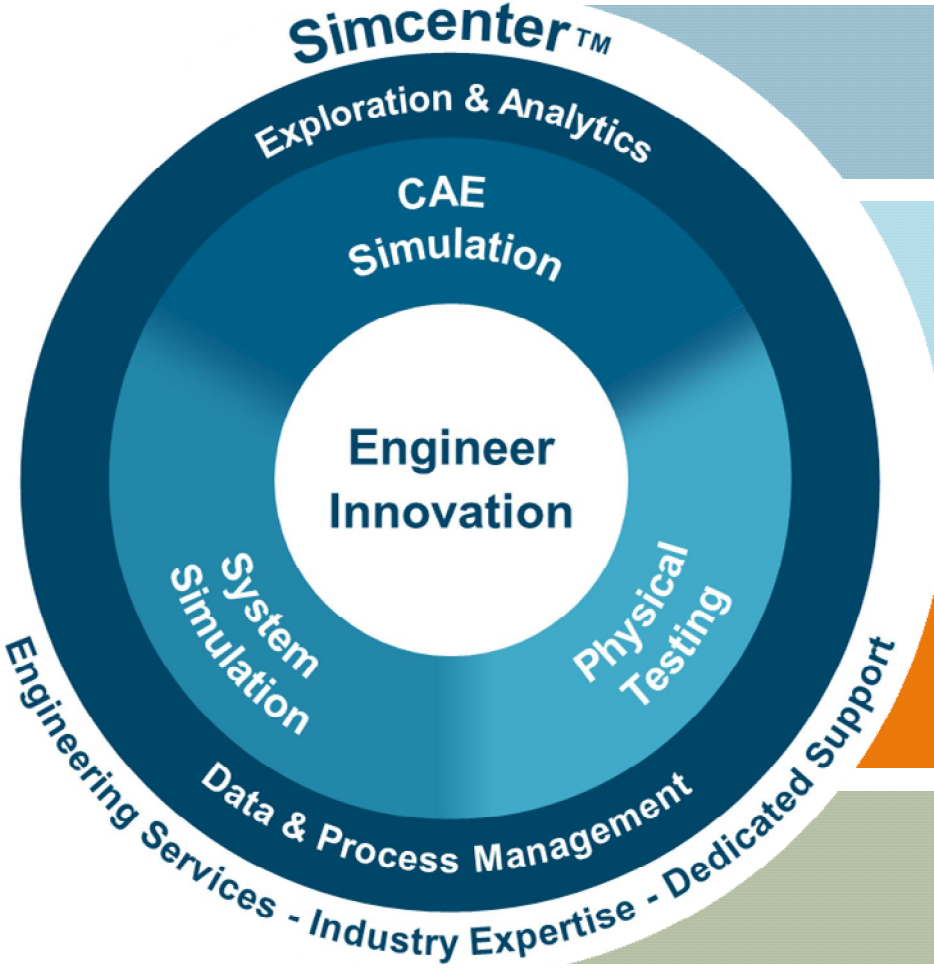
Keun Woo Shin, Research engineer, Mechanics and Hydrodynamics

Unrestricted © Siemens AG 2018

# Simcenter Portfolio

## Engineer innovation for marine performance

SIEMENS
Ingenuity for life




- Hydrodynamic Performance
- Aerodynamic Performance
- Propulsion Systems
- Systems Performance and Controls
- Engines and Power generation

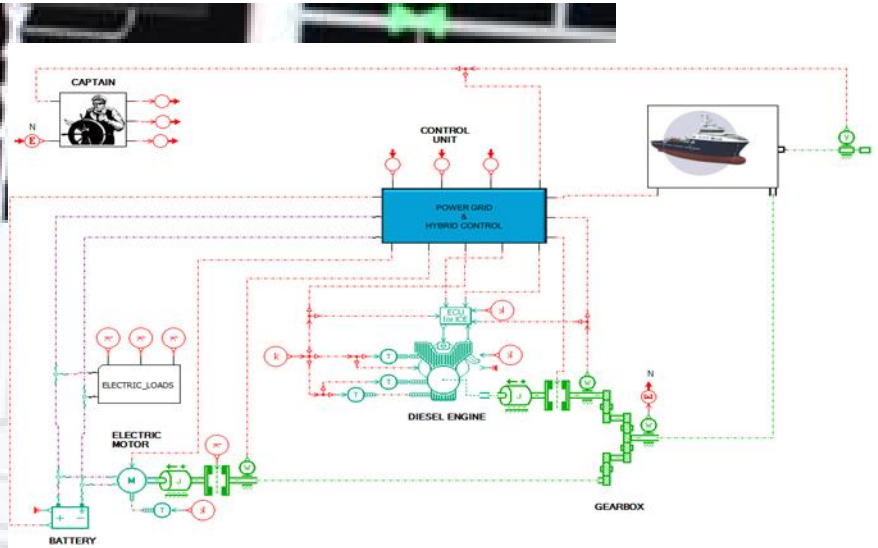
Unrestricted © Siemens AG 2018

# Simcenter for Systems Performance and Controls

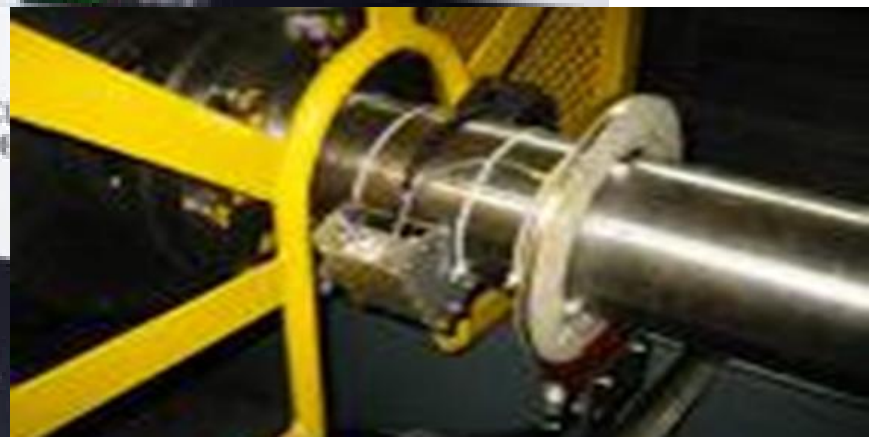
## Covering a wide range of applications

SIEMENS
Ingenuity for life

- Dimensioning and control
- Exhaust emissions and after treatment
- Air conditioning and refrigeration




- Energy and thermal management
- Steering and torsional vibration
- Hydraulics components and systems



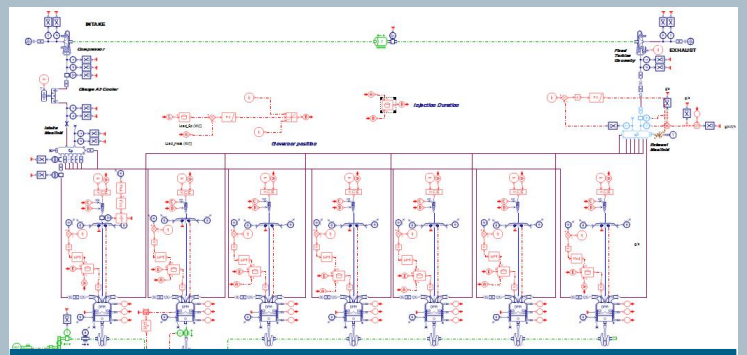
Unrestricted © Siemens AG 2018

# Hyundai Heavy Industries
# Engine design and integration into a hybrid vessel with Simcenter

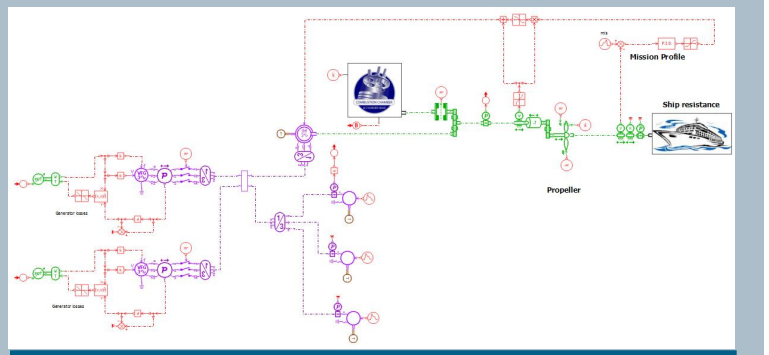
SIEMENS
Ingenuity for life

- **Shorter simulation time compared with other competing software results**
- **Streamlined modeling process from engine design to ship integration**
- **Fuel consumption and NOx emissions efficiently assessed over different load cases**

## Engine model conversion with Simcenter for real-time solutions and hybrid system integration



High-Frequency engine model for design




MVEM model integrated in hybrid vessel

- Validate HF engine model versus baseline model in steady and transient operations
- Generate mean value engine model for HIL (Hardware-In-the-Loop) validation
- Integrate engine model into hybrid ship architecture for analysis on different load cases

**“Simcenter Amesim is helpful in the integrated interpretation of systems through the provision of sufficient libraries in various fields. It also has a strong advantage in computing speed in HiL”**

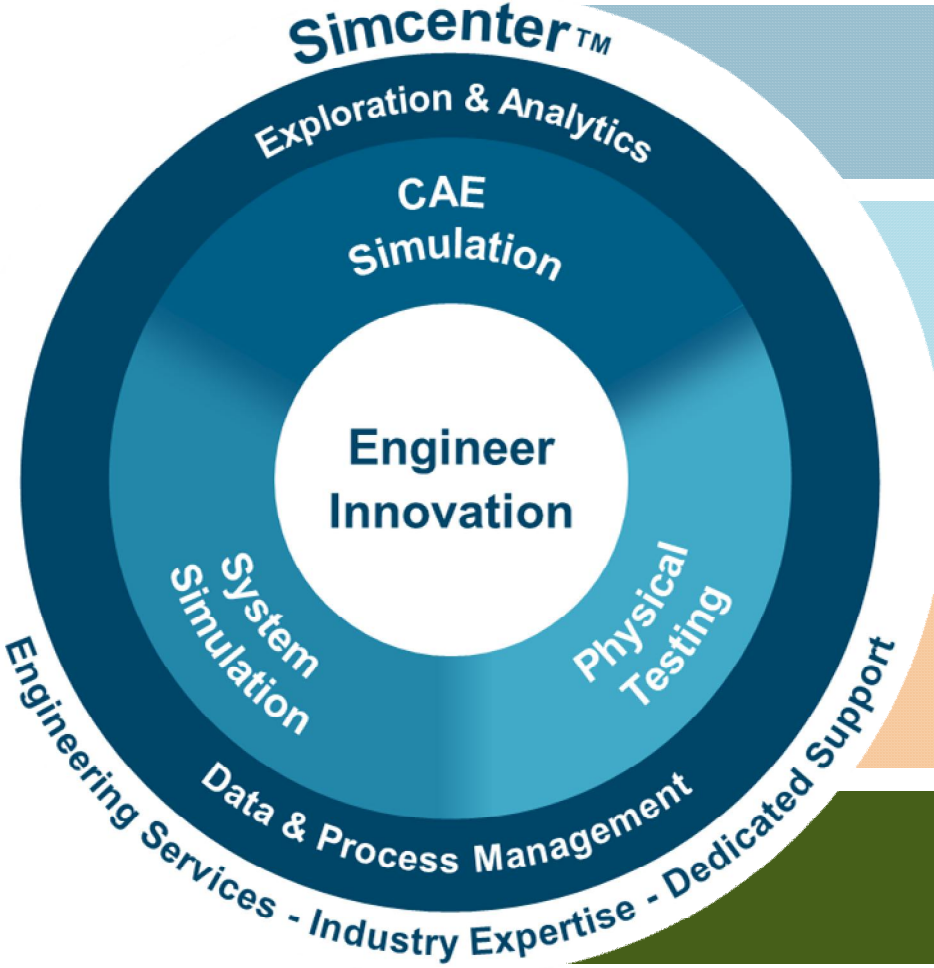
Dr Hyun Sook Yoon, Senior researcher, Engine and Machinery, Hyundai Heavy industries

Unrestricted © Siemens AG 2018

# Simcenter Portfolio

## Engineer innovation for marine performance

SIEMENS
Ingenuity for life



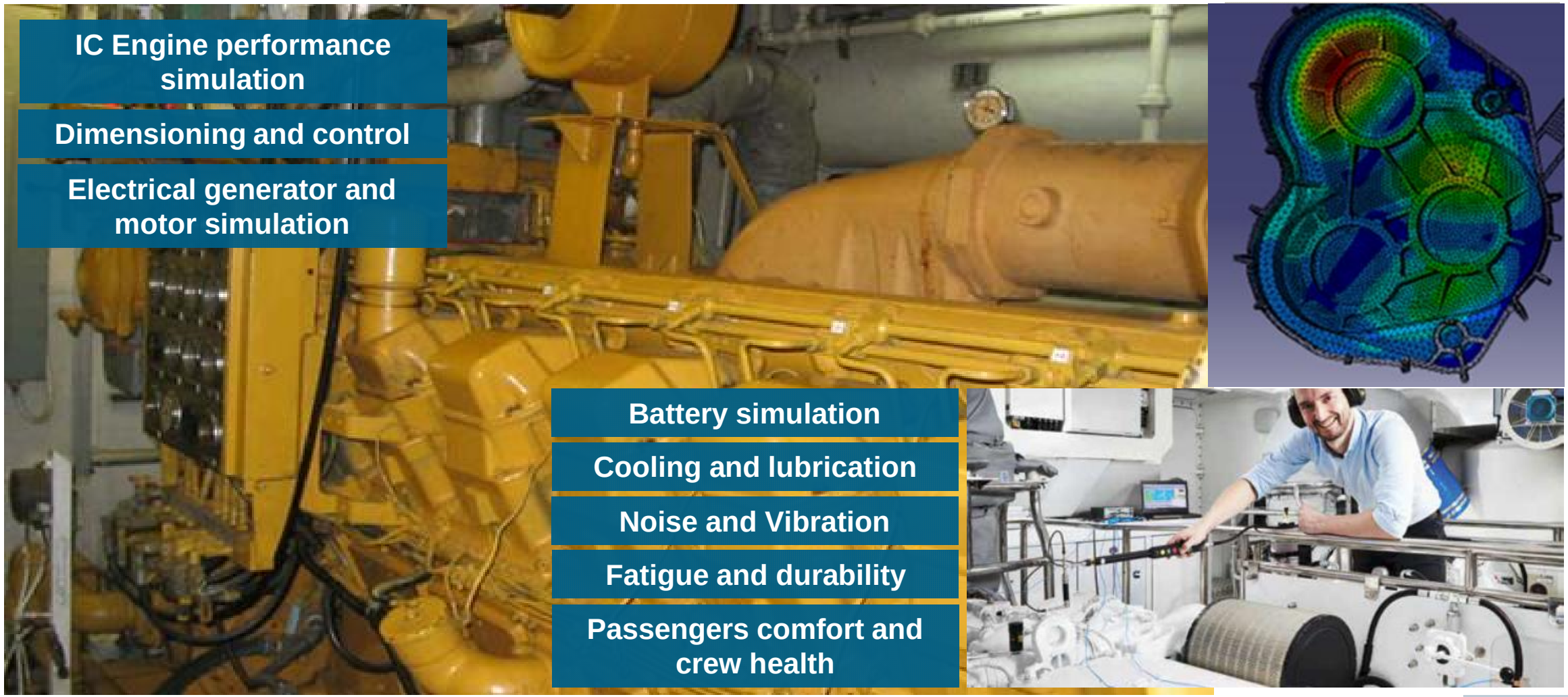

- Hydrodynamic Performance
- Aerodynamic Performance
- Propulsion Systems
- Systems Performance and Controls
- Engines and Power generation

Unrestricted © Siemens AG 2018

# Simcenter for Engines and Power generation

## Covering a wide range of applications

SIEMENS
Ingenuity for life




Unrestricted © Siemens AG 2018

Go back

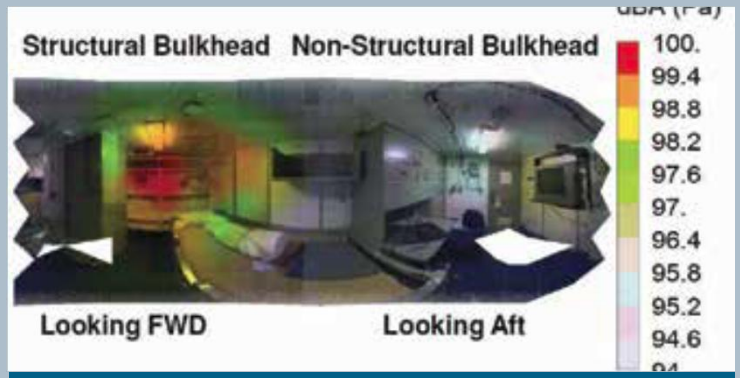
# U.S. Navy
## Improve working conditions for aircraft carrier crews

SIEMENS
Ingenuity for life

- **Come up with the optimal noise control treatment schemes in terms of effectiveness, cost and weight**
- **Improve the U.S. Navy fleet personnel's health and well-being by reducing the risk of noise induced hearing loss (NIHL)**

### Simcenter testing tools and services help the U.S. Navy to reduce noise

**Testing throughout the flight and gallery deck**




**360° noise distribution in the deck spaces**

- Easily measure more then 100 channels to evaluate airborne and structure-borne transmitted noise
- Simcenter Solid Sphere Array to verify the sufficient acoustic hot spots insulation

**"We can be sure that we locate the right acoustic hot spots after just a few seconds of measuring."**

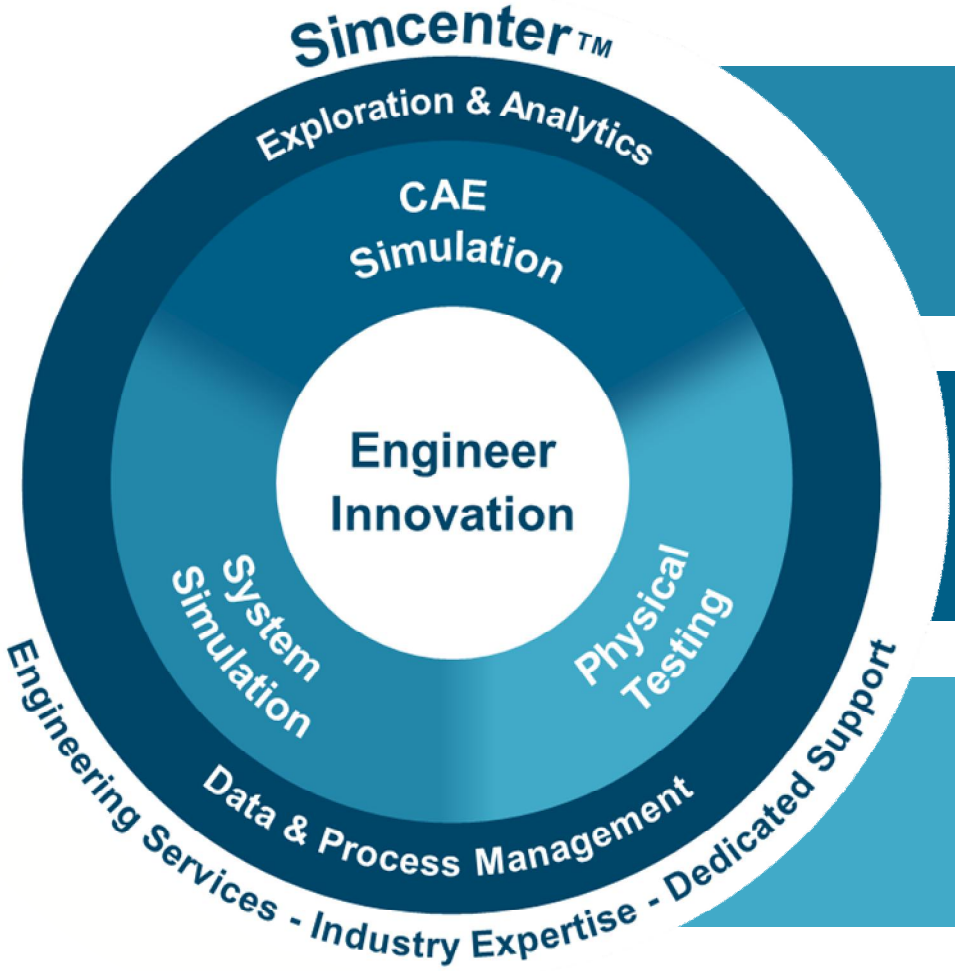
Jeffrey Komrower - Senior Engineer, Noise Control Engineering LLC

Unrestricted © Siemens AG 2018

# Simcenter Portfolio

## Engineer innovation for marine performance

SIEMENS
Ingenuity for life




**System Simulation**
Simcenter Amesim, Simcenter ESD,
Simcenter System Synthesis, …

**CAE Simulation**
Simcenter 3D, STAR-CCM+, NX Nastran,
FEMAP, SPEED, BDS, …

**Physical Testing**
LMS Test.Lab, LMS SCADAS,
LMS Test.Xpress, LMS Tecware, …

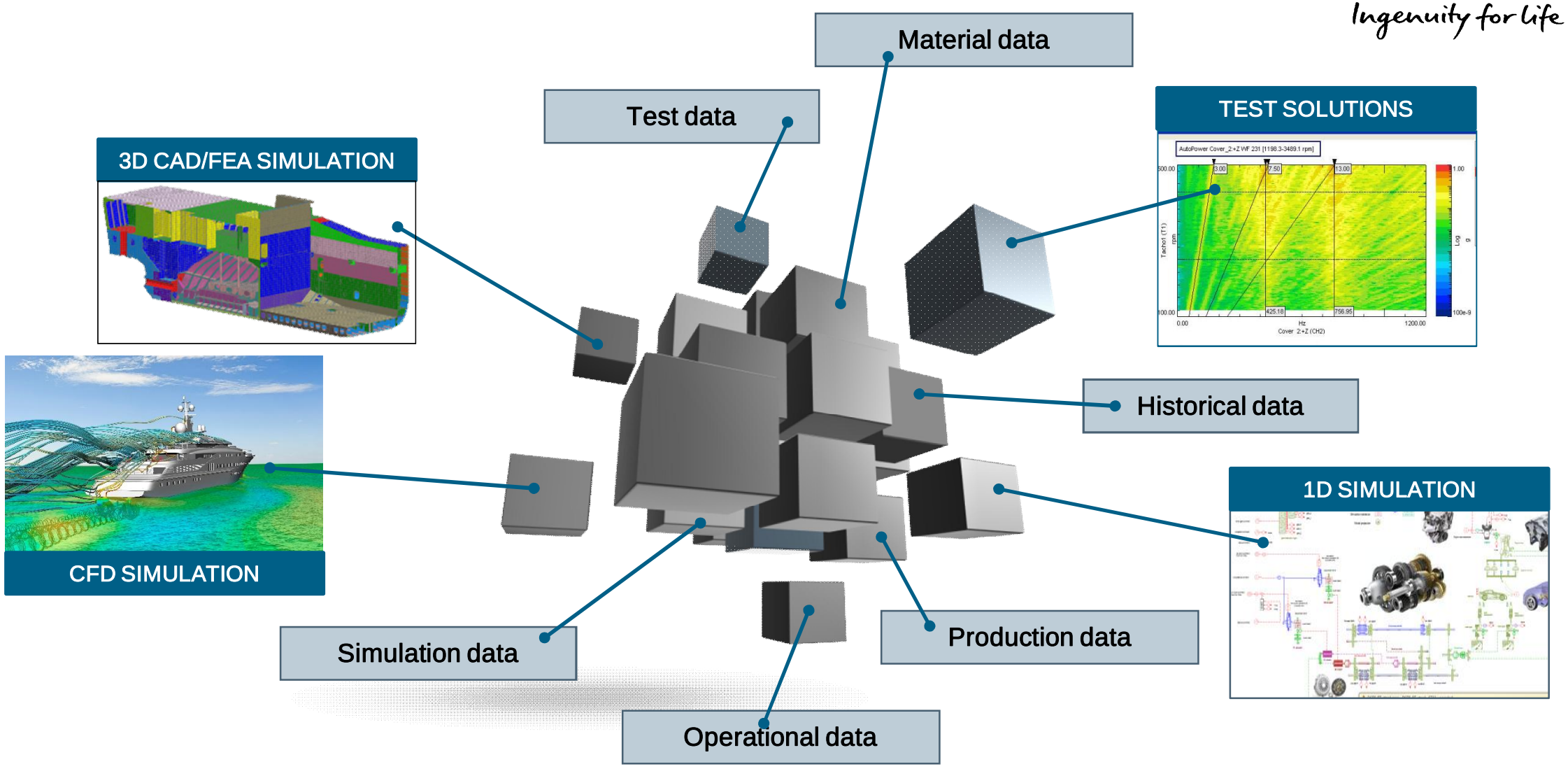
Exploration & Analytics - HEEDS

Data & Process Management - Teamcenter

Unrestricted © Siemens AG 2018

# From Disconnected Models and Data …

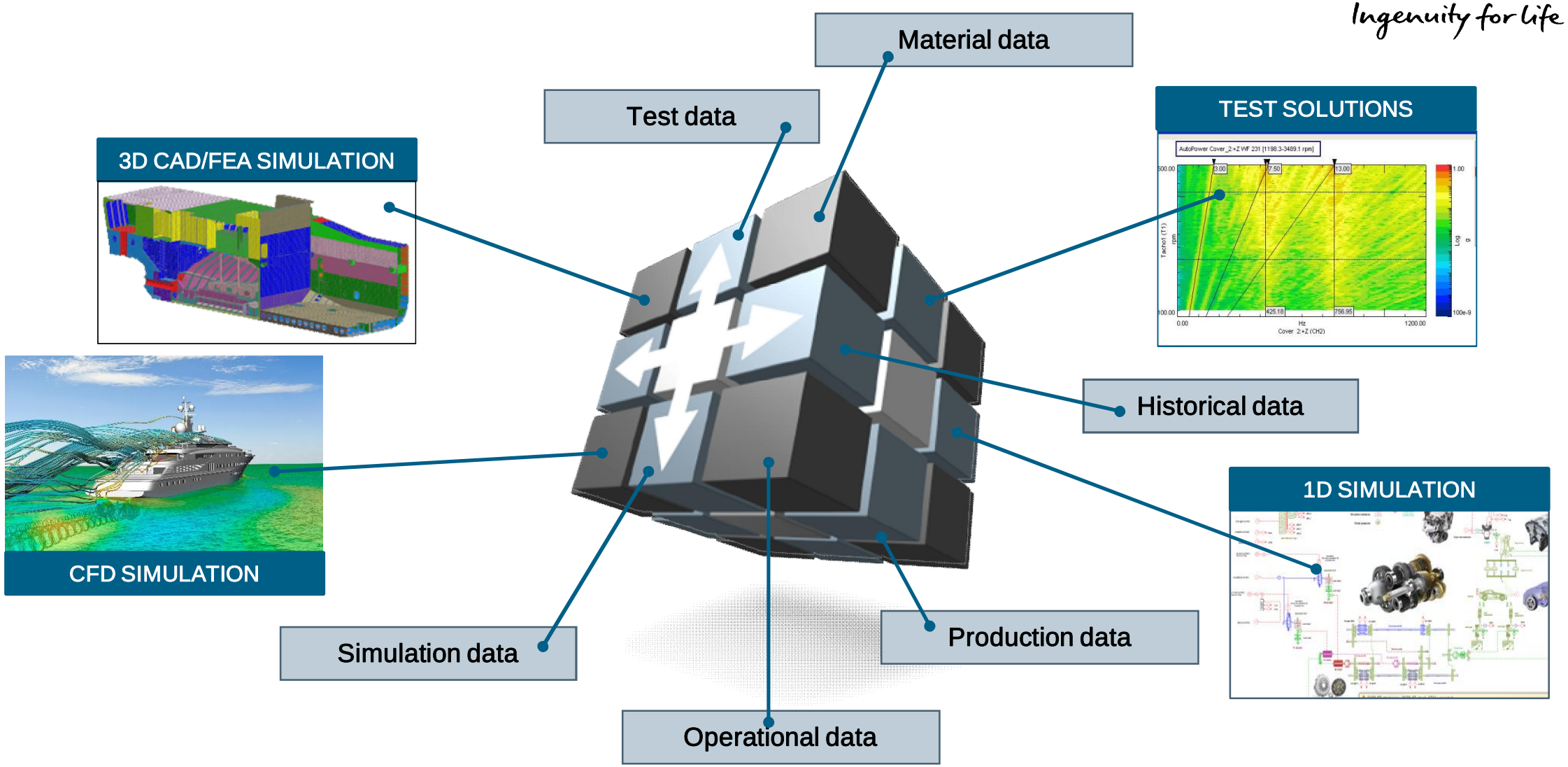
SIEMENS
Ingenuity for life




Unrestricted © Siemens AG 2018

# … To a Performance Digital Twin

SIEMENS
Ingenuity for life




Unrestricted © Siemens AG 2018

SIEMENS
Ingenuity for life

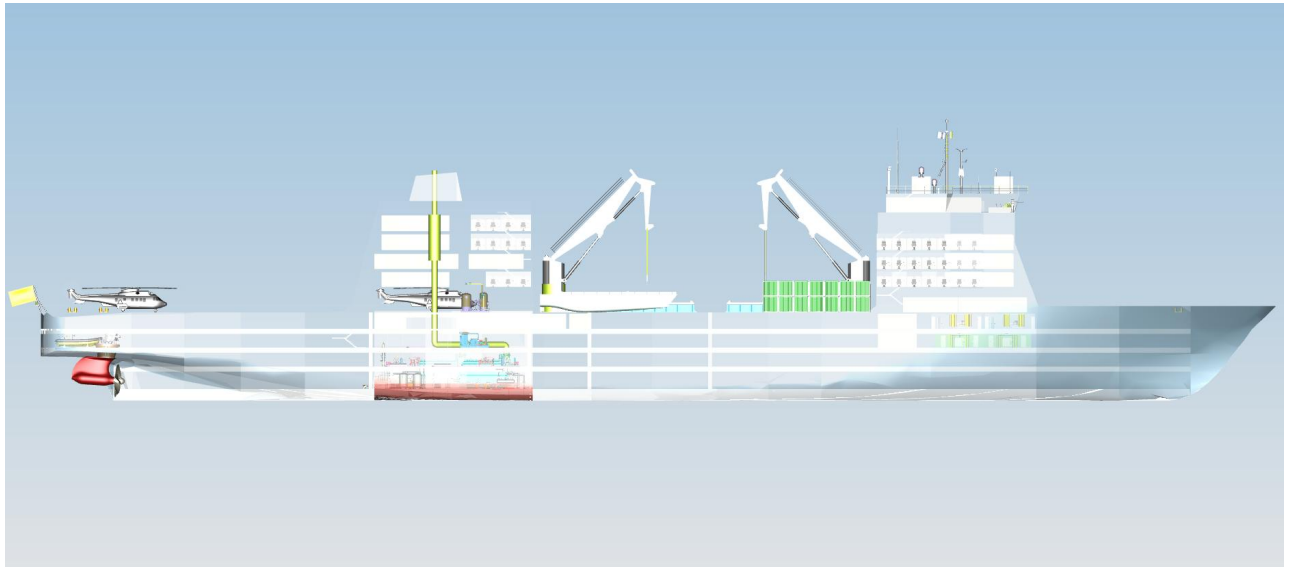
# Co-simulation for the Marine Industry
## Simcenter STAR-CCM+ to Simcenter Amesim

Restricted © Siemens AG 2018

# Marine Co-simulation
## Simcenter STAR-CCM+ to Simcenter Amesim

SIEMENS
Ingenuity for life

- **Siemens Multi-role Vessel**



Length **190m** Breadth **28m** Disp. Vol **25,418 m³**
Draft **8m** Speed **13kts**

**Challenge**

**Minimizing assumptions given system complexity is increasing to reduce overdesign.**

**Objective**

**To be able to accurately predict fuel consumption and emissions early in the design process.**

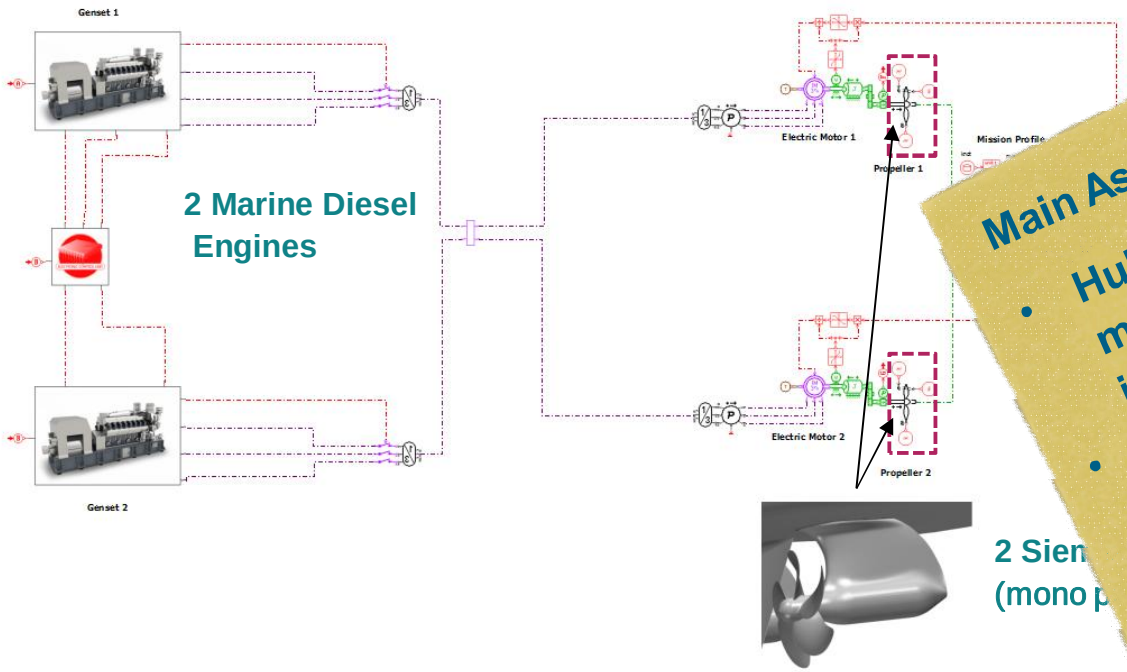
Unrestricted © Siemens AG 2018

# Marine Co-simulation
## Simcenter STAR-CCM+ to Simcenter Amesim

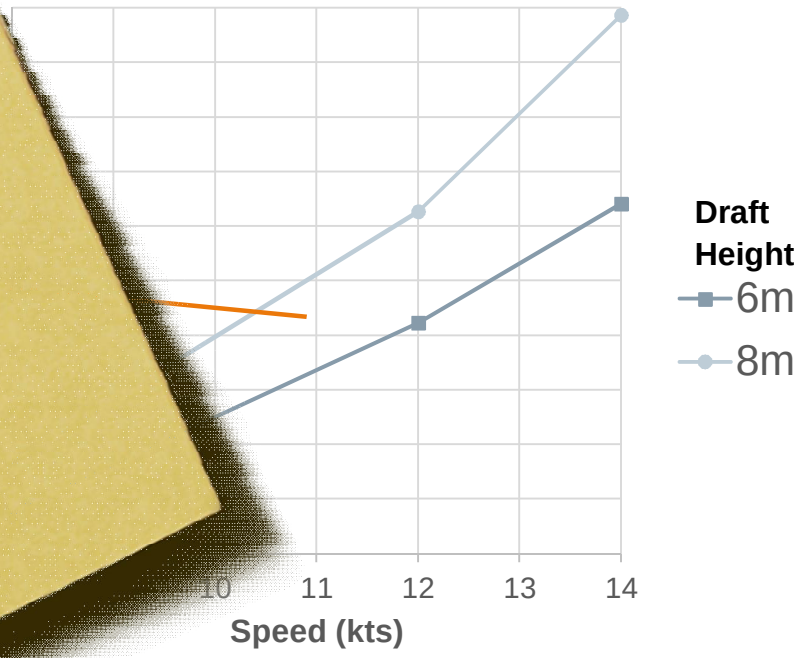
SIEMENS
Ingenuity for life

- **Loose coupling case (bare hull CFD imported to 1D system model)**

### Simcenter Amesim (1D system model)




### Simcenter STAR-CCM+ (3D hull only)




**Main Assumptions:**

- Hull is fixed in position, might not know CoB, inertia etc
- No propeller/hull interaction

**Benefit**

- Very quick

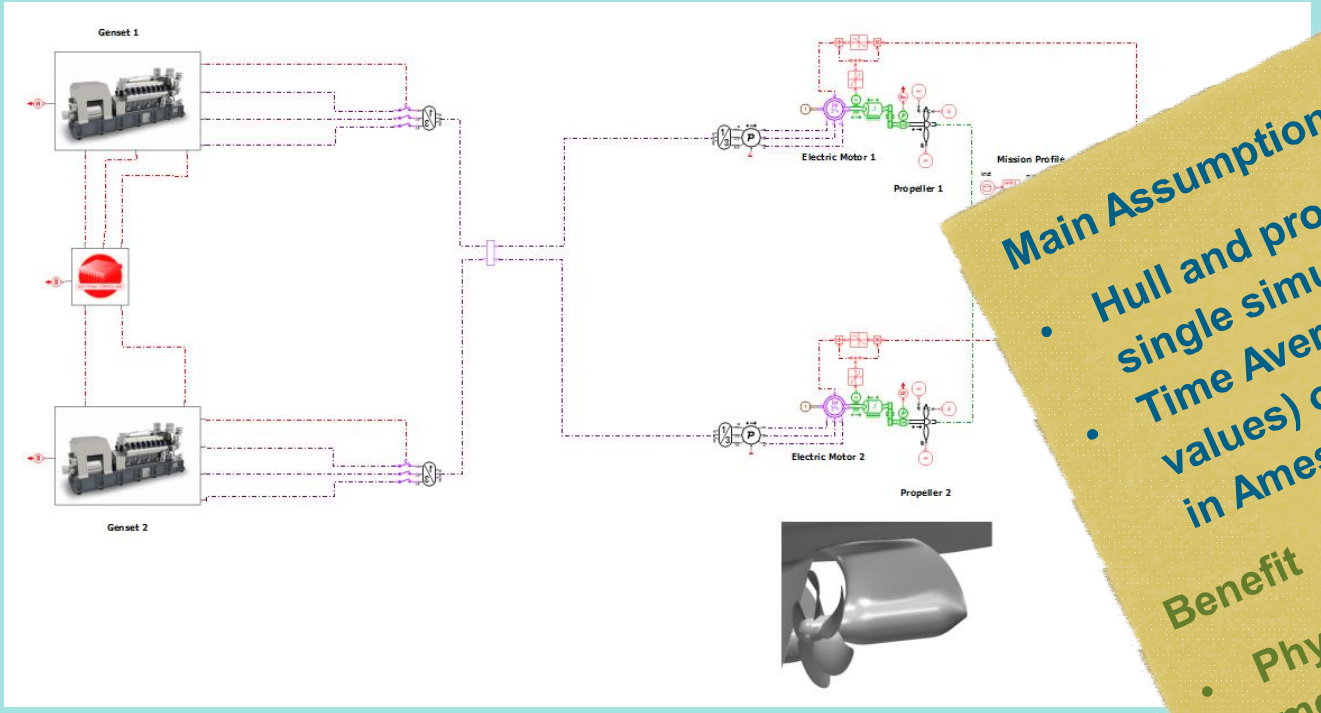
Unrestricted © Siemens AG 2018

# Marine Co-simulation
## Simcenter STAR-CCM+ to Simcenter Amesim

SIEMENS
Ingenuity for life

- **Loose coupling case (Hull and propeller “open water propulsion” case)**

### Simcenter Amesim (1D system model)



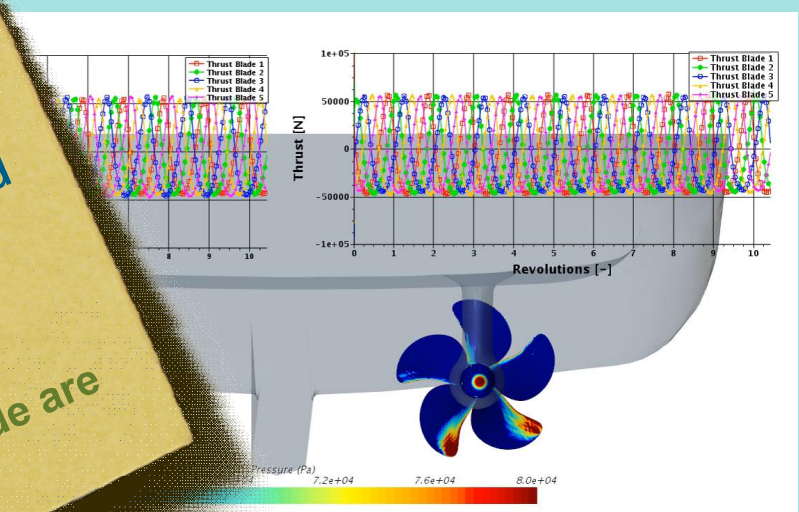

### Simcenter STAR-CCM+

**Main Assumption:**

- Hull and propeller in single simulation
- Time Averaged (single values) of drag etc. used in Amesim

**Benefit**

- Physics on CFD side are more accurate



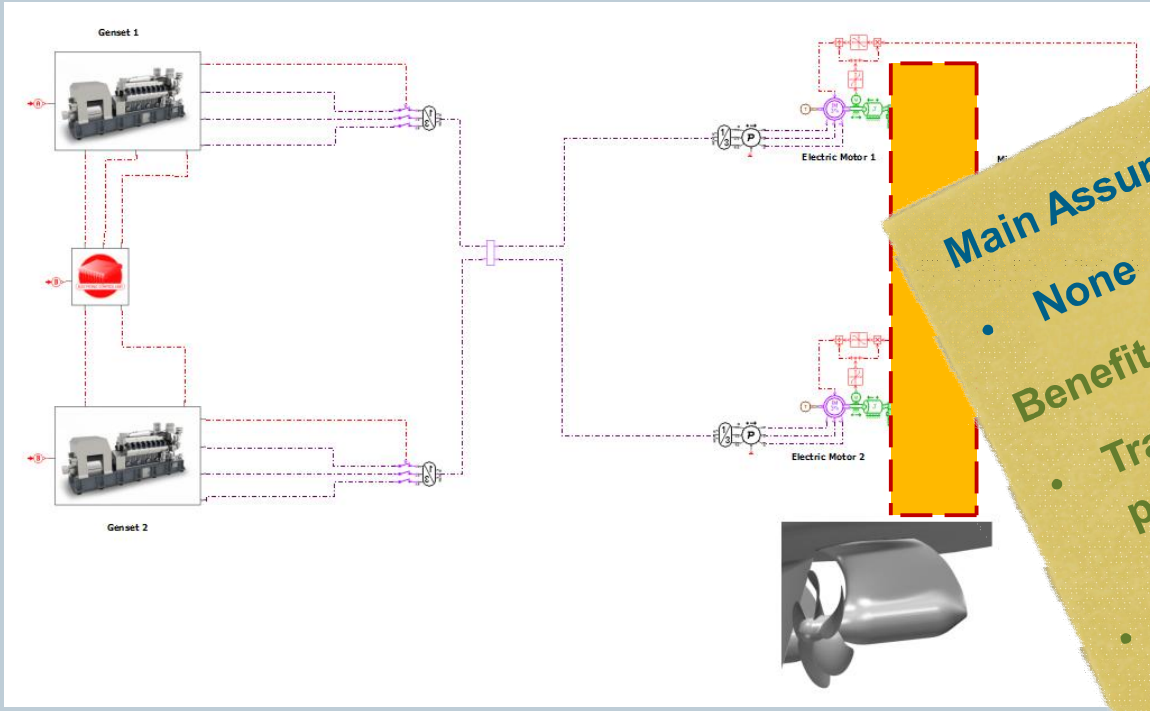

Unrestricted © Siemens AG 2018

# Marine Co-simulation
## Simcenter STAR-CCM+ to Simcenter Amesim

SIEMENS
Ingenuity for life

- **Tight Coupling Cases**

### Simcenter Amesim (1D system model)

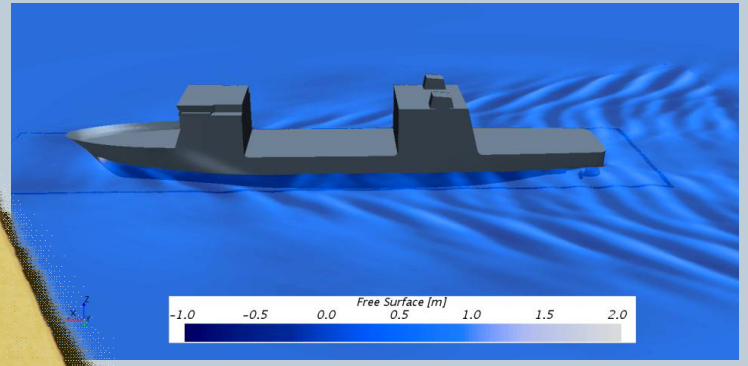


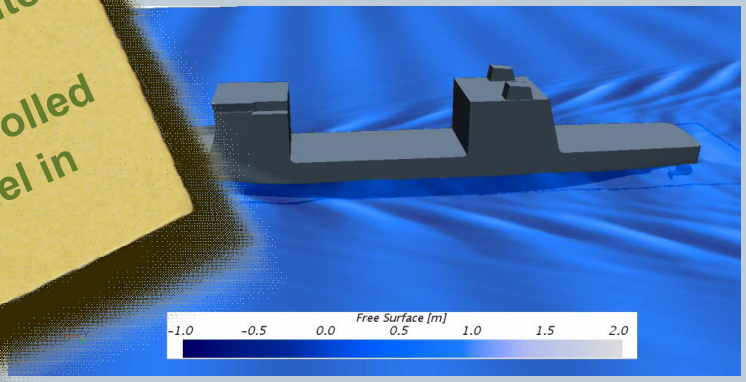

**Main Assumption:**

- None

**Benefit**

- Transient loadings on propeller are passed into Amesim
- STAR-CCM+ is controlled by the system model in Amesim




Unrestricted © Siemens AG 2018

SIEMENS
Ingenuity for life

- **Predicted Tight coupling case**

| Fuel Consumption @ 13kts | CO2 emissions @ 13kts |
|---|---|
| **333 kg/hr** *(Calm)* *[435 kg/hr loose]* | **1,050 kg/hr** *[1370 kg/hr loose]* |
| **415 kg/hr** *(Head waves)* | **1,307 kg/hr** |

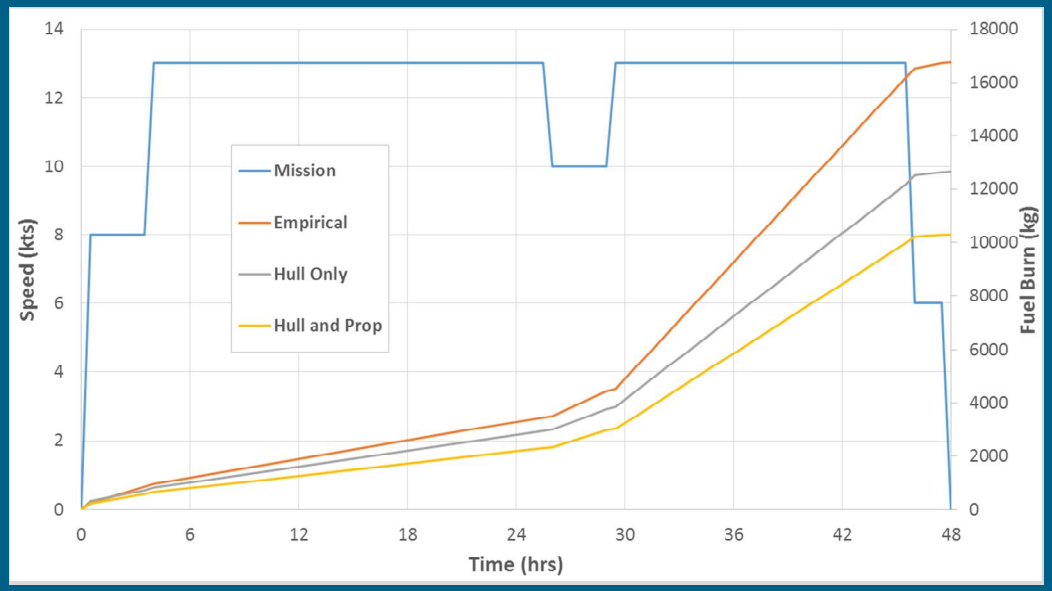
Unrestricted © Siemens AG 2018

# Marine Co-simulation
## Simcenter STAR-CCM+ to Simcenter Amesim

SIEMENS
Ingenuity for life

- **Predicted Two Day Mission Profile**

### Loosely Coupled

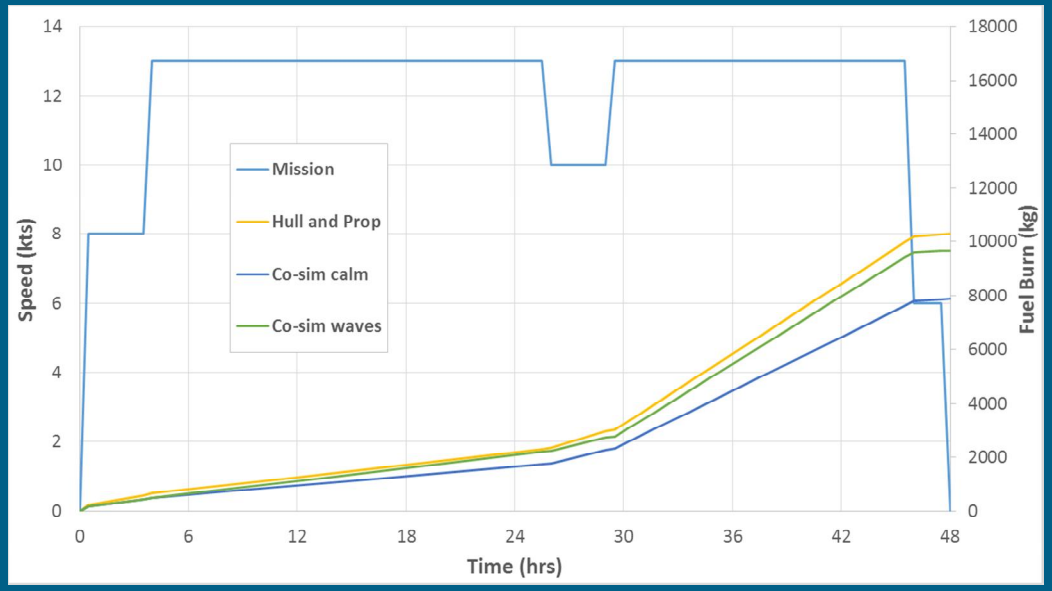



**16,746 kg**
Empirical

**12,640 kg**
Bare Hull

**10,287 kg**
Hull and Propeller

### Tightly Coupled




**7,870 kg**
Calm

**9,666 kg**
Waves

We haven't changed or optimized the design, we've increased the fidelity by adding in realism and reducing assumptions

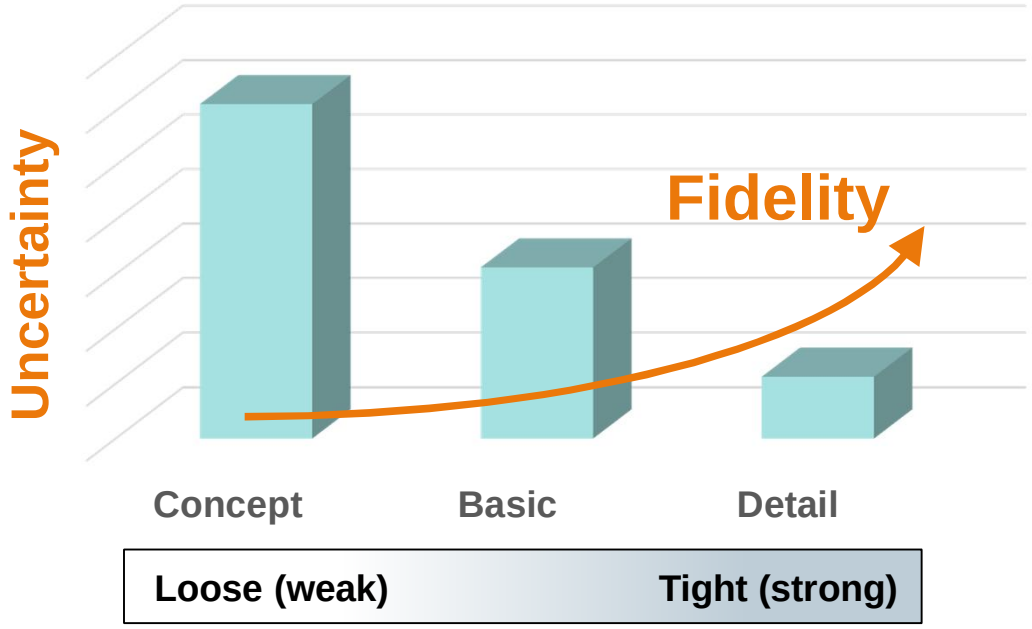
Unrestricted © Siemens AG 2018

SIEMENS
Ingenuity for life

- **Conclusions**

  The influence that assumptions have on fuel consumption and CO2 emissions are evident.

  The level at which you assess the “value” of co-simulation fidelity depends where you are in the design cycle




**Concept phase** **Speed**
Simcenter Amesim with (semi) empirical data, data, previous designs (CFD etc).

**Basic Design** **Speed and more accuracy**
Simcenter Amesim with Simcenter STAR-CCM+.

**Detail Design** **Accuracy**
1D and 3D models coupled for full dynamic model.

Unrestricted © Siemens AG 2018

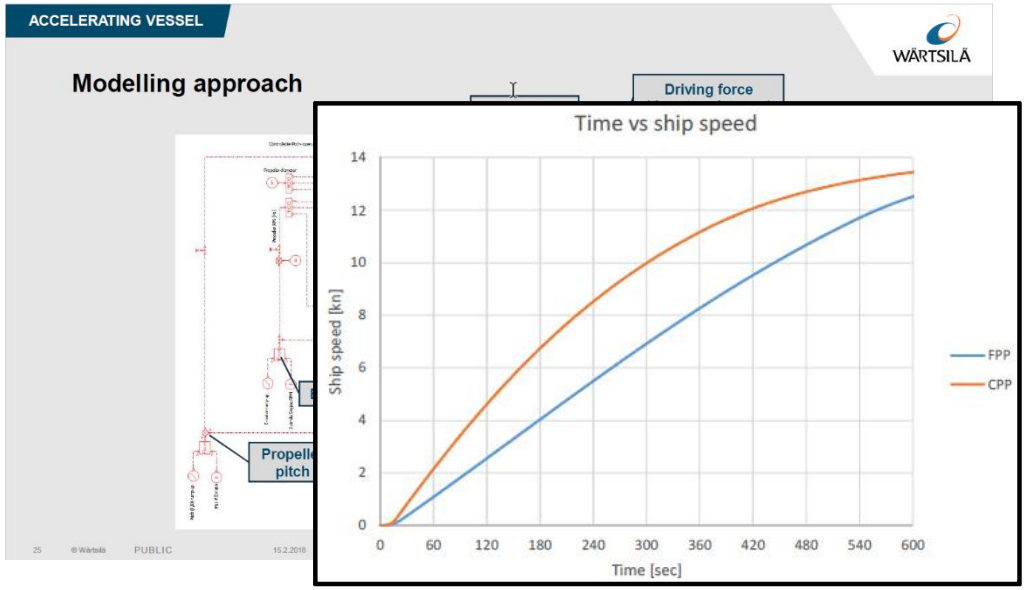
# Marine Co-simulation
## Simcenter STAR-CCM+ to Simcenter Amesim

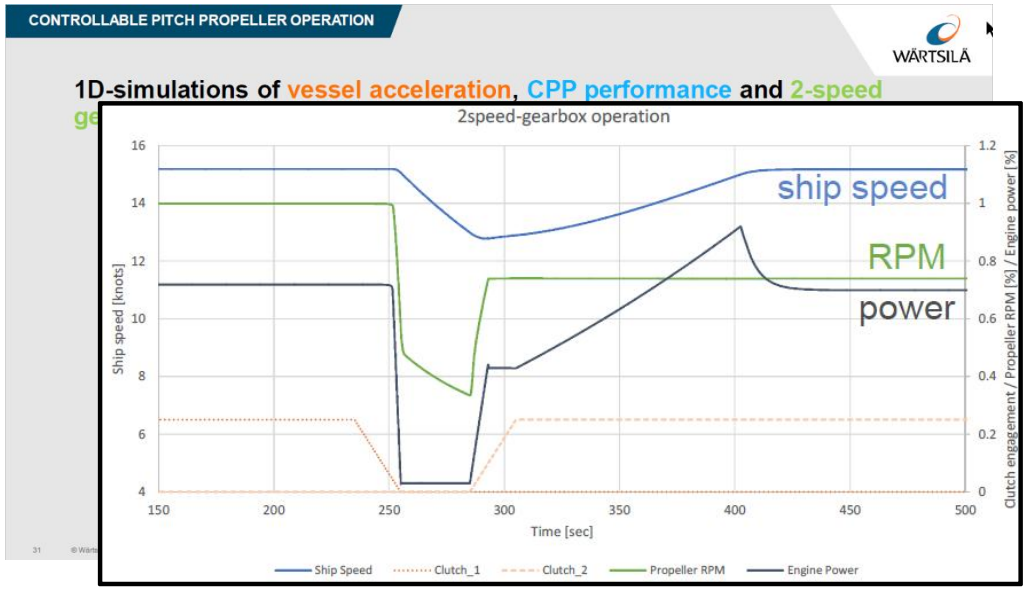
SIEMENS
Ingenuity for life

- **The next steps**

  Model dynamically and transient maneuvers (i.e., steering) with and without sea states

  Factor in more system modelling effects such as acceleration and gearbox performance, as demonstrated by Wärtsilä in the webinar.




Unrestricted © Siemens AG 2018