Faculty Engineering Technology
Program Mechanical Engineering

UNIVERSITY OF TWENTE.

COLLOQUIUM

Group: **Engineering Fluid Dynamics**

As part of his MSc thesis assignment

B. Feldbrugge

will give a presentation, entitled:

Development of an optimization process for pre-swirl stator designs for ships

Date: **Monday December 19, 2016**
Time: **14:00**
Room: **HT-1300**

Summary:
A pre-swirl stator is a tool to reduce a ship's propulsion power, resulting in more sustainable transport of goods at lower costs. Previous research has shown that a 7% reduction of the propulsive power is possible, saving up to $84.000 and 540 MT CO_2 a year for an average cargo ship. With a pre-swirl stator, the flow field towards the propeller can be changed in a favourable way. This allows the propeller to have a lower rotation rate with constant net-thrust of the propeller. Due to the lower rotation rate of the propeller, the rotational velocity components in the wake behind the ship are reduced; losses due to rotational kinetic energy left in the wake decrease.

In this research, an optimisation tool is developed to optimise the pre-swirl stator geometry in open water, i.e. homogeneous distributed axial inflow. This tool uses a Single Objective Genetic Algorithm (SOGA) and is tested for two different sets of design parameters. Also, different generation sizes and number of generations are tested. The effect of the pre-swirl stator on the propeller is simulated with Computational Fluid Dynamics (CFD) which calculates the velocity and pressure around the pre-swirl stator and propeller with a Boundary Element Method (BEM). With this method, calculation times are short, though at the cost of a less detailed flow field description.

The optimisation objective is to find the minimum required power to generate a given thrust. Optimal designs show a power reduction of 5.3-6.5\%, which is slightly lower than the results found in literature. A parameter study showed that the pitch angle of the pre-swirl stator is the main design parameter to vary in an optimisation. It has a larger influence on the power compared to the chord or the camber of the pre-swirl stator blades. Comparison of the flow field of a propeller with and without pre-swirl stator showed a difference in both tangential and axial forces, which is increased over a large part of the propeller blade. The pressure distribution was changed mainly at lower radial sections, where the lift coefficient increased for the propeller with stator.

A comparison of results from the BEM code is made with results from a more detailed Reynolds Averaged Navier-Stokes simulation. Differences were found in the prediction of the friction force and the power, which could be a topic of further research. Overall, with the optimisation tool developed in this research, a new step is taken to improve the design process and effect of a pre-swirl stator for ships.

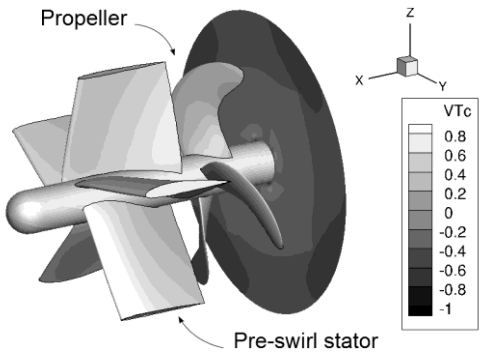

Figure 1: Pre-swirl stator in front of propeller with resulting tangential velocity field behind propeller.

Assessment committee: **Chairman,**

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