Faculty Engineering Technology
Program Mechanical Engineering

UNIVERSITY OF TWENTE.

COLLOQUIUM

Group: **Engineering Fluid Dynamics**

As part of his MSc thesis assignment

R.W.J. Kuin

will give a presentation, entitled:

Hydrodynamic Improvements of a Generic Submarine Using Viscous Flow Calculations

Date: Friday December 13, 2013

Time: 14:00

Room: **Horstgebouw N.109**

Summary:
The Defence Materiel Organisation (DMO) of the Royal Netherlands Navy (RNLN) and the Maritime Research Institute Netherlands (MARIN) have been cooperating on submarine hydrodynamics since a long time. In the last couple of years, the application of viscous-flow calculations has become more and more important from a design analysis point of view. Currently, DMO and MARIN are involved in an R&D project on the hydrodynamic design of future submarines.

Generally, underwater vehicles such as gliders or submarines have a hull or fuselage shape with low drag properties. However, additional appendages are generally required for control or storage of equipment. These appendages induce additional resistance and may be detrimental to the quality of the inflow to the aft control surfaces or propeller. This, in turn, can lead to loss of propulsion performance or increase of vibrations and radiated noise. The underlying hydrodynamic mechanism is the penetration by the appendage of the boundary layer developing on the hull, which causes the formation of a so-called horseshoe vortex in a region of separated flow near the stagnation area on the appendage.

Computational Fluid Dynamics (CFD) has matured to a state that it can be applied successfully to investigate and optimise the flow around ships and offshore structures. In this research, CFD is used to study the flow around a typical wing-body junction in order to obtain insight in how to suppress the horseshoe vortex that is wrapped around the appendage. A generic submarine hull shape has been selected and the impact of a range of modifications of the sail (sometimes called fin or fairwater) on the resistance, propulsion, manoeuvring and wake field are investigated. To quantify the non-uniformity of the wake field, a so-called Wake Object Function (WOF) is used. The WOF is defined such that decreasing its value reduces the chance of (erosive) cavitation and radiated noise.

This research presents the results of the CFD computations for a number of sail variants and discusses the changes in the flow in detail. Design guidelines regarding the most promising modifications have been developed. It is shown that a thicker and a tapered sail have a significant negative influence on the main hydrodynamic characteristics, however, quite significant improvements of the resistance as well as the wake quality can be obtained by properly designing the junction between the sail and the hull.

Assessment committee: **Chairman,**

Prof.dr.ir. H.W.M. Hoeijmakers (chairman)
Dr.ir. S.L. Toxopeus (MARIN/Mentor)
Ir. B. Nienhuis
Dr.ir. H.J.M. Geijselaers
Dr.ir. E.T.A. van der Weide

d.d. _____