Faculty Engineering Technology Program
Mechanical Engineering

UNIVERSITY OF TWENTE.

COLLOQUIUM

Group: **Engineering Fluid Dynamics**

As part of his MSc thesis assignment

N.J.G. van Dijk

will give a presentation, entitled:

The Effect of the Atmospheric Boundary Layer on Truck Aerodynamics with Numerical Investigations

Date: **Friday August 26, 2016**
Time: **10.00**
Room: **Horst Building Room** OH-111

Summary:
Aerodynamic tests for both wind tunnel and computational fluid dynamics (CFD) simulations still show significant different drag coefficients compared to test track results. An important cause is the presence of the atmospheric boundary layer (ABL), which is one of the major differences between the flow conditions in real situations versus wind tunnel and CFD conditions. In the ABL which is usually a few hundred meters thick, the wind speed profile increases rapidly in velocity in the first few meters in height. As a result of the ABL the truck faces a varying air speed over height, as well as the yaw angle. The effect of the ABL is analysed with CFD simulations using the commercial tool STAR-CCM+ and a steady state RANS modelling approach.

The first part of this thesis consists of the simulation of the ABL within an empty domain in order to monitor the profile development through the domain in longitudinal direction. The development of the velocity profile proved to be very sensitive to the boundary conditions, the mesh settings, roughness parameters and the turbulence models and parameters.

In the second part a DAF XF truck model and a generic truck model are simulated with the ABL and compared to simulations with an air speed that does not vary over height. The latter one resembles the traditional CFD approach. Differences between both approaches are represented in terms of drag coefficients and calculated for wind angles varying between 0 to 180 degrees relative to the driving direction. The results show a noticeable difference in drag coefficients between the ABL and the traditional CFD approach. Considering pure head- and tailwind with an ABL reveals that for zero yaw a difference in drag of 4% can be found. This relates directly to the expected spread in measurement data due to the ABL for on-road testing methods. Flow field analyses show that the ABL mainly affects the stagnation area and the amount of air passing the underhood. However, with increasing yaw angle the difference in drag coefficients between the ABL and the traditional CFD approach decreases significantly while differences in the flow field are still clearly visible.

Another aspect that is investigated is the effect of the ABL on trailer side skirts. Trailer side skirts are known to improve the aerodynamic performance for large yaw angles. In case of the ABL the trailer side skirts are 2% less effective for a 6° yaw angle compared to the traditional CFD approach. Where the traditional CFD approach results in an improvement of 17% for the maximum yaw angle.

The variation in velocity and yaw angle over height have significant influence on the drag coefficients and also on the flow phenomena on both the lower and upper parts of the truck geometries. Modelling of the ABL provides valuable insight in the aerodynamic design criteria for the affected regions.

Assessment committee:

Prof.dr.ir. C.H. Venner	(chairman, mentor UT)
Dr.ir. D.W.E. Rentema	(mentor DAF Trucks NV)
Ir. E. Norde	(internal member)
Dr.ir. R. Loendersloot	(external member)

Chairman,

N P Kruyt [i.o.]

d.d. 29/06/16