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The Next Steps of SeaZero

Armin Pobitzer – Vard Design
Jon Schonhovd Dæhlen – SINTEF Ocean

OSP Conference 2025
2025-11-12

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The SeaZero project - recap

- **Green Platform** Initiative (funded by Research Council of Norway)
- Targets **emission-free operation** of coastal route Bergen-Kirkenes by 2030
  - Round trip of 11 days, 34 harbours, year-round operation,
  - important passenger and freight transport route
- Consortium of 14 partners, led by **Hurtigruten**

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Pictured: Hurtigruten's first-ever zero-emissions cruise ship, set to launch in 2030 with 'AI manoeuvring' and amazing 164ft-tall retractable sails covered in solar panels

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Hurtigruten vil seile utslippsfritt fra 2030

Innen 2030 ønsker Hurtigruten å seile langs norskekysten med skip uten utslipp. Nå utvikles splitter nye nullutslippsskip for selskapet.

Forbes

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Future Of Cruising? Norway's Hurtigruten Unveils Radical Zero-Emission Ship Design

David Nikel Senior Contributor

Travel and lifestyle in Europe with a focus on Norway & Scandinavia.

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0 | Jun 7, 2023, 07:43am EDT

The Sea Zero concept with the solar panel sails fully extended. VARD DESIGN

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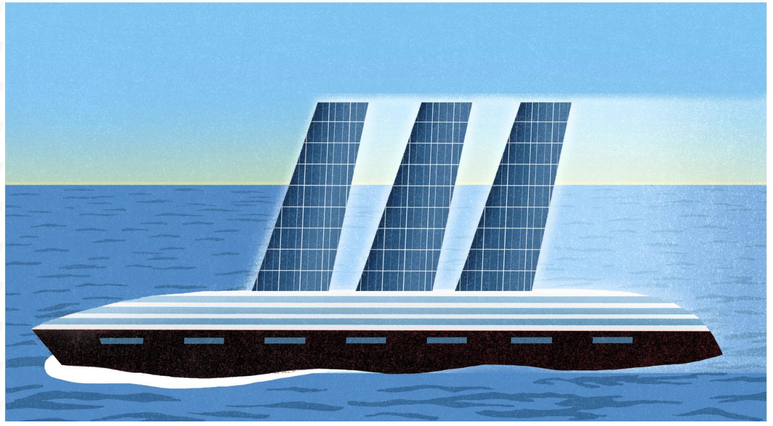
Ecopreneurs

Concept art showing the design of Hurtigruten's zero-emission cruise ship Courtesy of Hurtigruten

TIME

The Cruise Industry Is On a Course For Climate Disaster



SPIEGEL Reise

Geplantes Zero-Emission-Küstenschiff

Hurtigruten setzt Segel

In sieben Jahren soll ein erstes Hurtigruten-Schiff vor der Küste Norwegens kreuzen, das keine Emissionen mehr ausstößt – es segelt und fährt elektrisch. Jetzt zeigt die Postschiff-Reederei erste Entwürfe.

07.06.2023, 16.05 Uhr

Artikel zum Hören • 3 Min | Anhören

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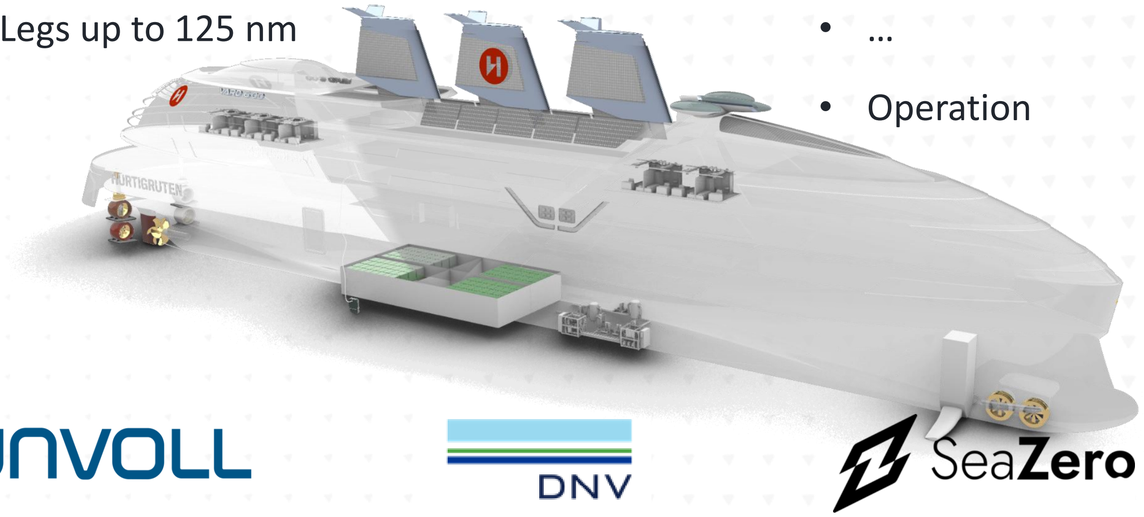
The SeaZero project - recap

Demanding requirements

- High regularity (precise schedule)
- Hotel standard
- Few long stops
- Many stops in rural communities
- Legs up to 125 nm

Zero-emission **requires research and innovation** on

- Hull design
- Propulsion solutions
- HVAC
- Charging system and infrastructure
- …
- Operation



Every kWh counts!
System perspective important
→ OSP

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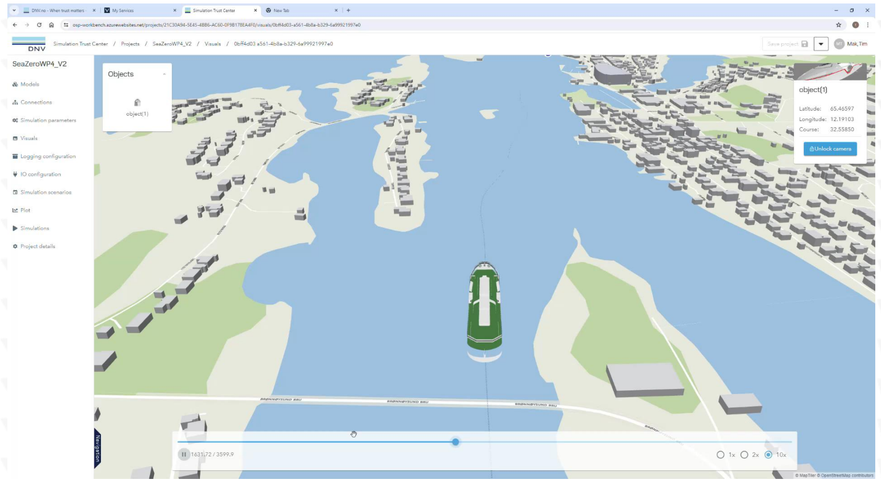
SeaZero @ OSP Conference 2024

Simulation of Autodocking in Brønnøysund in OPS
through DNV's Simulation Trust Center

Background: **verify operational envelop** of autodocking

2024: development of model + initial simulations (selected weather conditions)

2025: Smart Testing → Melih's presentation this afternoon



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Updates since OSP Conference 2024

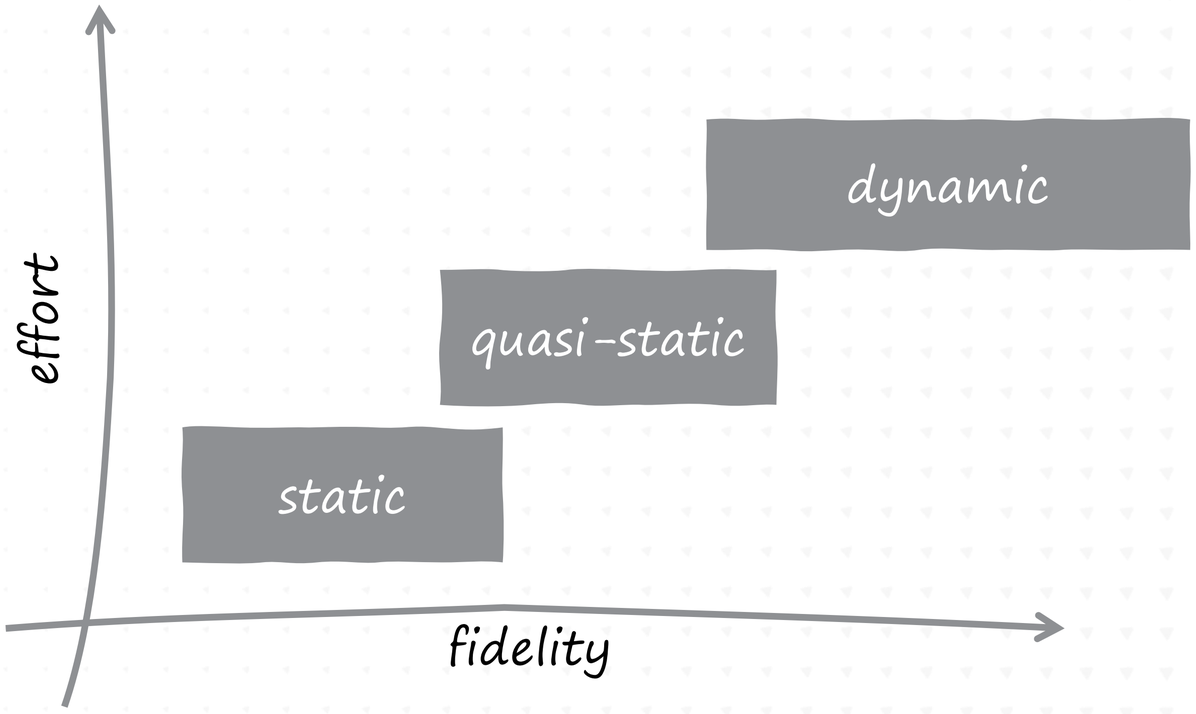
Design changes

- Vessel lengthened: new hydrodynamic model!
- Change in main propulsion setup: 2 pods → new central counter rotating propeller + 2 pods
- New control system

New simulation type: route simulation

Background: **energy requirements** (battery size and charging infrastructure)

What simulation tools should we use?



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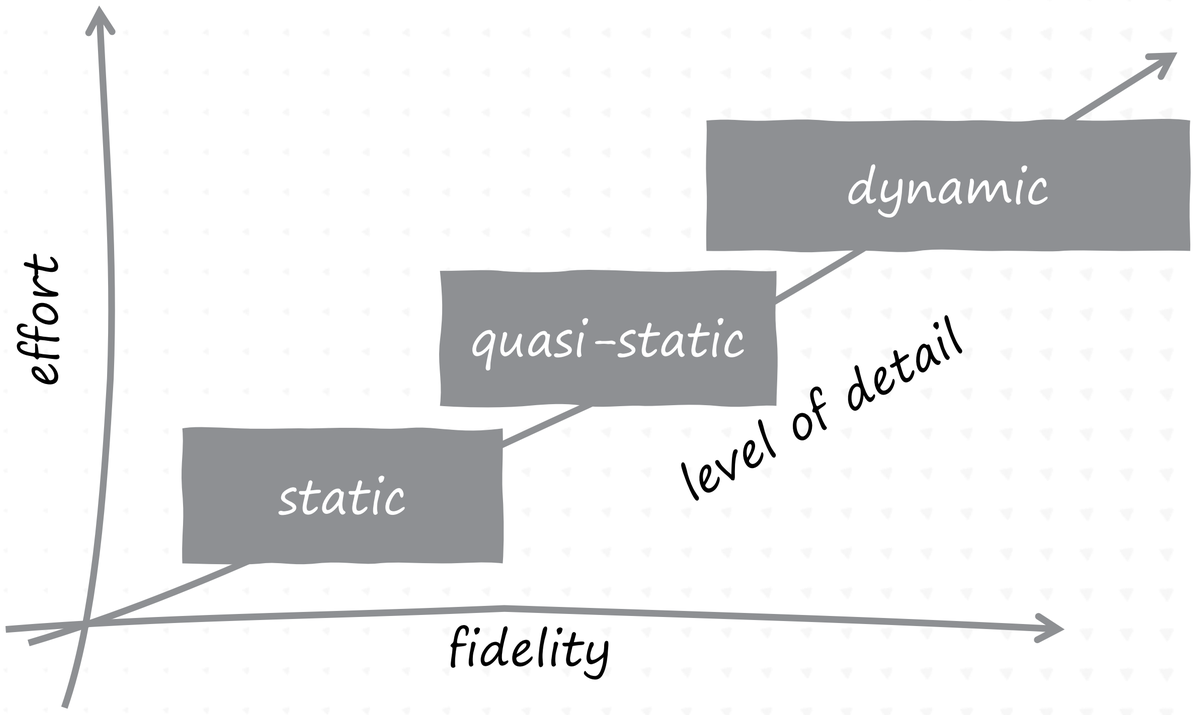

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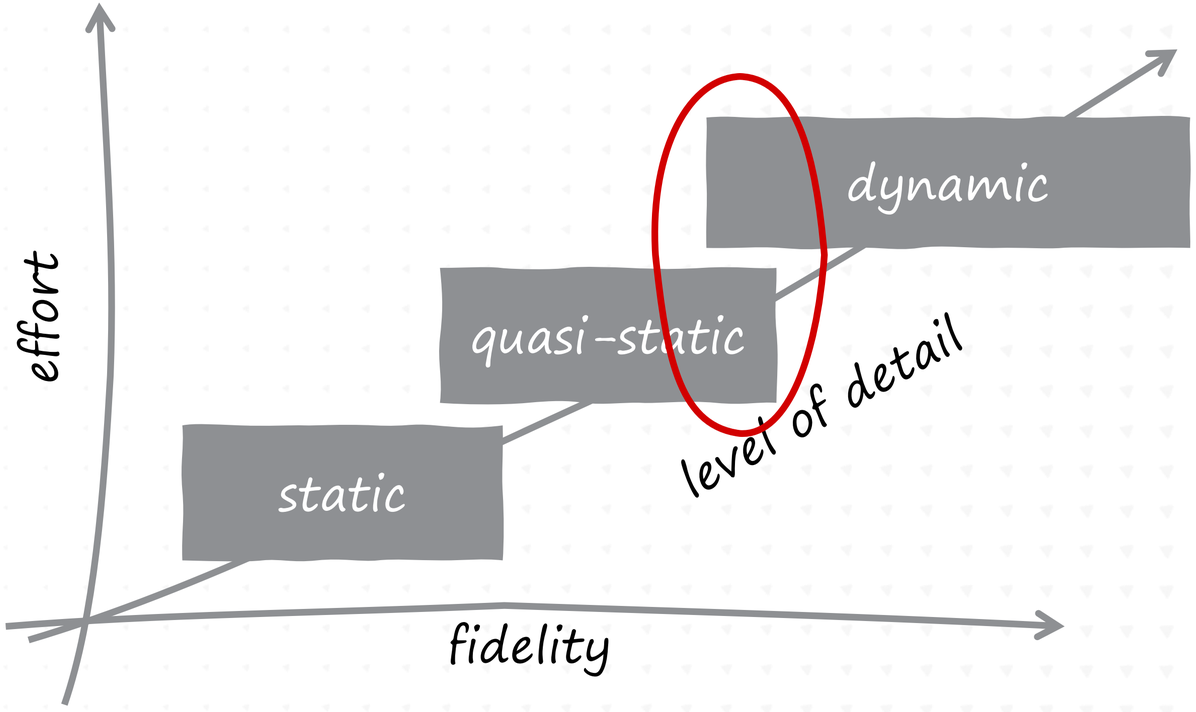
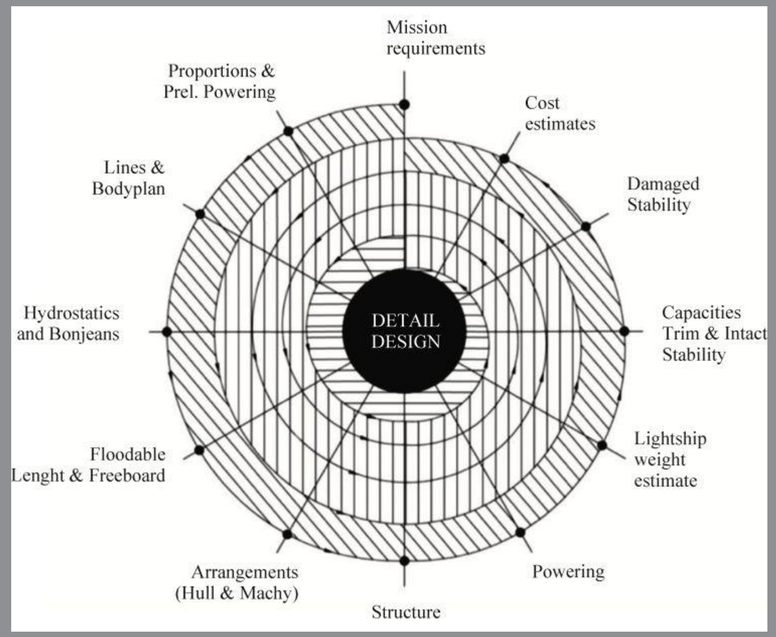


The big picture

ship design spiral



Salman et al., *Naval Architecture: From Theory to practice*, 2019

- Every iteration adds details
- When to switch tools?
- How to ensure continuity / sanity across tools?

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Simulation methods and frameworks used in Sea Zero

Quasi-static

Gymir

Intention: **Simulate several years to reveal trends**

- Time steps in the scale of minutes to hours
- Input is statistical wave parameters and sailing speed

Pros:
- Fast calc. time
- Limited model input required

Cons:
- No steering loss
- Important dynamics may miss
- Missing dynamic decisions required

Co-simulation

Simulation Trust Center / OSP

Intention: **Simulate minutes to hours to evaluate performance in given scenario**

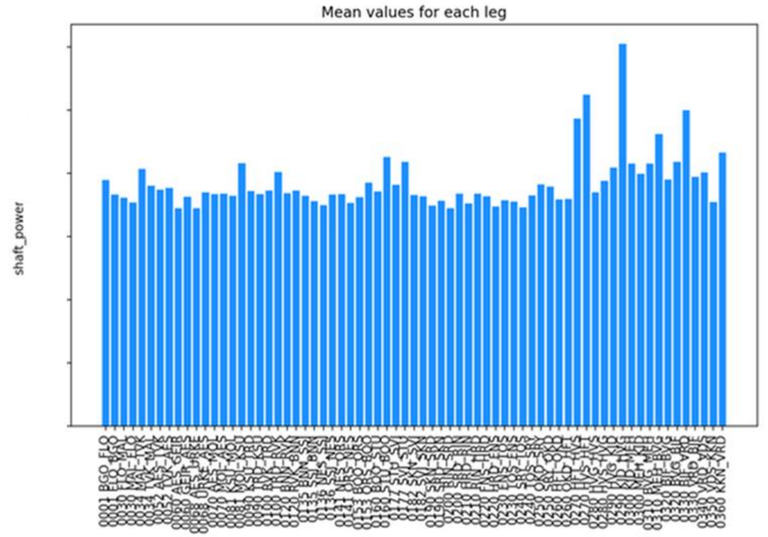
- Time steps < seconds
- Input is instantaneous variables

Pros:
- Great detail
- Decisions/control fits natively

Cons:
- Computationally heavy
- Lot of effort to model everything

GYMIR in SeaZero at a glance

- Route table modelled
- Each leg is simulated independently
- Each leg simulated once a day for one year (2022) using departure time from route table
- Wind, waves and current from met.no hindcast (WAM800)
- Ship modelled in ShipX and calibrated from basin tests
    - Calm water from CFD
    - Aerodynamics from CFD
    - Wave resistance from Veres
    - Propulsion coeff. from Brunvoll / cavitation tests
    - Wind propulsion using lifting line (not use here)
    - Hotel consumption from IDA-ICE (not use here)



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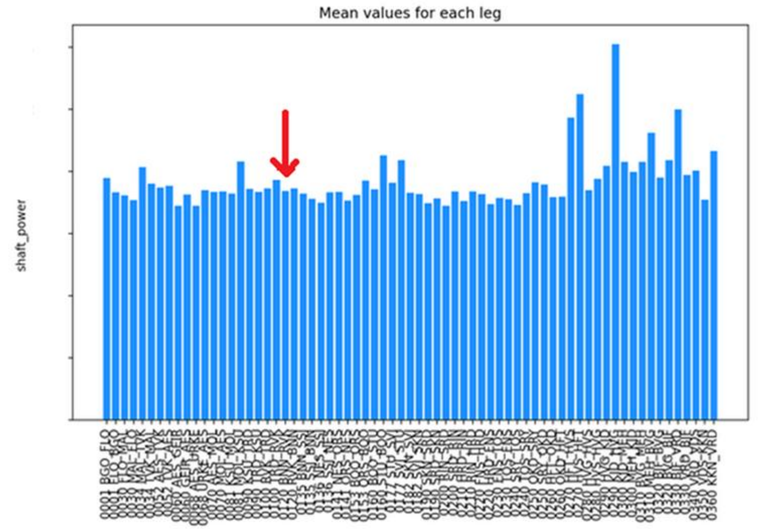
Comparing quasi-static and dynamic simulation

The Trondheim – Rørvik sailing leg

- Longest leg on the coastal route (10 hours)
- Contains both sheltered (Trondheimsfjord) and open water, and significant manouvering
- Relatively average power consumption level
- Leg with highest energy demand (due to extent)
- A period with straight sailing for hours (where quasi-static and dynamic should be similar)

June 3rd 2022 selected as it’s the trip with median average wind for that year



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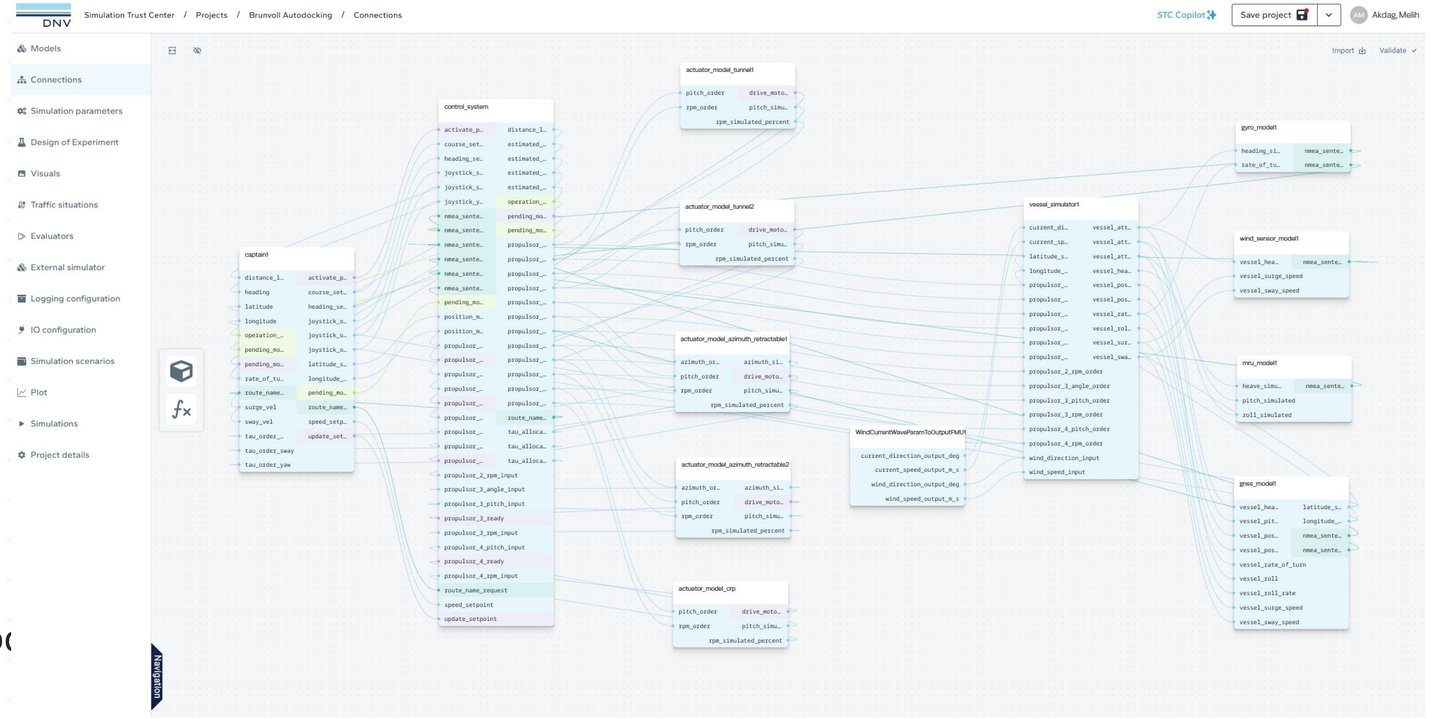
Modelling Trondheim – Rørvik in STC

- Using path-following controller from Autodocking simulations (presentation later)
- Newly developed weather-FMU providing data to simulation (same source as in quasi-static)
- Propulsion similar to the quasi-static simulation
- Calm water resistance calculated using form factor method and Holtrop-Mennen (to be updated)
- Added resistance in waves from strip theory calculations
- Manoeuvring coefficients from slender body metho (Söding)
- Wind forces from CFD (same as quasi-static simulation)



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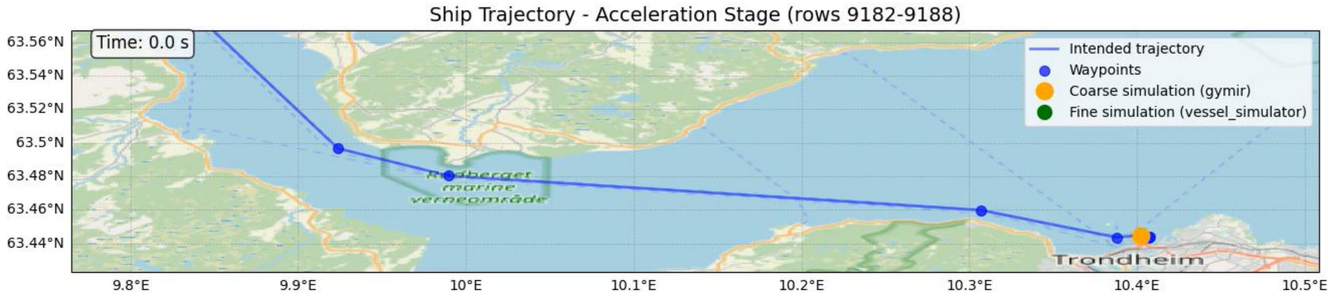

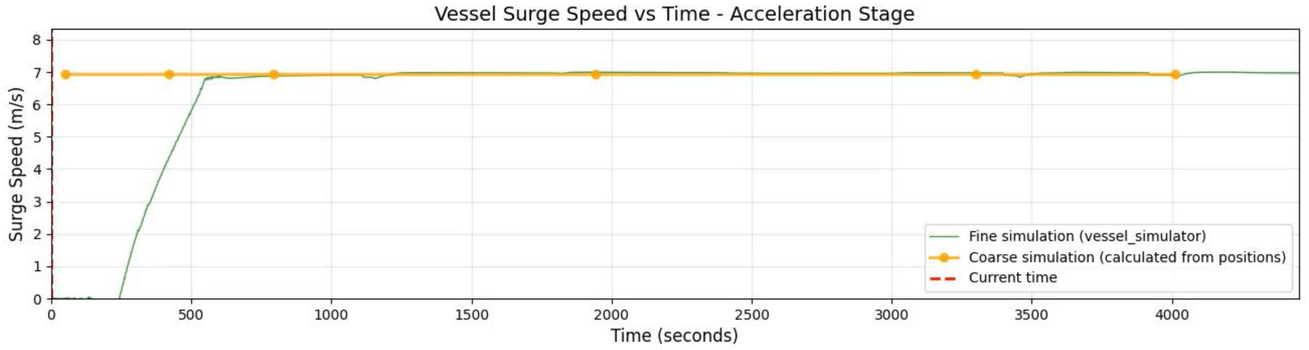

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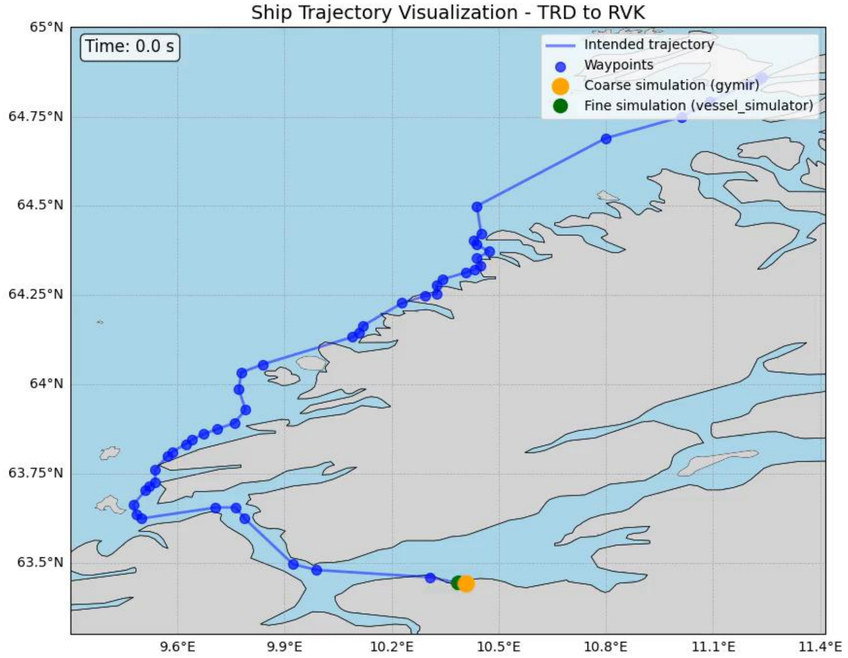

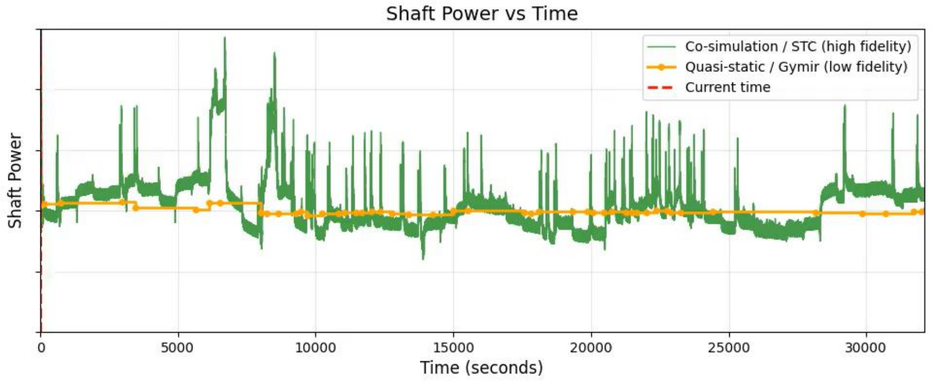

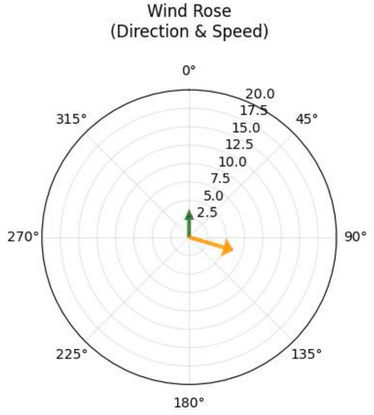

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Results and summary

Developing parallel simulation reveals something about the uncertainty in the simulations. What don't you know?

- **Parallel Simulations Provide Value**
  - Running both quasi-static and dynamic simulations highlights discrepancies and forces developers to identify bugs.
- **Control System Behavior is Critical**
  - Aggressive path-following in dynamic simulation causes significant steering losses, especially near waypoints.
- **Differences in Speed and Path**
  - Quasi-static: constant speed, perfect route following, optimal drift angle.
  - Dynamic: mimics captain behavior with continuously updated speed, leading to different paths and speeds.
- **Trondheim–Rørvik Scenario**
  - Overall agreement between Gymir and STC acceptable (Avg. power deviates 4.5%).
  - Dynamics and control have major impact.
  - Co-simulation (and system simulations in general) are complex and integration is time consuming —similar to commissioning, not "plug-and-play."

Large changes are challenging; multi-tool simulation of the same scenario provides valuable insights into both models.

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Results and summary

Lessons Learned

- Signal grouping should have been applied early on
- DNV-RP-0513 (Assurance of Simulation Models) should have been used more actively also after initial setup
- **Collaboration is Essential!** Sitting down in the same room is still the best way to work together on complex tasks

Way Forward

- Investigate if a low-gain controller improves similarity to quasi-static without losing path fidelity.
- Enhance calibration of dynamic simulation to better replicate captain behavior while maintaining route consistency.
- Apply best practices for model assurance and signal grouping in future setups.
- Continue multi-tool scenario simulation for cross-validation and deeper insight.