Faculty Engineering Technology
Program Mechanical Engineering

University of Twente.

COLLOQUIUM

Group: **Engineering Fluid Dynamics**

As part of his MSc thesis assignment

Ruud Herman Maria Weersink

will give a presentation, entitled:

Multi-point Optimisation of Wind Turbine Blade Aerofoils

Date: Friday, October 14, 2011

Time: 12.00

Room: N 109

Summary:
The aerodynamic design of wind turbine blade aerofoils is not a trivial matter. The designer not only has the task to optimise the aerodynamic performance of wind turbine blade aerofoils, but also has to take into account additional design considerations, e.g. structural properties. The task of the designer of wind turbine blade aerofoils can be alleviated by using an optimisation method. The development of such a method is presented. A potential flow method coupled with an integral boundary-layer method, developed by Drela at MIT (XFOIL), is employed for the computation of the aerodynamic performance of the aerofoil. The gradients of the objective function, which includes the aerodynamic performance, needed in the optimisation procedure are computed with a complex-step finite difference method and are supplied to the gradient-based optimiser SNOPT.

Successful numerical optimisation of wind turbine blade aerofoils can only be achieved with a proper choice of the objective function combined with suitable constraints. This choice has also been an important part of the present research. The quality of the final design largely depends on the parametrisation of the geometry of the aerofoils. With NURBS curves it is possible to parametrise a wide variety of aerofoil geometries requiring a relatively small number of design variables. Furthermore, NURBS curves allow local modification of the geometry.

Wind turbine blade aerofoil optimisation at a single operating point often shows poor off-design performance. Therefore, the objective function and its constraints should be such that the optimisation method results in an aerofoil that performs well within a range of operating conditions, e.g. angles of attack. The developed optimisation method is used to obtain aerofoils with a maximal lift to drag ratio, subject to aerodynamic, geometrical and structural constraints. Conventional wind turbine blade aerofoils are taken as initial guess. The bounds enforced on the constraints are based on existing wind turbine blade aerofoils. Due to the nature of gradient-based optimisation, the results obtained are local optima in general. The performance of the optimised wind turbine blade aerofoils is analysed in detail.

Assessment committee: **Chairman:**

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