FLUID STRUCTURE INTERACTIONS RESEARCH GROUP

SHELL SHIPPING

UNIVERSITY OF Southampton

Investigation of Numerical Methods for Achieving Energy Efficient Ships

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Motivation

- The increasing cost of fuel is having a significant impact on the maritime industry. Mid and long term fuel prices are expected to increase including surcharges for carbon-dioxide emissions. This increases the need for a paradigm shift in design and powering so as to construct vessels which are more fuel efficient
- The use of flow control mechanisms in restoring the wake flow distribution of the propeller have been identified to improve performance. This requires detailed numerical and experimental tools in resolving such complex flow field with the adequate accuracy.
- The use of Reynolds Averaged Navier Stokes (RANS) simulations have been considered to be a powerful tool for such maritime flow problem.

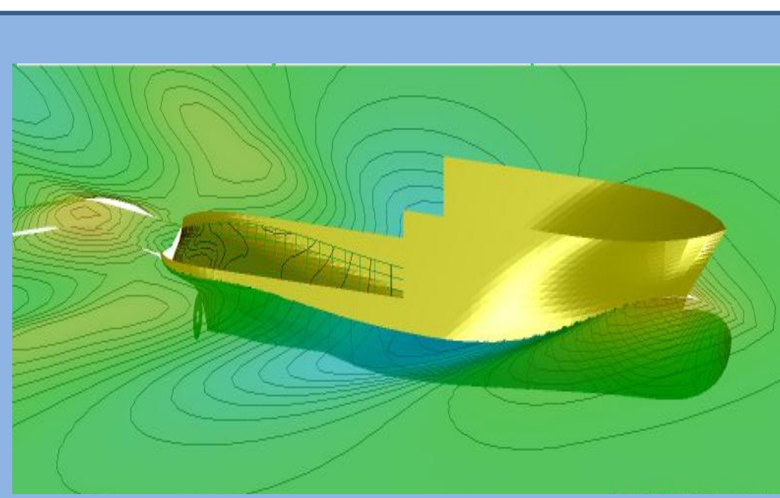


Figure 1: Hull line optimisation for a specific boat

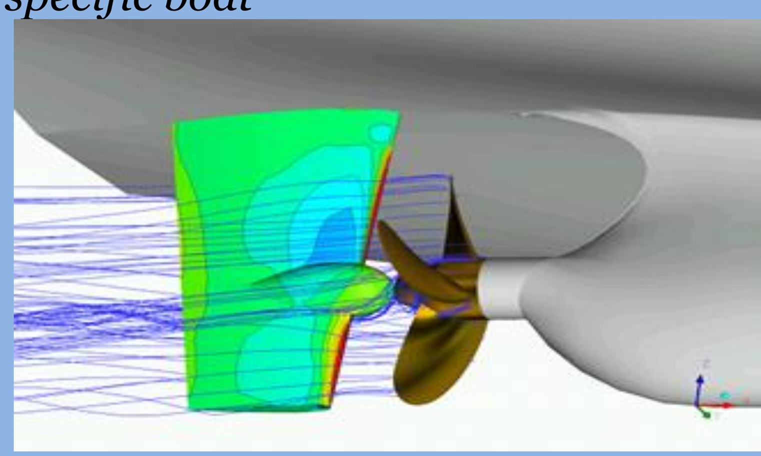


Figure 2: costa bulb investigation

Aims and Objectives

The aim of the research is to achieve a 15% reduction in fuel efficiency for a proposed LNG carrier.

The project will work towards the following objectives

1.Developing rigorous CFD approaches to ships stern flow
- -conduct validation test on 2D & 3D aerofoils section
- -propeller-rudder study
- -validation of twin skeg LNG carrier hull shapes

2.Investigation of energy saving strategies
- -methodical tests to establish the effect of varying key dimensions and ratios at the aft body on propeller wake field, propulsive efficiency and propeller vibrations
- -investigation of possible improvements to overall propulsive efficiency.

Initial study:
Open FOAM Investigation of flow around an airfoil

- The purpose of this study is to evaluate the Open Source CFD tool [Open Foam] for simulating incompressible flow over a 2D NACA0012 aerofoil operating at Reynolds number =3x10^6 over a range of incidence angles. OpenFOAM (Open Field Operation and Manipulation, www.openfoam.org) allows the user to gain full control over implementation of different features in research activities.
- The physical model is based on the mass [$\nabla \cdot U = 0$] and momentum [$(U \cdot \nabla)\, U + (\nabla P/\rho) = \nu\, \nabla 2U + g$] conservation equations and the spalart allmaras one equation model for the turbulent viscosity.

Boundary conditions

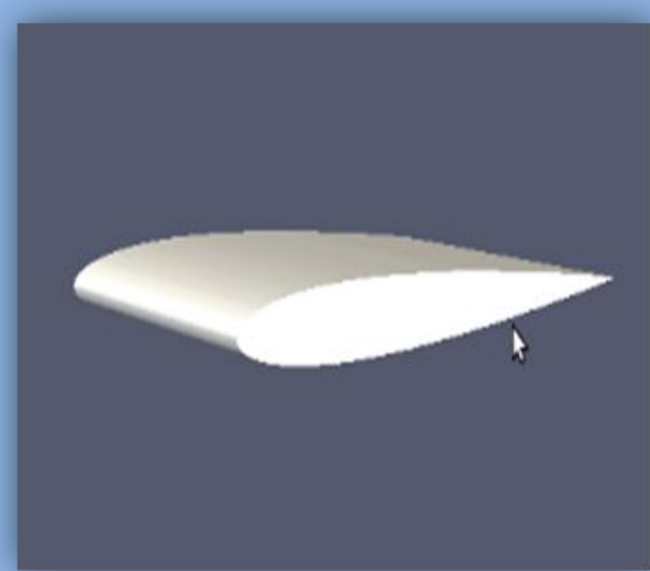
Designation	description	Type of boundary condition
1	Inlet	Freestream
2	Outlet	Freestream
3	Wall	No slip (Fixed wall)
4	Top	Freestream
5	Bottom	Freestream
6	Front	Empty
7	back	Empty

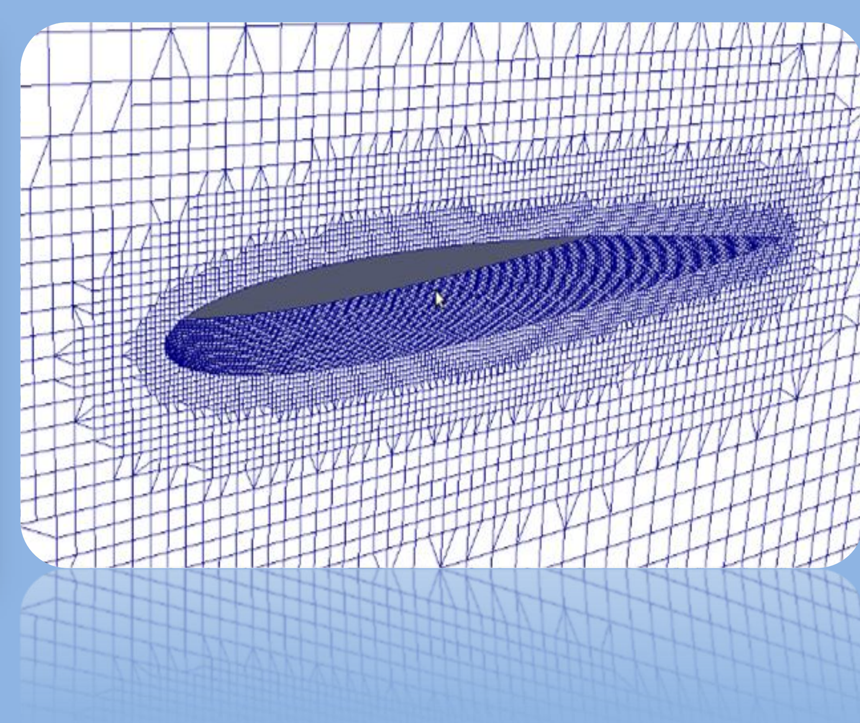
Preliminary Results

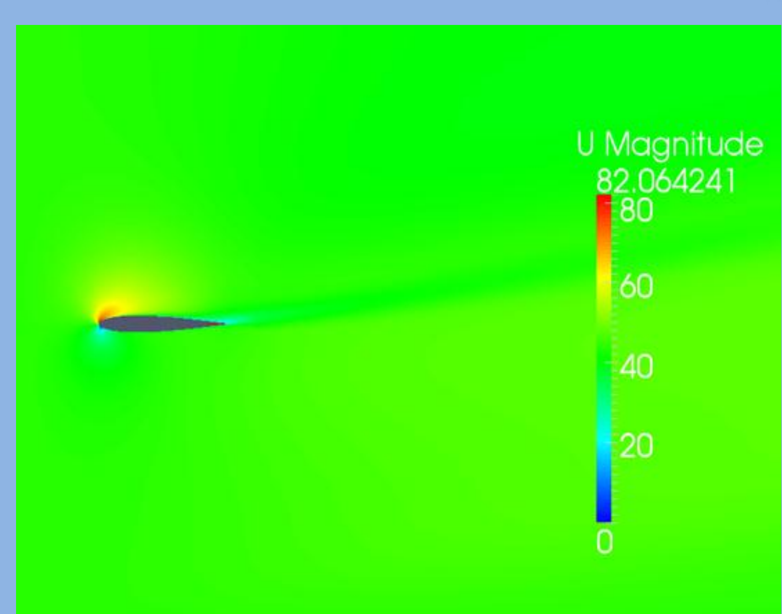
- Simulations on an initial coarse mesh (fig 2) generated using snappyHexMesh show good agreement with experimental data up to ten degrees incidence. The coarseness of the initial mesh lead to poorer prediction of stall.

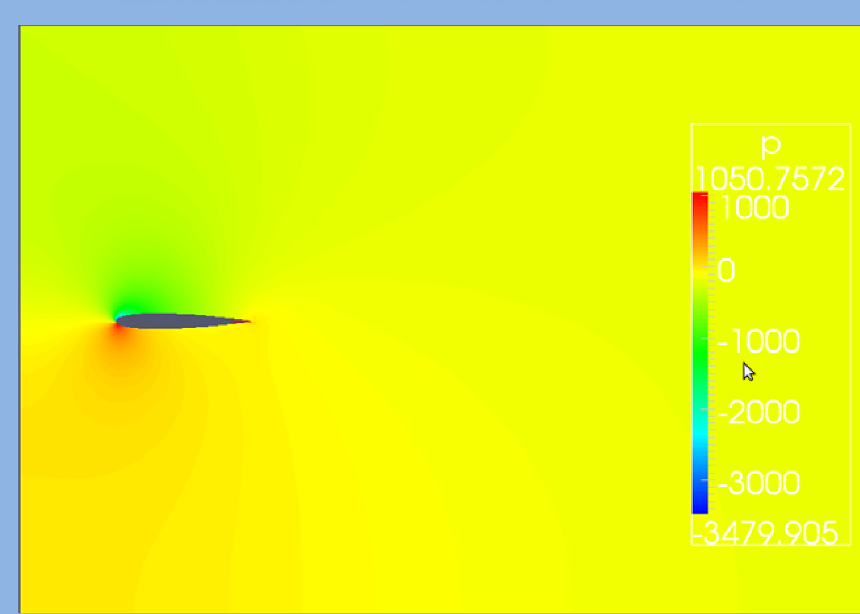
Future work

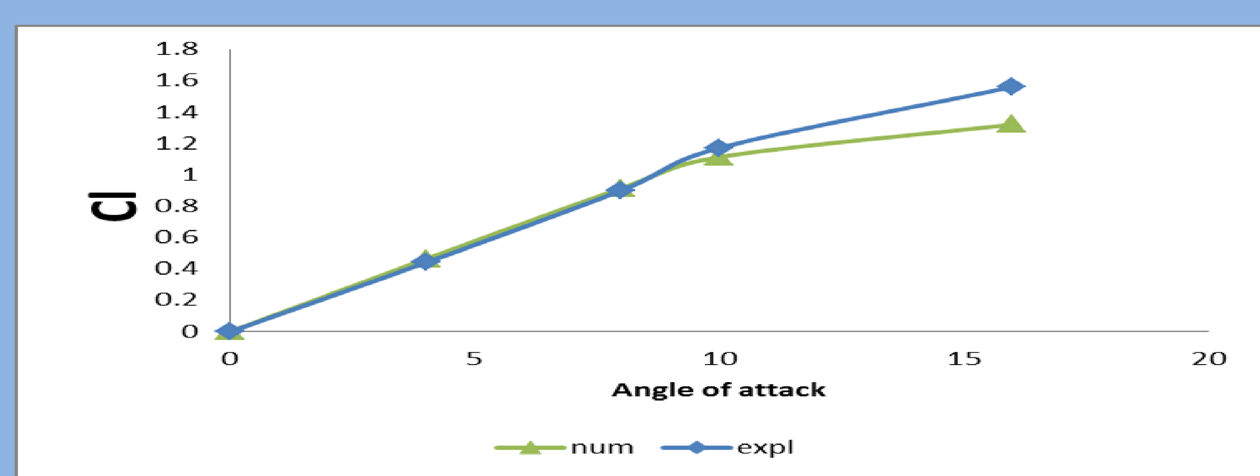
- Refining of the meshing in order to capture the wake field
- Boundary layer profile











From top :
Fig 1.naca0012 aerofoil geometry,
Fig 2.Zoom of the generated mesh using snappyHexMesh , Fig 3.velocity Fig 4 .Pressure contours, Fig 5.Lift plot vs. incidence

FSI Away Day 2012

References

- *Pictures (fig1:&2):Schiffbau-Versuchsanstalt Potsdam GmbH, Marquardter Chaussee 100, 14469 Potsdam* **www.sva-potsdam.de**
- *Turnock et al (2010) Energy efficiency of ship propulsive systems: rudder-propeller interaction. In, Ship Propulsion Systems Conference, London, UK 27 - 28 Jan 2010. London, UK, Institute of Marine Engineering Science & Technology, 30pp.*
- *Phillips et al (2010) Free surface CFD prediction of components of Ship Resistance for KCS. In, 13th Numerical Towing Tank Symposium, Duisburg, DE, 10 - 12 Oct 2010. 6pp.*
- *Herbert Schneekluth and Volker Bertram (1998) Ship design for efficiency and economy, Butterworth-Heinemann, ISBN 0750641339, 9780750641333.*