Faculty Engineering Technology
Program Mechanical Engineering

University of Twente.

COLLOQUIUM

Group: **Engineering Fluid Dynamics**

As part of his MSc thesis assignment

Emiel Koopmans

will give a presentation, entitled:

Experimental Study on Flow Separation Control using Synthetic Jet Actuators

Date: Friday June 7, 2013

Time: 14:00

Room: **N 109**

Summary:
The flaps of airplane wings can suffer from flow separation, which greatly decreases the wing's aerodynamic performance. The flow separates due to the boundary layer possessing insufficient momentum to engage the adverse pressure gradient along the airfoil surface. The goal of flow separation control is to actively influence the flow such that flow separation is delayed and airfoil performance is improved.
The current research is aimed to contribute to the knowledge in the field of flow separation control by applying flow separation control on a NACA0018 airfoil with a 0.165 m chord using tangentially directed synthetic jets. The actuator is located inside the airfoil and the jet exits from a slot. The synthetic jet inhales the low momentum fluid in the boundary layer during instroke and during the outstroke the fluid adds momentum to the boundary layer.
The actuator design is based on a design by the University of Florida. The actuator, with a piezo-electric diaphragm, is improved by decreasing the slot width from 0.5 mm to 0.25 mm in order to further increase the jet velocity. With this design jet velocities up to 65 m/s have been achieved at an optimum frequency of 900 Hz.
Ten actuators are placed inside the airfoil, covering with their slots about 66% of the airfoil's span. During wind tunnel experiments aerodynamics forces have been measured using a balance. The tests have been performed at a fixed free stream velocity of 25 m/s ($Re_c = 2.73\times10^5$) and for various actuation frequencies and jet velocities.
It is shown that for given actuation frequency a higher jet velocity results in a higher maximum lift coefficient and a corresponding higher stall angle. However for the performance of the synthetic jet actuation, actuation frequency proves to be of greater importance than jet velocity. The best actuation frequency, in combination with the maximum jet velocity possible with the current actuator, corresponds tos a dimensionless frequency F^+ of 5.9 (1300 Hz) and a momentum coefficient c_μ of 0.0014 (maximum jet velocity 32.9 m/s). Using these actuation parameters the lift coefficient is increased by 12% and the stall angle by 22%.

Assessment committee:
Prof.dr.ir. H.W.M. Hoeijmakers (mentor/chairman)
Prof.dr.ir. A. Hirschberg
Dr.ir. G.R.B.E. Römer
Dr.ir. E.T.A. van der Weide
Dr.ir. C.H. Venner

Chairman,

d.d. _______________