Digitalization and Smart Technologies: Impact on Ship Design and Operations

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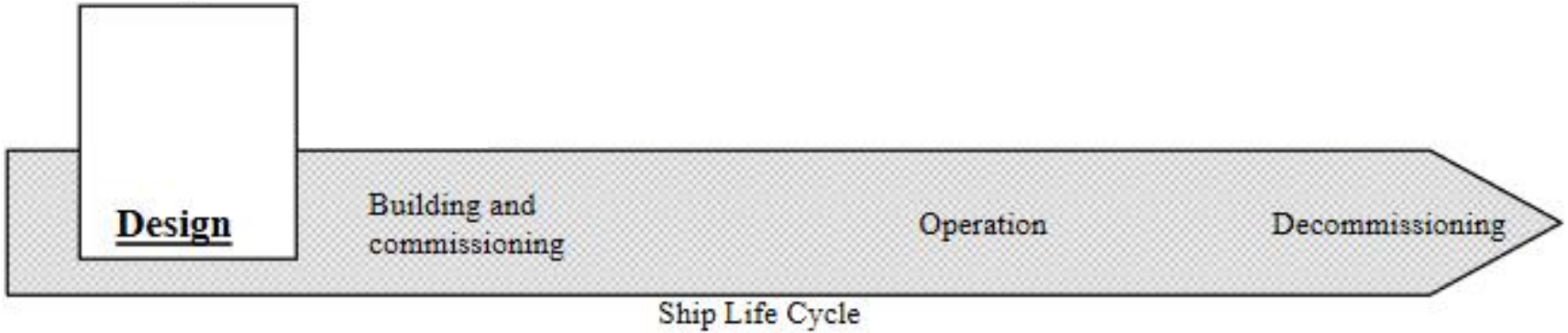
TCOMs

Traditional Approach to Ship Design

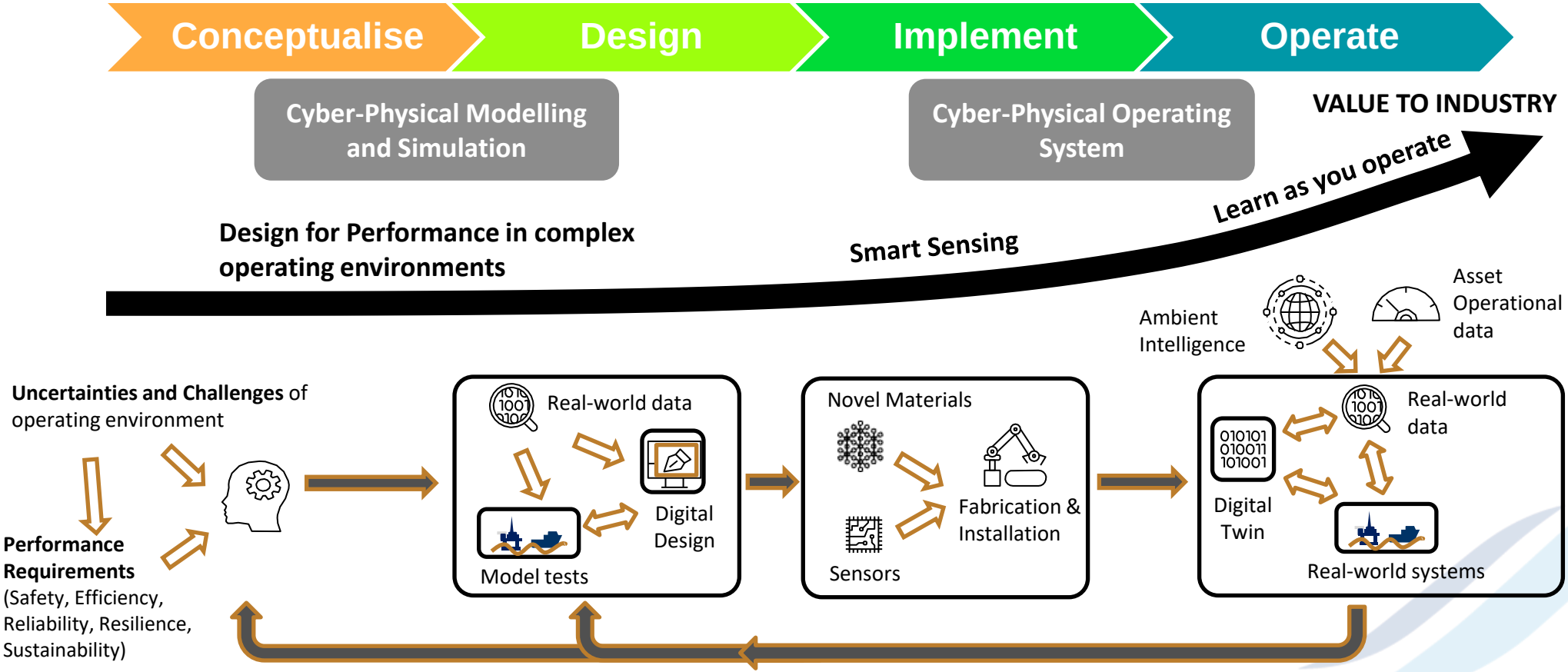
Ship Design driven by "common sense" feedback

- Regulatory policies (e.g. accidents, emission control)
- Industry developments

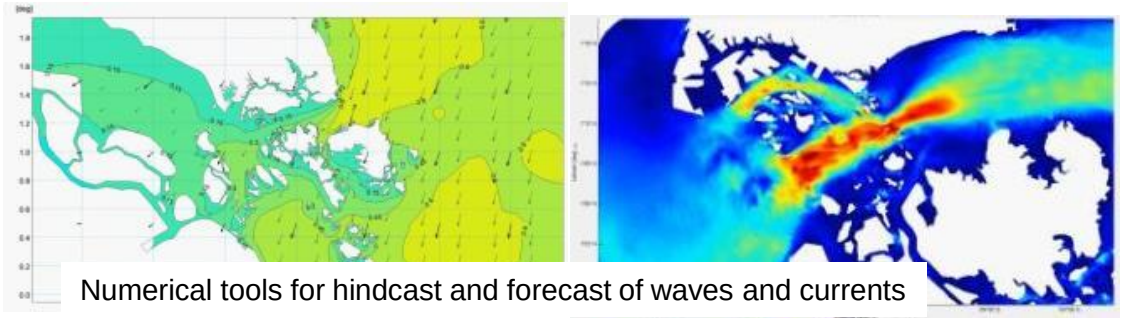


Adapted from: Maritime and Coastguard Agency Lectureship Final Report, D. Konovessis, 2006

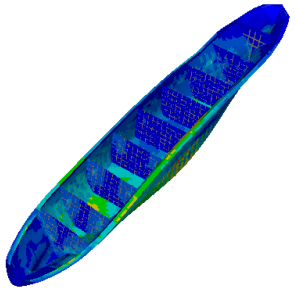
Life-cycle Transformation of Maritime & Ocean Systems

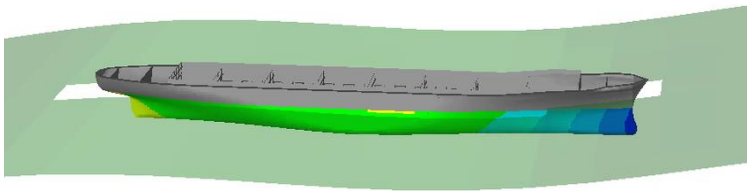


Digital Twinning @ CEAOPS

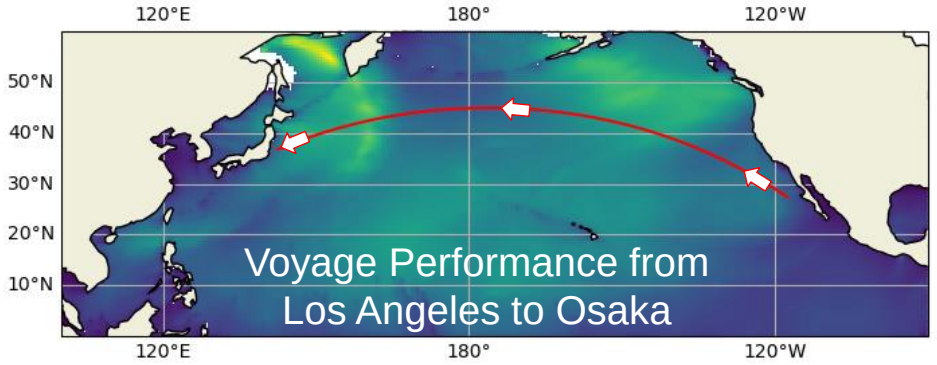


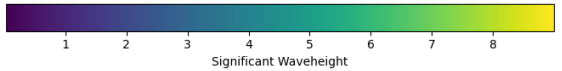
Numerical tools for hindcast and forecast of waves and currents

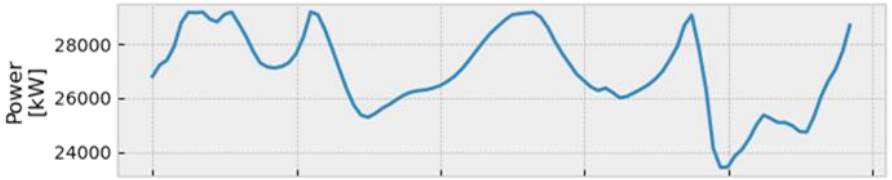




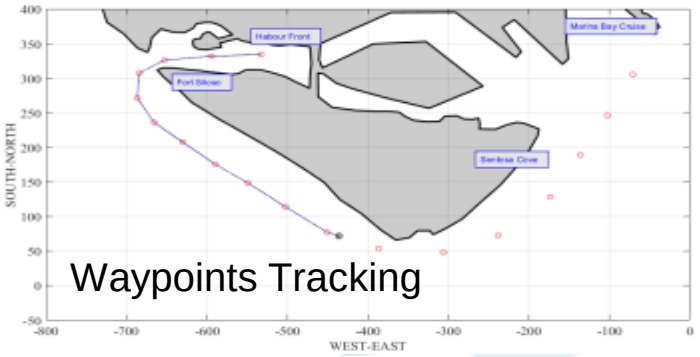
Structural Digital Twinning



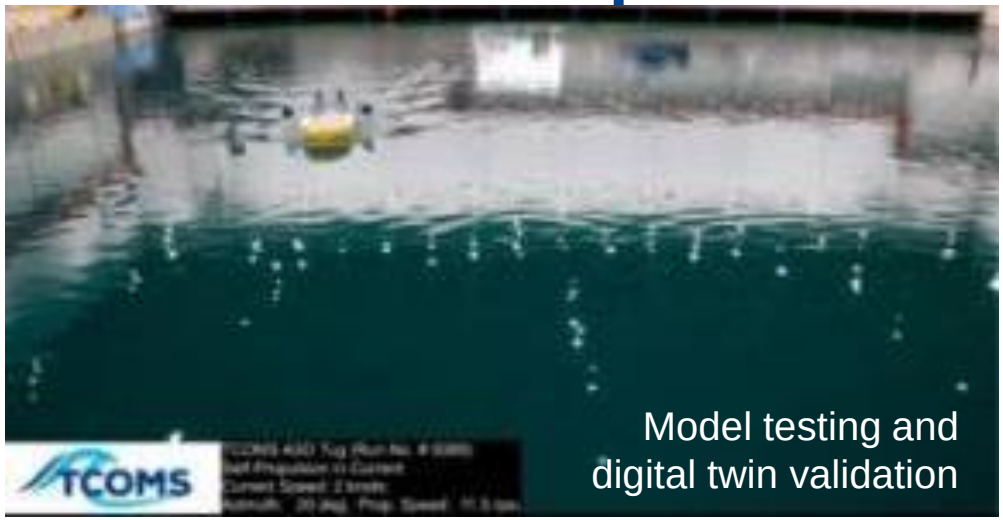


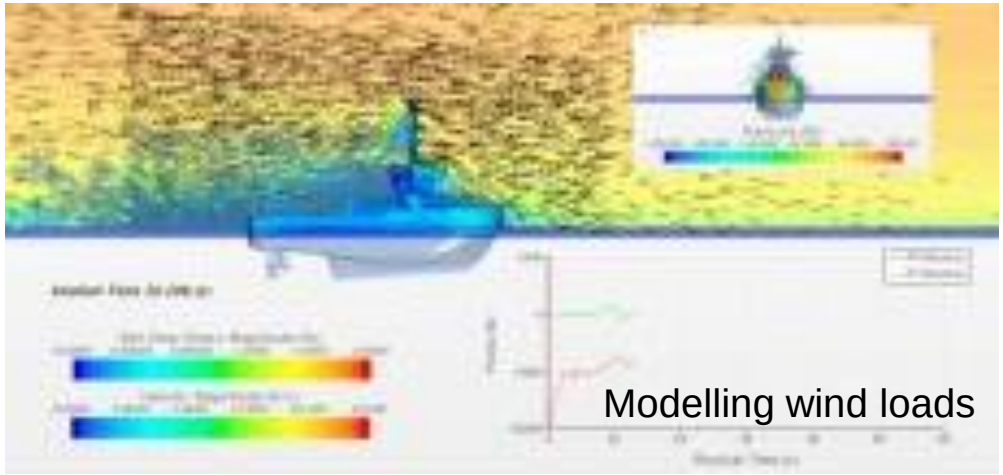


Voyage planning tools



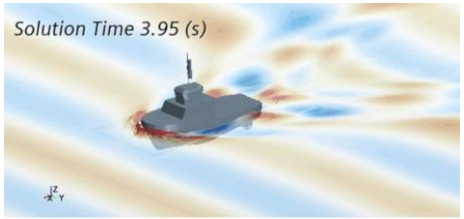
Real-time Simulation Modelling of Vessel Motion, Behavior and Response





Modelling resistance and propulsion

Vessel Performance in Waves

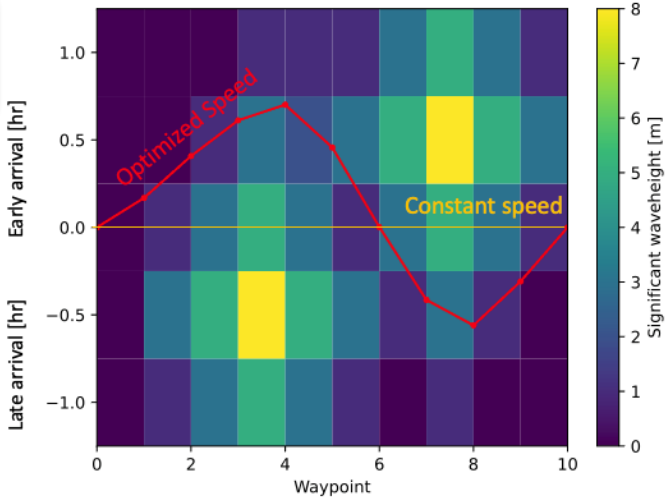


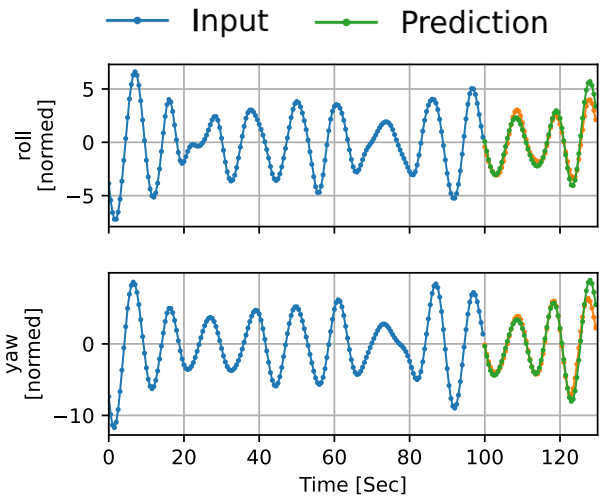
Vessel Response in Waves

In-house seakeeping code for evaluation of wave-induced motions

Speed Optimisation

Optimize ship speed to minimize fuel consumption by avoiding harsh weather





Vessel Motion Prediction

Industry Project
Advance motion prediction for safer and more efficient offshore operations and crew transfer vessels

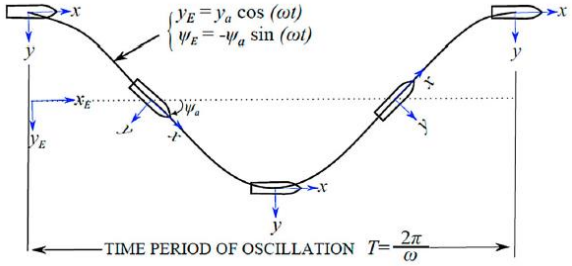
Benefits to industry:

Proof of concept for the development of safer and more efficient offshore operations and crew transfer vessels

Enhancing Predictability of Vessel Behavior for Robust Control Strategies

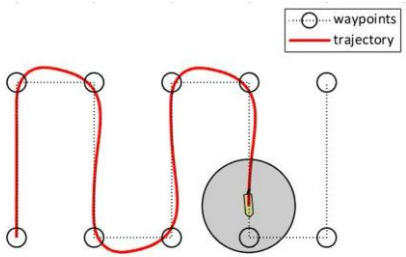
Manoeuvring Behaviour

Development of high fidelity manoeuvring models using CFD simulations to accurately access manoeuvring characteristics



Pure Sway

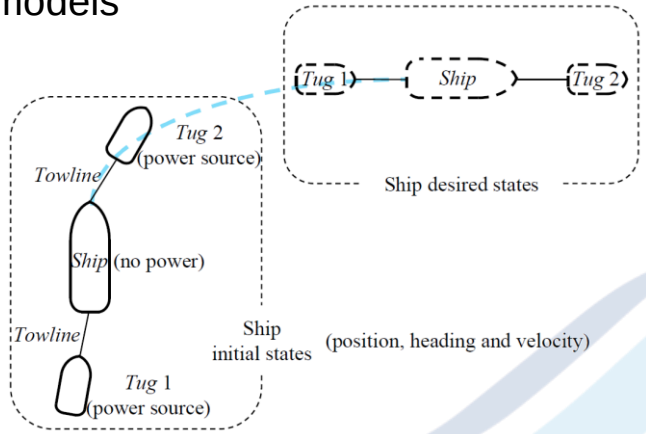
Waypoint Tracking for Single Ship



Waypoint tracking algorithm for single ship using Model Predictive Control (MPC) utilizing manoeuvring models

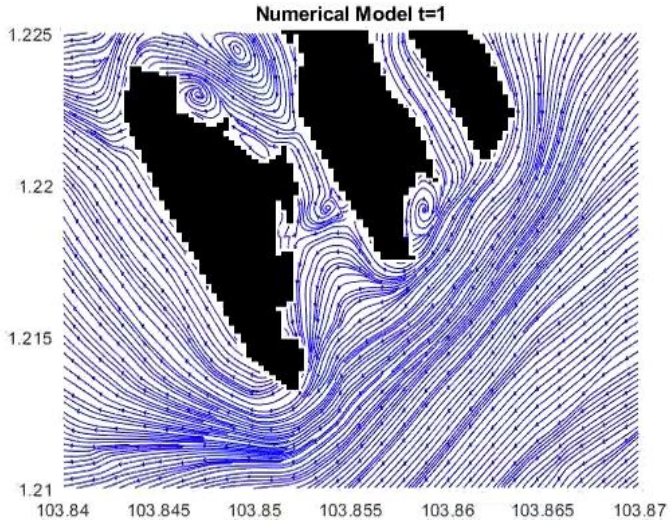
Control Strategy for Autonomous Tugging

Cooperative tugging/towing control strategy to manoeuvre a tanker to wharf with multiple autonomous harbour tugs

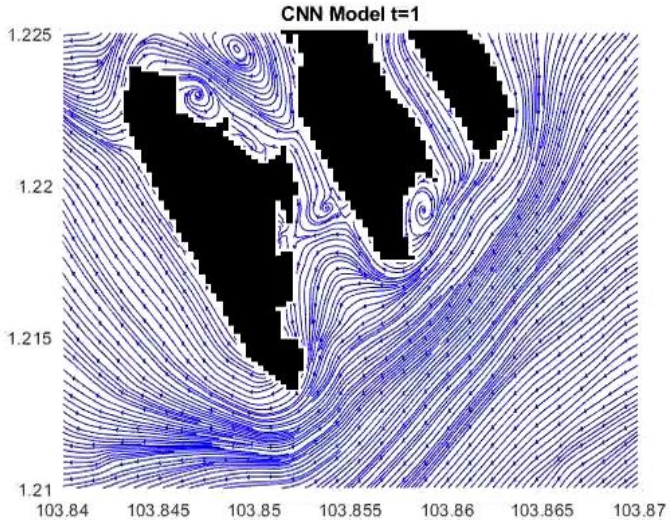


High-fidelity digital twins of vessels allows for reliable stress-testing of MASS systems for verification and validation.

Prediction of Tidal Currents



Numerical Model

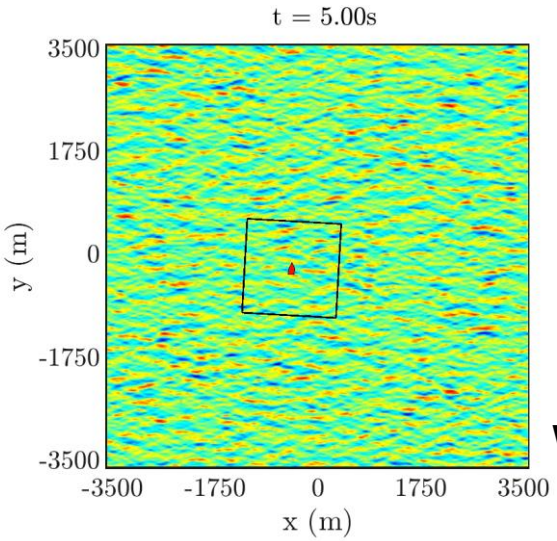


Data-Driven Model

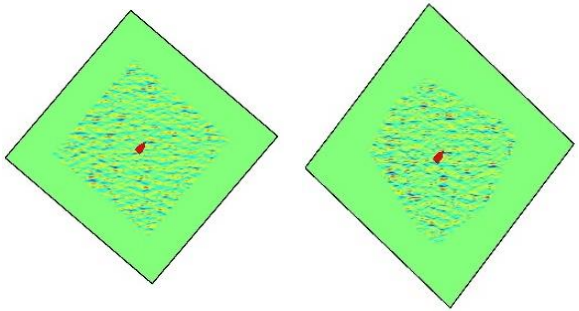
Cheaper, faster and more accurate

Benefits to industry: Support autonomous vessel development by industry through on-demand forecasts of the metocean environment, including for sea trials.

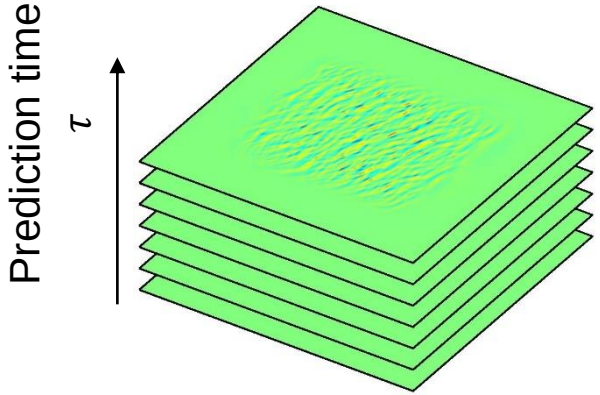
Prediction of Phase-resolved Waves



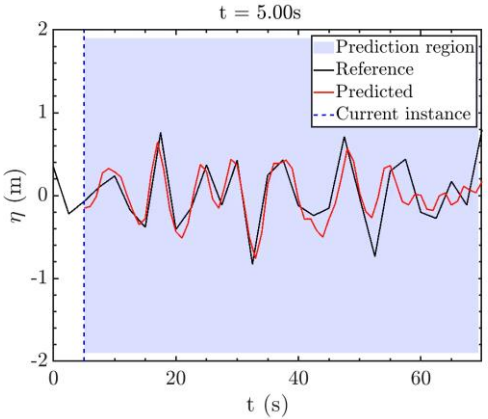
Synthetic wave field



Wave-field Reconstruction

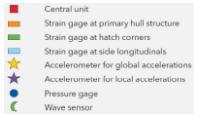


Wave-field Prediction

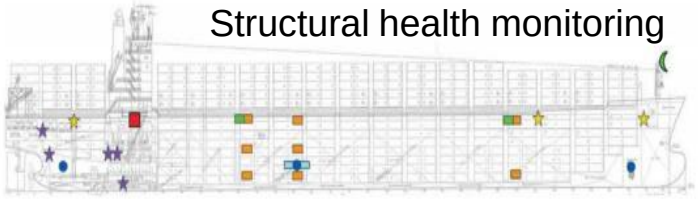


Encounter wave prediction

Digital Twins for Structural Health Monitoring

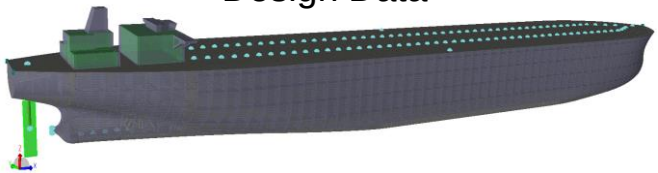


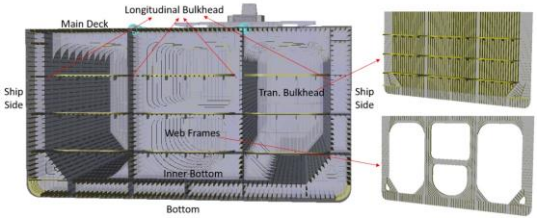
Sensor employment for Structural health monitoring



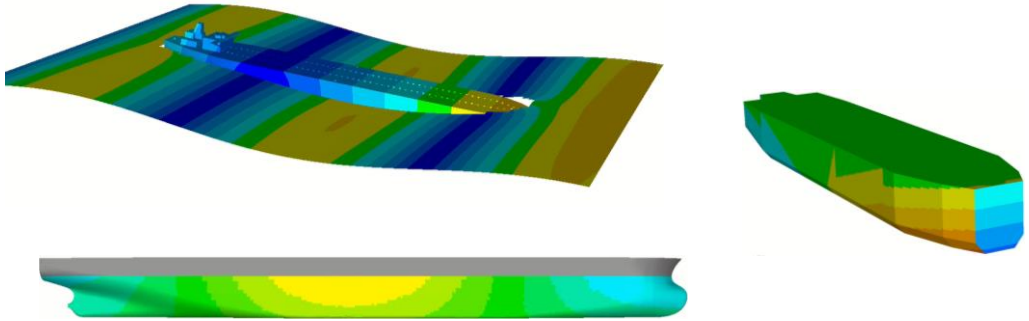
(source: DNV)

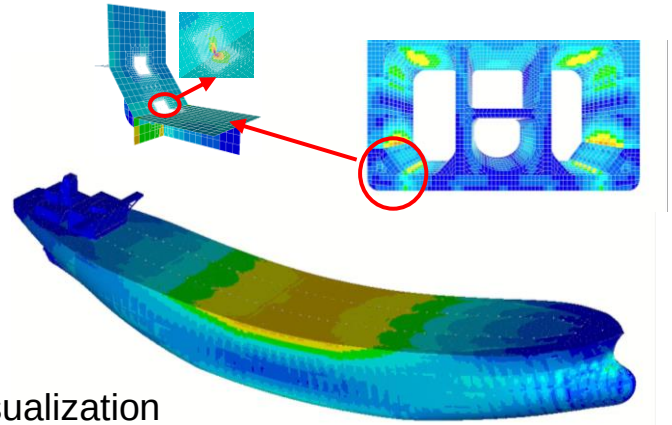
Design Data





Numerical database

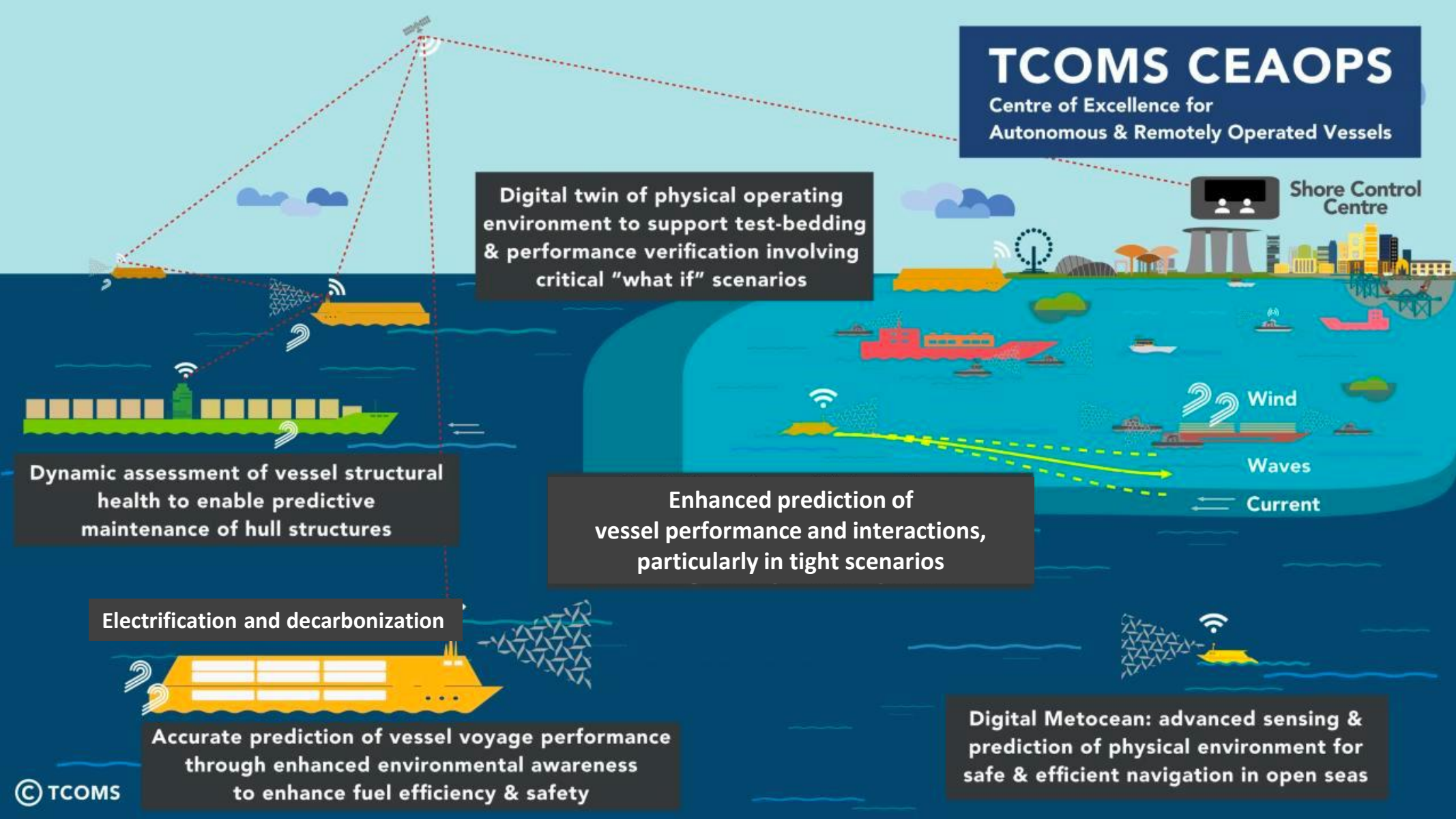




Visualization

Benefits to industry:

Enhance safety & reliability
Reduce lifecycle costs
Assist in optimizing hull structural design of future ships


TCOMS CEAOPS
Centre of Excellence for
Autonomous & Remotely Operated Vessels
Digital twin of physical operating environment to support test-bedding & performance verification involving critical "what if" scenarios
Shore Control Centre
Wind
Waves
Current
Dynamic assessment of vessel structural health to enable predictive maintenance of hull structures
Enhanced prediction of vessel performance and interactions, particularly in tight scenarios
Electrification and decarbonization
Accurate prediction of vessel voyage performance through enhanced environmental awareness to enhance fuel efficiency & safety
Digital Metocean: advanced sensing & prediction of physical environment for safe & efficient navigation in open seas
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