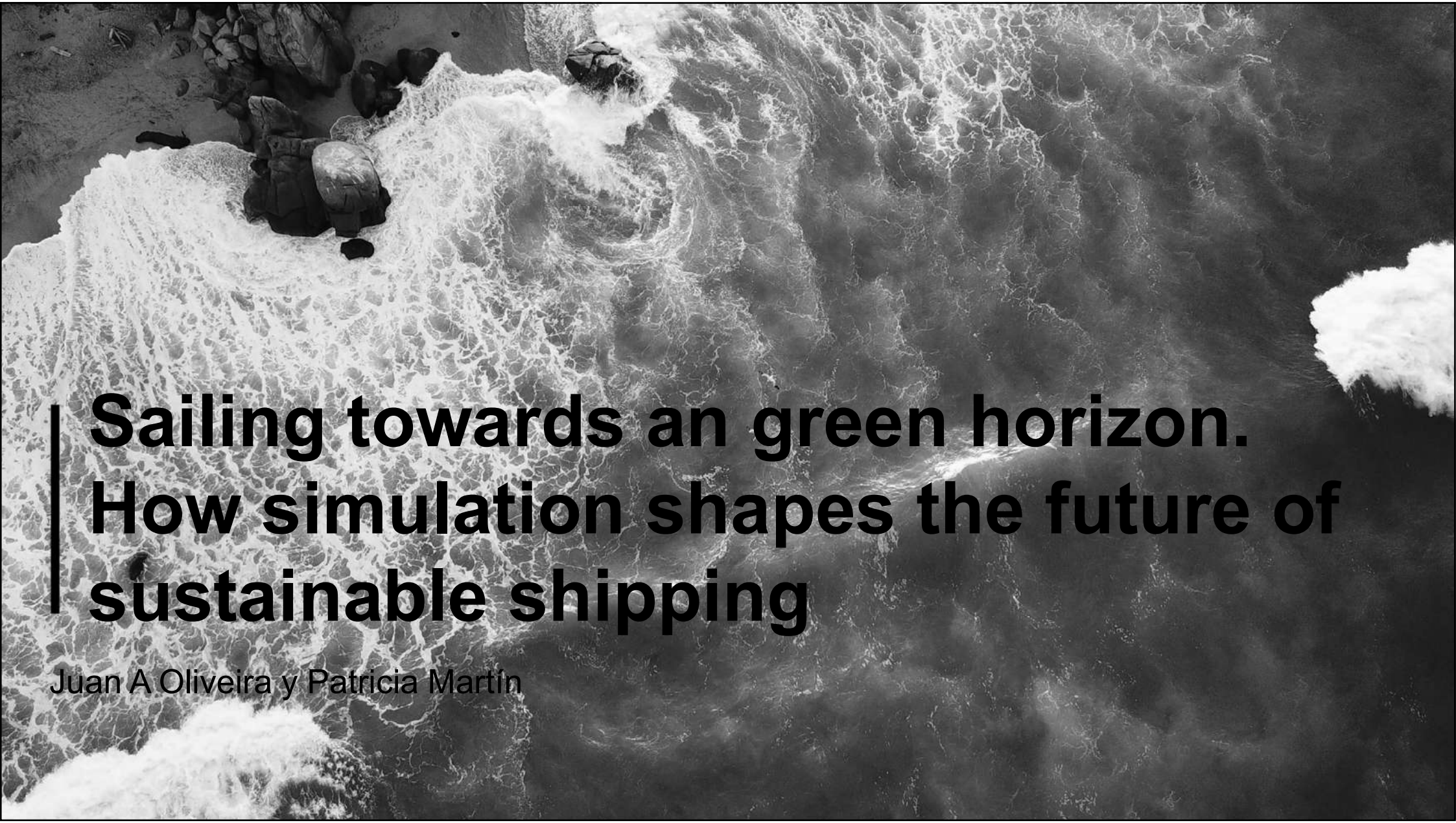


Sailing towards an green horizon. How simulation shapes the future of sustainable shipping

Juan A Oliveira y Patricia Martín

KEY TRENDS

Uncertainty in the global economy

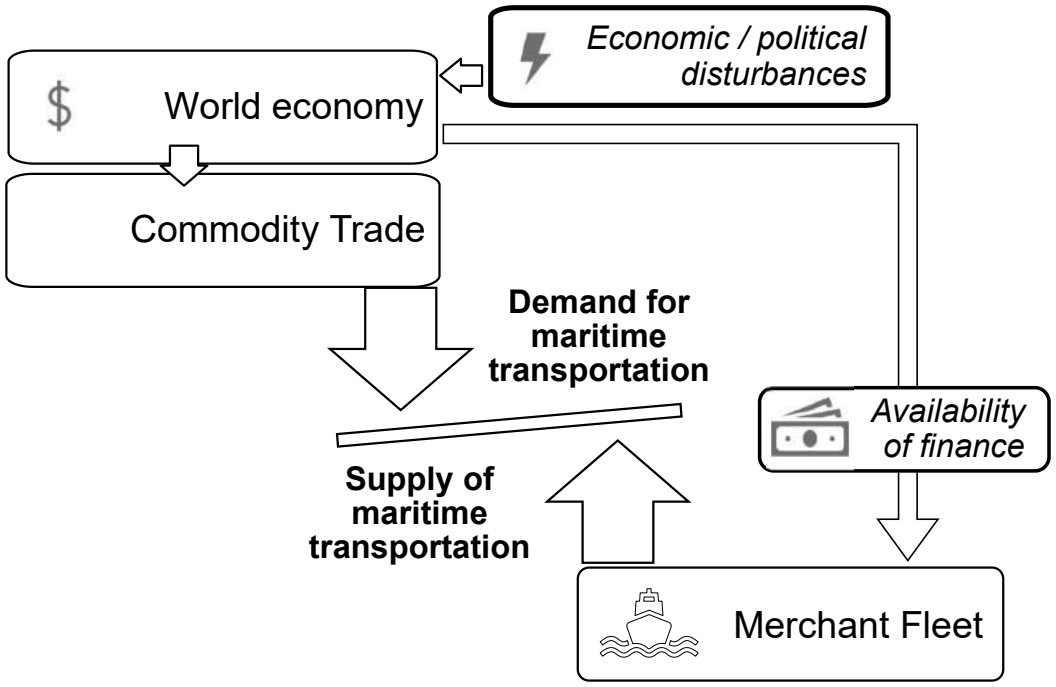
Increased demand for high-tech vessels

Focus on sustainability

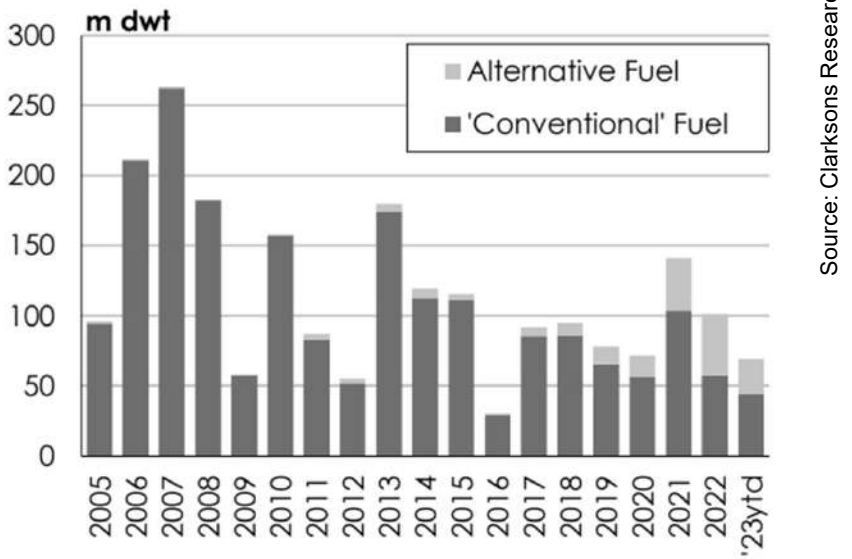
SIEMENS

Increased competition in the newbuild market

Shipping market model



Newbuild contracting



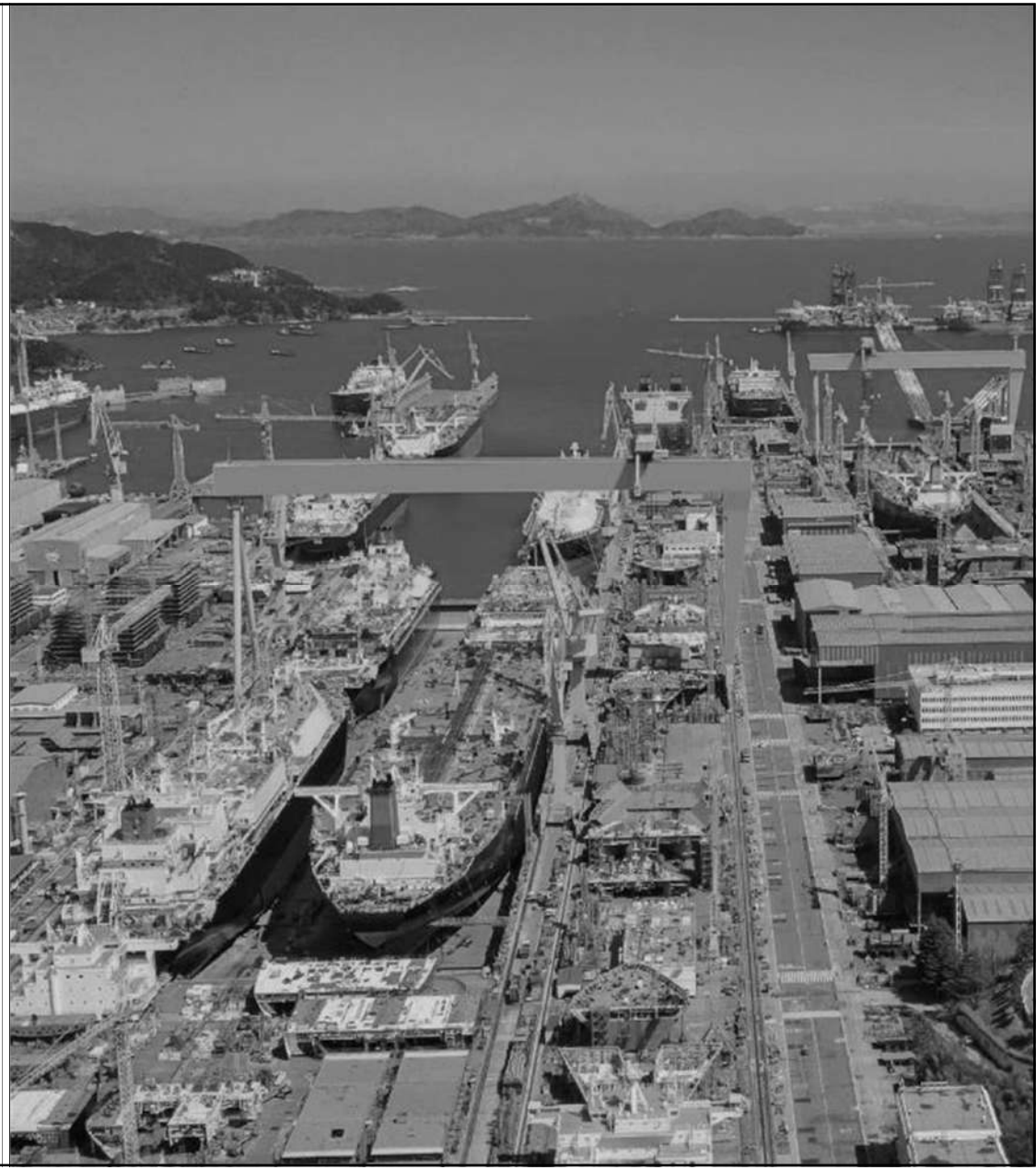
Source: Clarksons Research

Implication

Ship owners & operators require more cost-effective vessels

Shipyard must compete for:

- Lower total cost of ownership
- Higher operational availability
- Shorter time to market



Increased demand for high value-added, multi-purpose, and autonomous vessels

Military operations other than war, e.g. humanitarian relief, emergency medical care

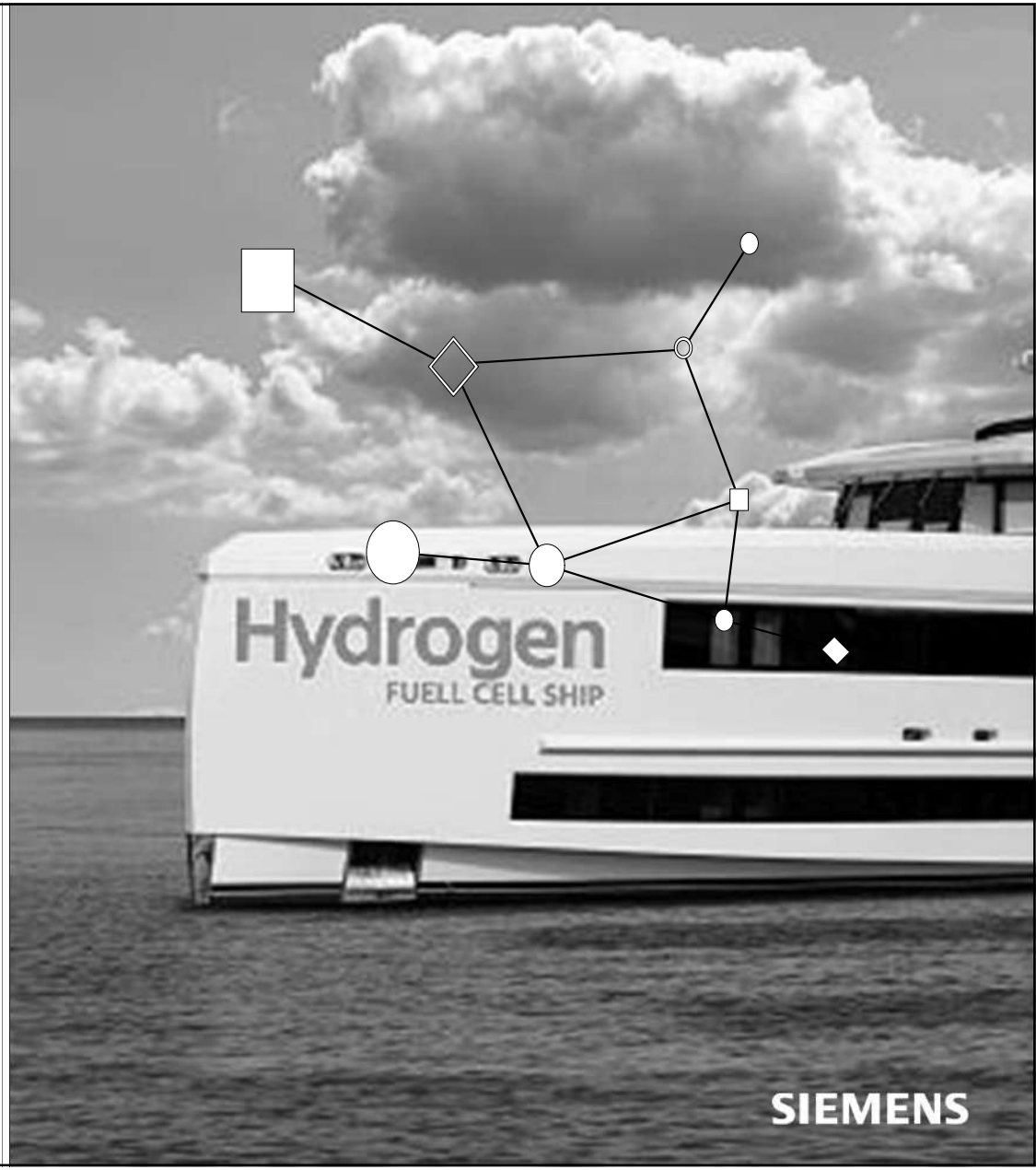
Broadening of horizons in the cruising & yachting industries

Growing interest in autonomous vessels for short-sea shipping, ferries & naval operations

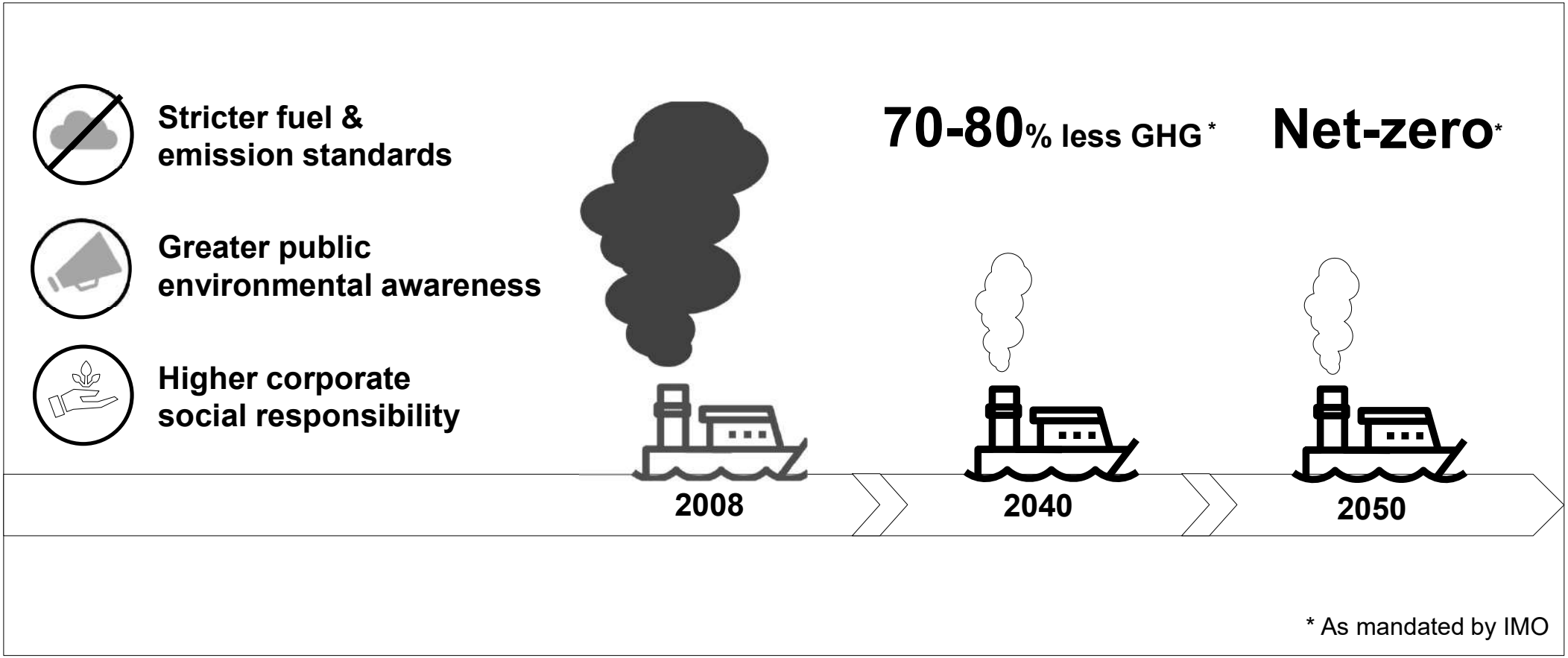
Implication

Ships today are more complex than ever before

- More complex equipment and systems onboard.
- More electrical systems: more sensors, cables, etc.
- More parties involved and more information to manage and communicate
- Workforce needs to continuously adapt and embrace new technologies



Global effort to control climate change and build a low-carbon future



Implication

New ship designs must offer significant fuel efficiency and emissions improvements

- Hull form optimization
- Innovative propulsion systems
- Transition to cleaner fuel alternative

FUTURE FUELS

LNG

- Fewer emissions
- Accessible
- Mature distribution network
- Non-renewable
- CO2 emissions
- Specific facilities and equipment

NUCLEAR

- Unlimited autonomy and range
- Cero emissions
- Power & speed
- High costs
- Regulations and limitations
- Risk and public opinion

BIOFUELS

- Renewable
- Less emissions
- Limited availability
- Competition for large cultivation areas

HYDROGEN

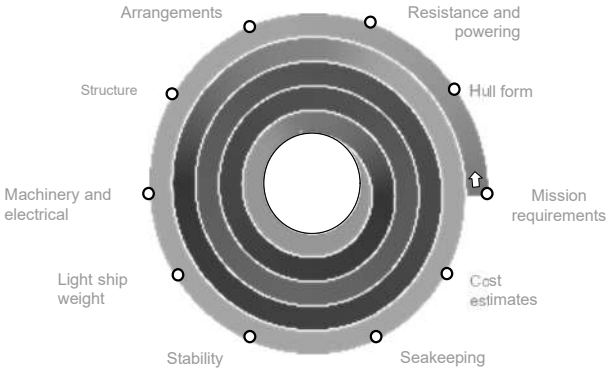
- Renewable
- Zero emissions
- High costs

SIEMENS

Rethink your ship design process

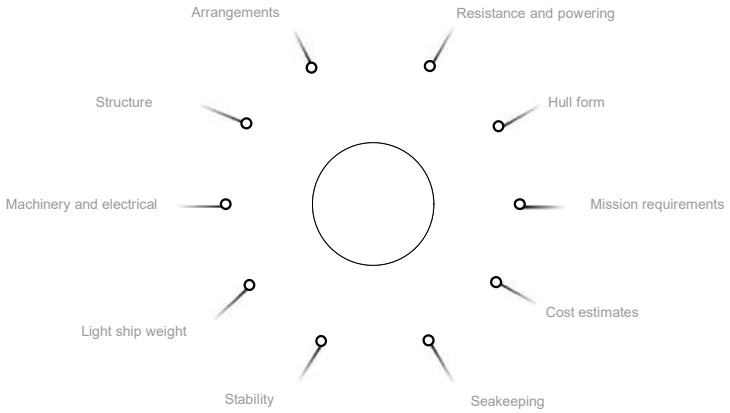
From traditional to integrated ship design - from spiral to V

Spiral design



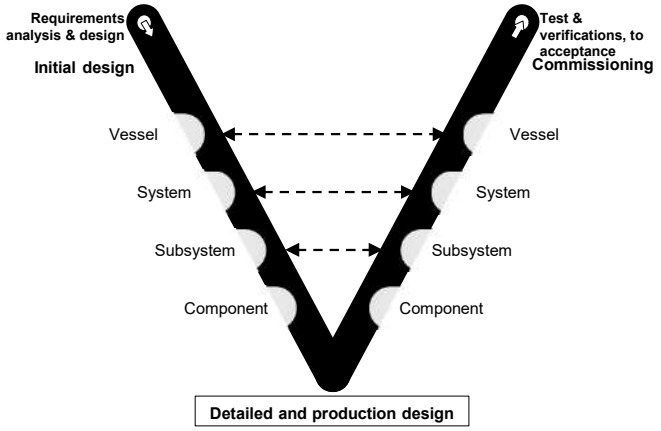
- Disconnected point solutions
- Manual data exchange
- Increased IT efforts/costs

Integrated design

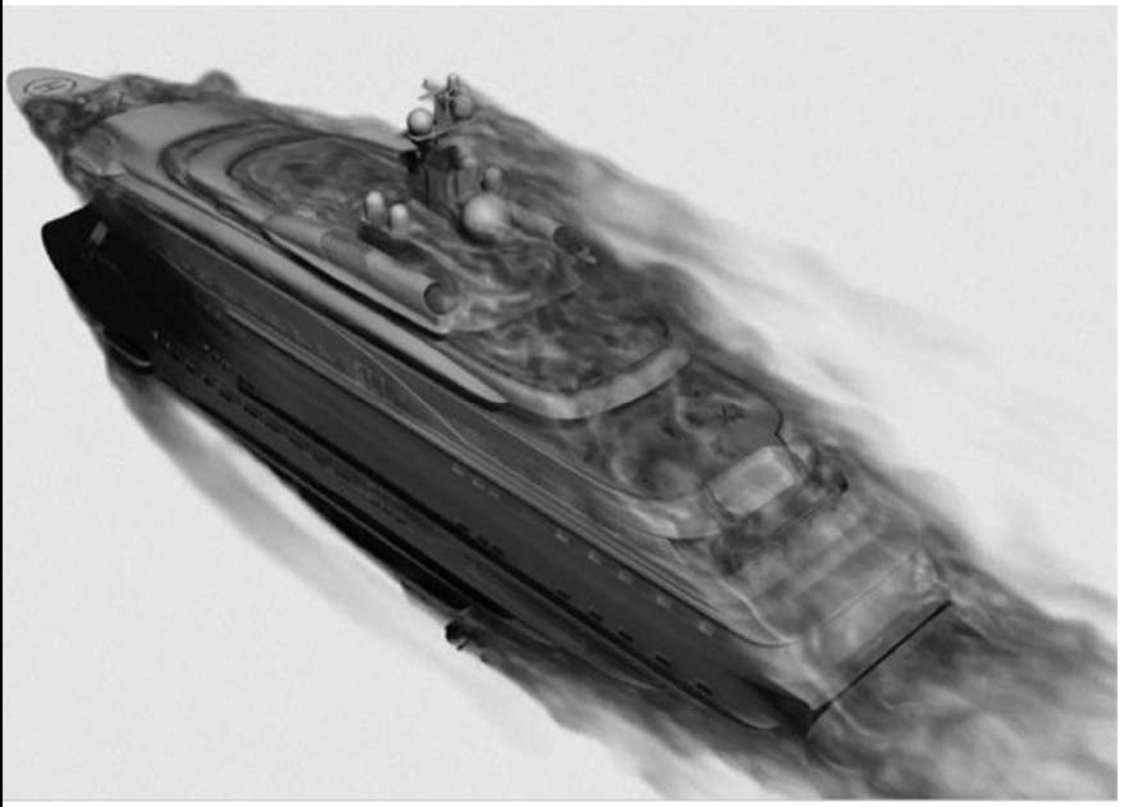


- Connected process
- Automation, AI
- Reduce costs/errors/delays

V-Model



- Streamlined process sarting with functional system model
- Increased automation/collaboration
- Embrace design complexity



Opportunity

Leverage software technology to support innovation

Simulation can be used to optimize fuel efficiency early in the design:

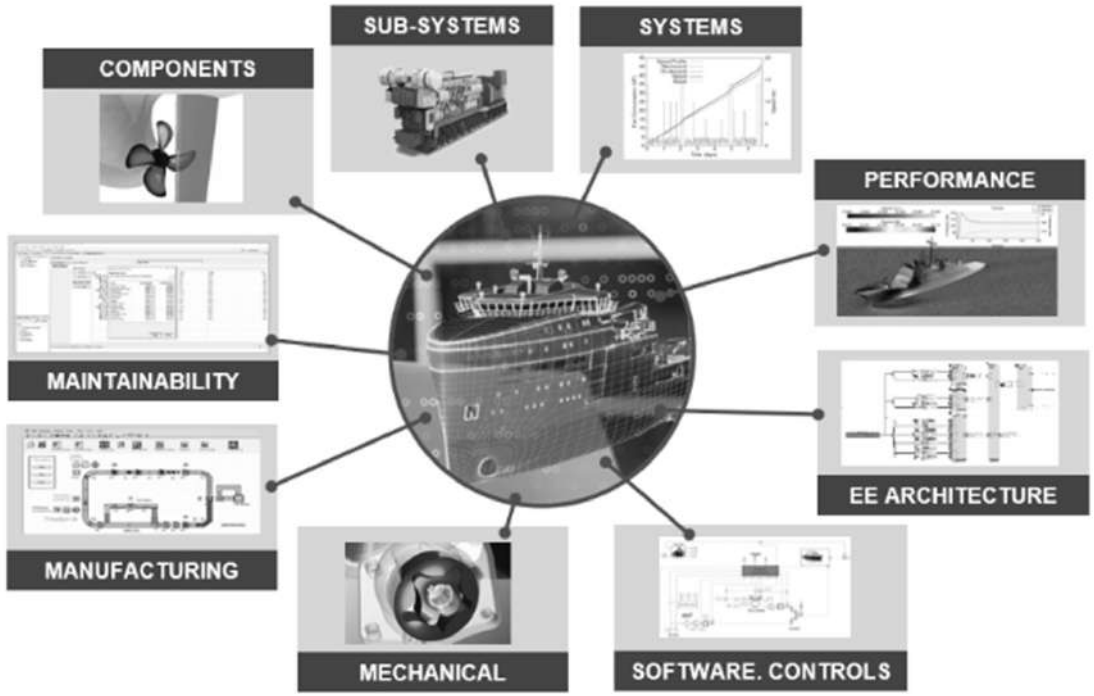
- ⇩ Lower operational costs
- ⇩ Reduce GHG emissions

Solution

Integration & orchestration across domains

Break down silos with seamless process execution and fully integrated solutions:

- Design including software, simulation, manufacturing & project management
- Requirements & BOM, traceability, weight & configuration management
- Integrated approach to engineering lifecycle management



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Simcenter Amesim

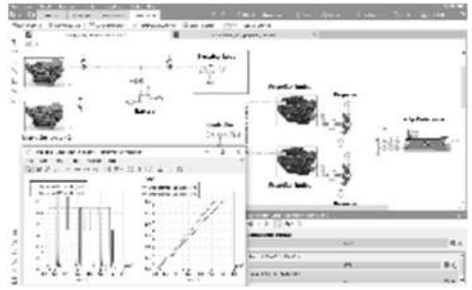
Extensive amount multi-physics libraries and components

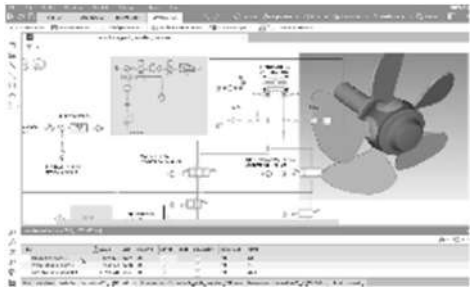
Pre-design

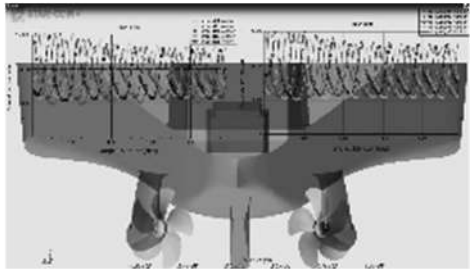
Systems sizing and integration

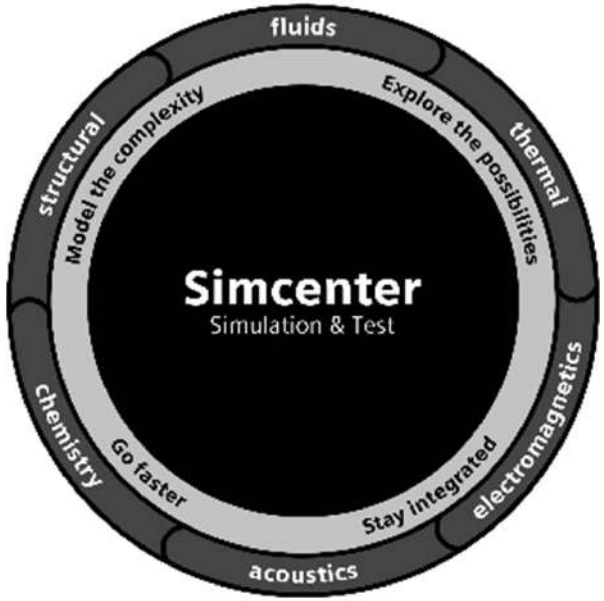
Performance balancing

Controls/PLC verification and validation in real-time (HiL)









Virtually assess and optimize the performance of mechatronic systems

SIEMENS

Marine Solution
Value proposition

Enables you to:

- Develop and validate strategy controlling the number of engines in operation

- Select the most fuel-efficient architecture
- Cope with EEDI and ECA regulations

- Understand oscillating modes
- Apply vibration reduction solutions

- Reduce OPEX through integration of Rankine cycle

- Avoid unplanned downtime in unmanned engine room

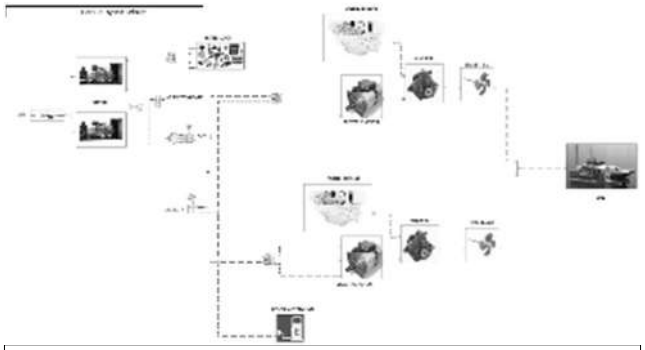
Typical applications:

- Propulsion control
- Ship hybrid architecture selection
- Propeller shaft torsional vibration analysis
- Engine waste heat recovery
- Predictive maintenance
- Steering gear system

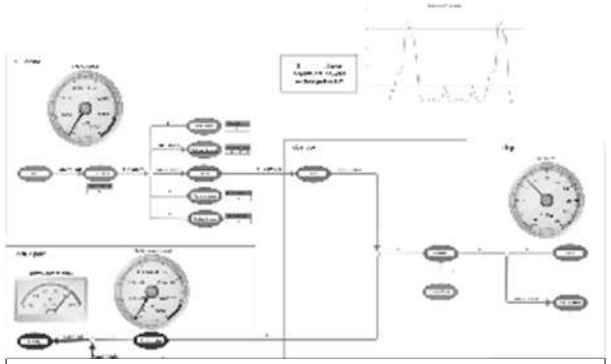
Techno Pro Hispania
Service vessel concept engineering and performance prediction with Simcenter Amesim

- **Quick architecture model based on real data from suppliers and data base from existing vessel**
- **Optimization algorithms used to reduce Diesel contribution and improve electrification**
- **CO_2 & NO_x emissions and global performances predicted**

Modeling and simulation of workboat hybrid propulsion system



Workboat hybrid propulsion architecture



Dashboard for power flow analysis and Emissions

- Ensure prediction of power budget for a dedicated mission profile
- Pre-sizing of the Main Diesel Engines, Electric Motors, Gensets, Li Propulsion battery and controllers

“Simcenter Amesim has allowed us to design and validate the advantages of an innovative design and predict future behavior”

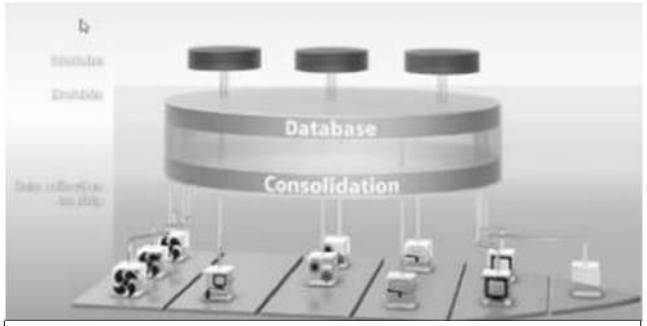
Andrés Sánchez Alcaraz, Propulsion systems engineer

SIEMENS

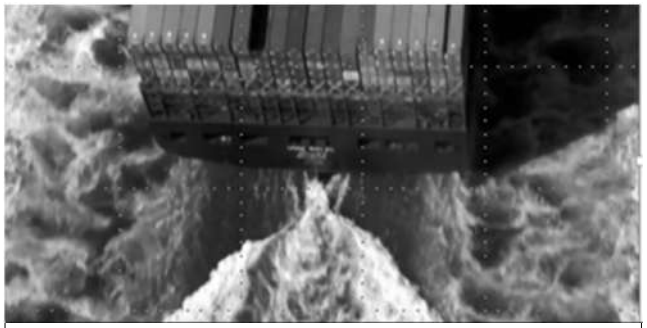
Siemens Marine
Monitoring ship energy efficiency with Simcenter Amesim

- **Good predictability of the system's behavior under changing ambient conditions**
- **Helped on-board personnel in their decisions and operations in an efficient way**

Optimize a waste heat recovery system



Multi-domain system modeling



Keep system performance under control

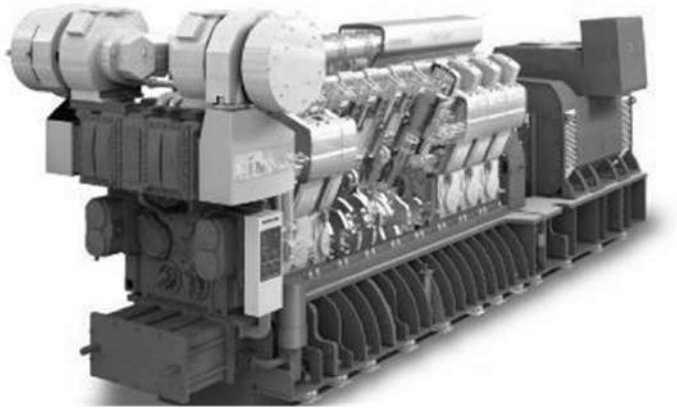
- Simulate the real world and achieve better efficiency
- Leverage Engineering Services to deploy a usable solution to control performance

"Simcenter Amesim and Engineering Services enabled us to provide our customers a system which can simulate the real world in a perfect way. We wouldn't have been able to do this with other solutions."

Kay Tigges, Siemens Marine

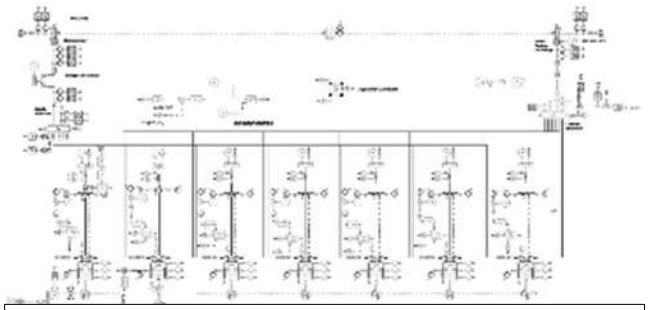
SIEMENS

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

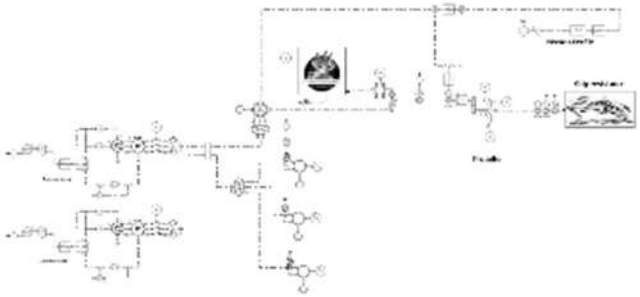


- **Shorter simulation time**
- **Streamlined modeling process**
- **Fuel consumption and NOx emissions efficiently assessed**

Real-time engine model capability and hybrid ship integration



High-Frequency engine model for design



MVEM model integrated in hybrid vessel

- Validate detailed engine model versus baseline model
- Generate Mean Value Engine model for Hardware-In-the-Loop validation
- Integrate engine model into hybrid ship architecture

“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

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Thank you

Published by Siemens Digital Industries Software

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