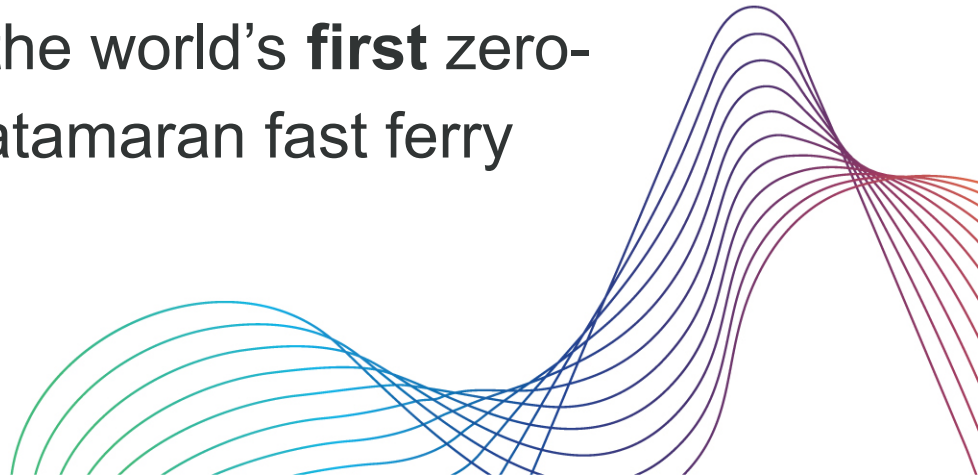
TrAM – Transport Advanced and Modular,

Design and construction of the world's **first** zero-emission & battery driven catamaran fast ferry

Prof. Dr.-Ing. Apostolos Papanikolaou
HSVA Hamburg



Challenges that requires new solutions.

- New competitive transport solutions in line with new climate goals.
- An ever increasing need for public transport.
- Need for new and cost-effective production methods.

KOLUMBUS

Aim: to set-up a zero-emission fast waterborne public transport system by 2024.

The world’s first zero-emission fast ferry

A fully electric zero-emission passenger fast ferry developed through advanced design methods and modular production.

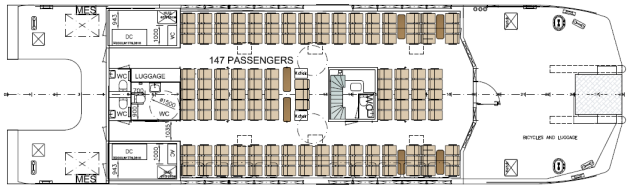
- Zero GHG and noise emissions
- 25% lower production costs
- 70 % lower engineering costs
- Superior hydrodynamic efficiency

Horizon 2020 project, 14 partners

- 16 MEUR total budget
- 4 years project period 2018-2022
- Kolumbus (Rogaland County council) coordinator

The Stavanger Demonstrator

- Minimum speed in operation: 23kn
- Tested maximum speed > 25kn
- Length OA 31.0m, Beam OA 9.0m
- Passengers: 147 (20 bikes)
- Fully electric operation
- Construction start: April 1st 2021 (Fjellstrand yard)
- Operation start: 2nd half 2022 (Kolumbus/Rogaland)



The TrAM Concept

Modular, lightweight construction

- Allowing easy adaptation to various routes
- Energy efficient hull
- Separate cockpit/bridge, passenger and propulsion/drive unit
- Adaptable to varying pax sizes, e.g. 100, 150, 200, 250, 300

Offer the same service speed as conventional, diesel-driven vessels

- Challenge: keep the same/similar high service speed

Hybrid adaptable zero emission drive unit

- Battery driven or combinations of battery and/or fuel cells?!

Land-side interface with Smart City integration

- Stavanger Smart Lighthouse City (Triangulum project)

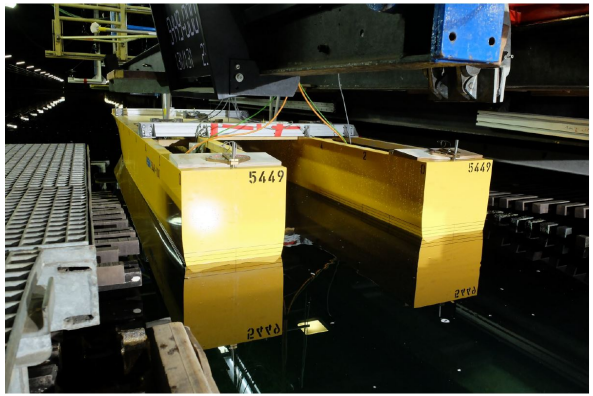
Built for multi-stop routes (Urban Water Metro)

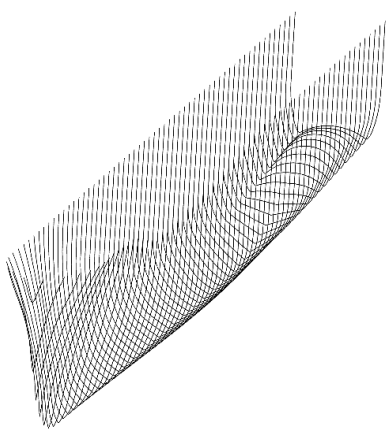
- Cold ironing charging; contactless inductive recharging technology ?!

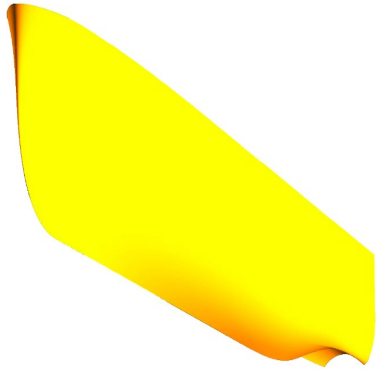
Efficiency and safety

Key design issues:

- Minimisation of weight
- Optimisation of hull form; minimisation of resistance and required propulsion power
- Maximisation of efficiency and safety of energy system
- Battery and e-motors technology and arrangements



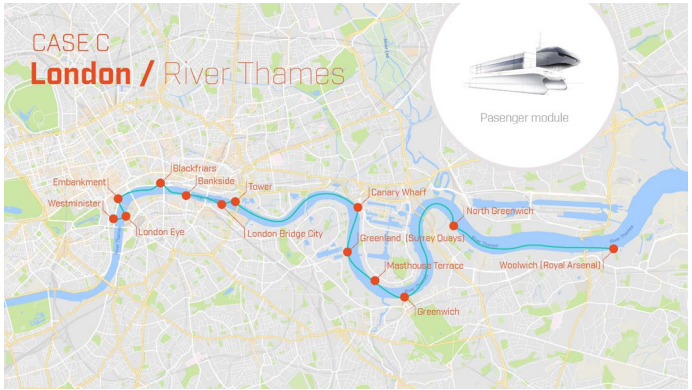




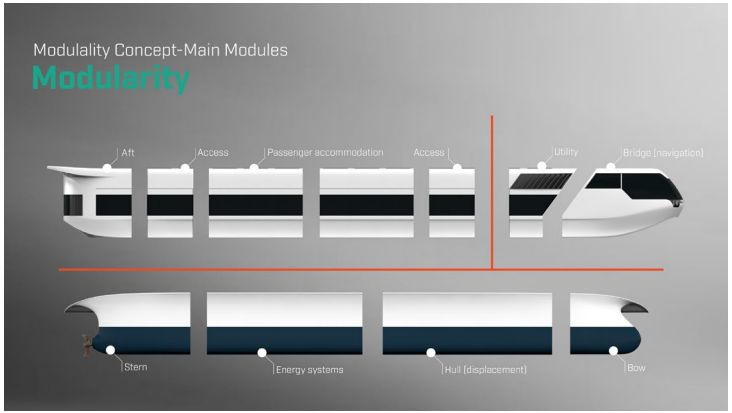
Two replicators

Investigating opportunities for similar zero-emission vessels on selected routes in Europe.

- River Thames – London (MBNA Thames Clippers)
- Belgian channels (de Vlaamse Waterweg)



New production methods (Fraunhofer IEM)



Three step procedure for module identification

1. Development of a logical generic ship architecture

- **CONSENS** modelling method is used to create a generic logical ship architecture

2. Adaption to Use Cases

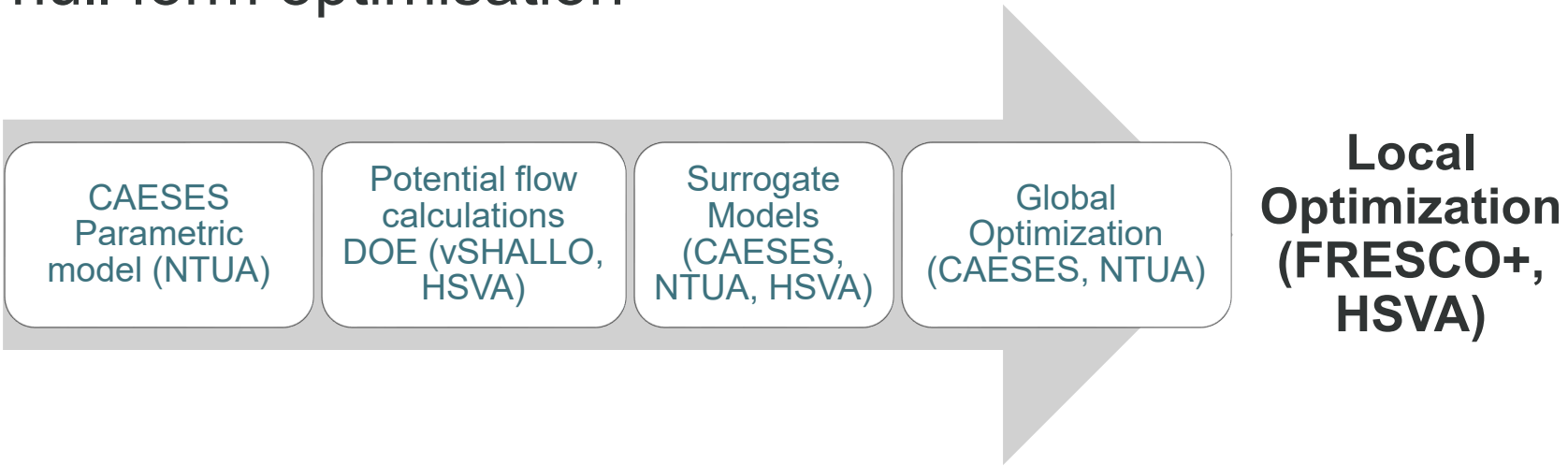
- **Solution decisions** are made by adapting the generic architecture to individual **Use Cases** (e.g. Stavanger, London)

3. Implementation of a Change-Impact Analysis

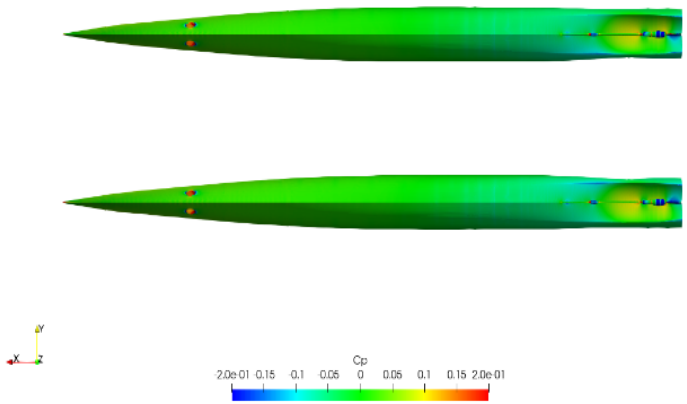
- System elements that have remained the **same** in each use case are identified
- These are potential candidates for future **modules**

Hydrodynamic Hull Form Optimisation

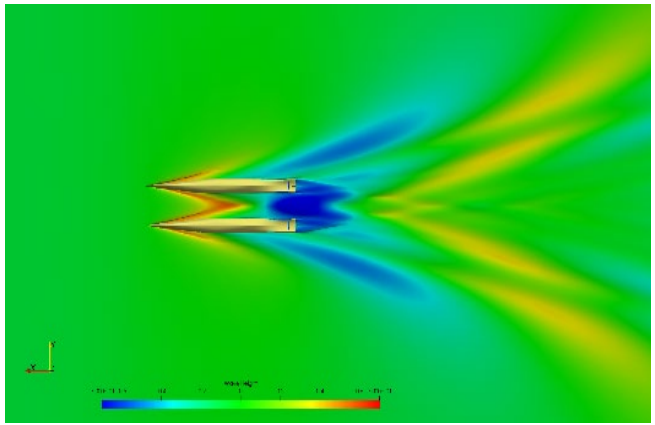
Parametric design and two-stage, **global and local** hull form optimisation



Typical Results of local Hull Form Optimisation by CFD

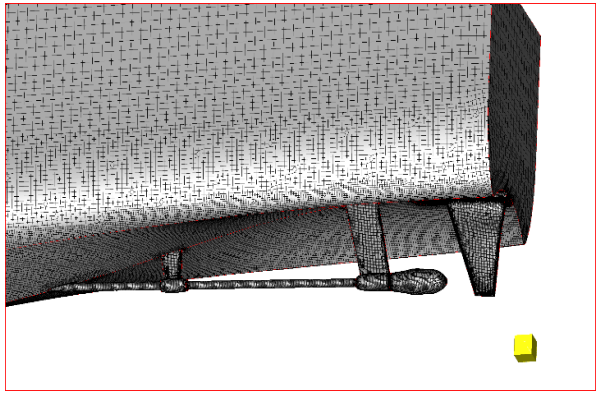


Pressure Field

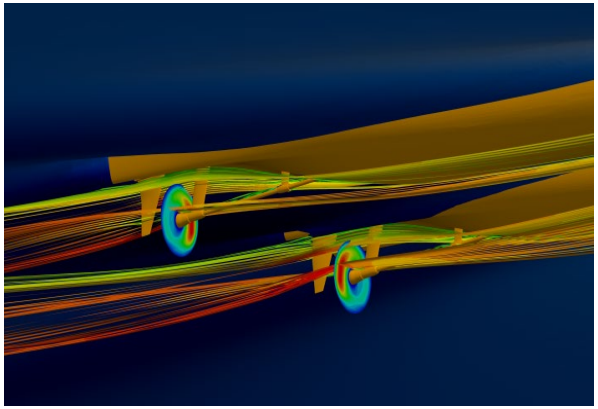


Wave pattern

Optimisation of the transom stern (FrESCO+ of HSVA) for highest propulsive efficiency

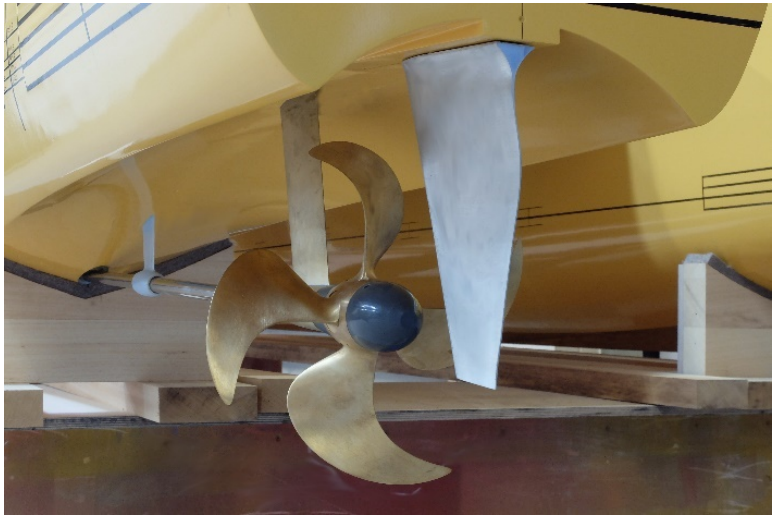


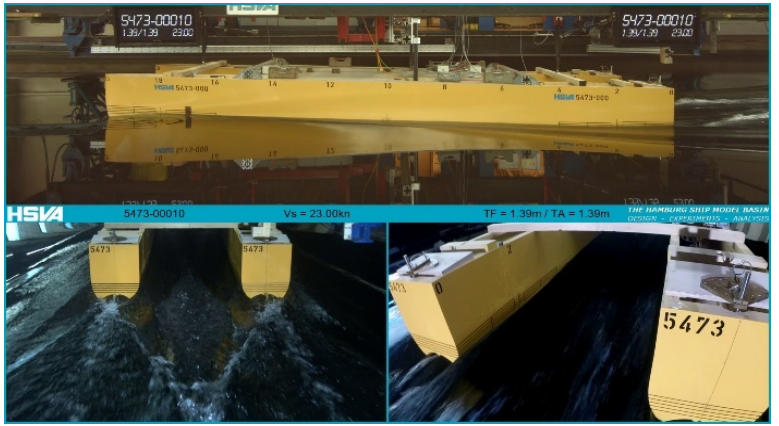
Numerical mesh with 5.3 Mil cells around the stern tunnel area for the local optimisation of the Stavanger Demonstrator.



Streamlines through propeller discs and propeller body force distribution at 23 knots

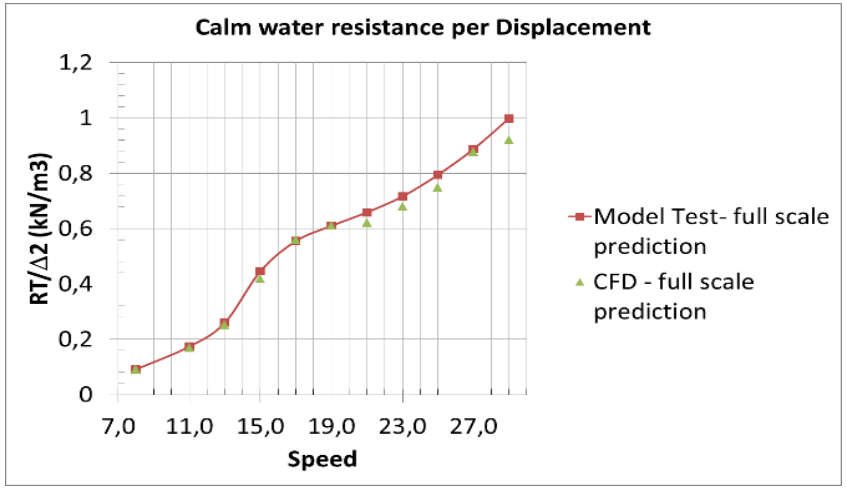
Verification of numerical predictions for the Stavanger demonstrator by model experiments (HSVA)

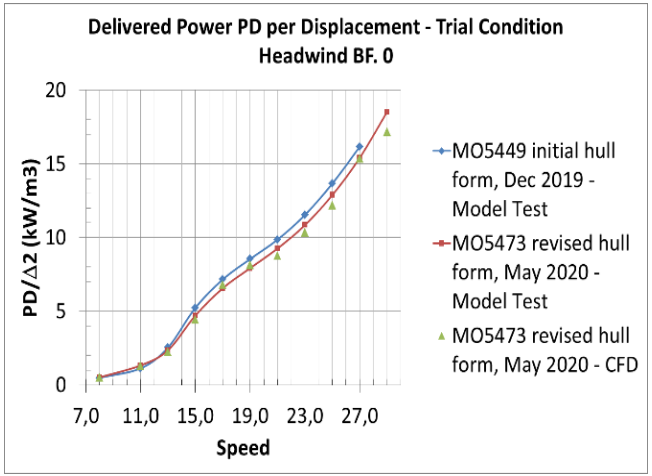




Model scale: 1:5.6
Length of demihulls: 5.34m

Comparison of numerical predictions by CFD with model experimental data (HSVA)





Summary and conclusions

- Feasibility of the TrAM zero emission and fast waterborne transportation concept has been established.
- Elaborate hydrodynamic optimisation of parametrically defined design led to high propulsive efficiencies of close to 80% at planned service speed of > 23 knots.
- Detailed design and engineering work on the Stavanger demonstrator under way, with expected delivery of the vessel in early 2022.
- Feasibility studies for two replicators servicing transportation needs in London (Thames River) and Antwerp (Belgian Channels) under way.

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