IMPLEMENTATION OF TRANSITION PREDICTION IN THE VKI "THOR" NAVIER-STOKES SOLVER FOR LOW REYNOLDS NUMBER AIRFOILS OF UAV AND MAV

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The need for high performance low Reynolds airfoils comes from the arising of UAV (Unmanned Airborne Vehicle) and MAV (Micro Airborne Vehicle), mainly for military purposes. Conducted in collaboration between VKI and the Royal Military Academy, this project aims at evaluating and improving computational tools for the computation of such airfoils. These are characterized by the influence of transition point and by the low speed for which they are designed.

A transition prediction module for a 2D unstructured grid RANS solver has been developed. In this module, transition is predicted directly based on the laminar boundary layer computed by the RANS solver. In contrast to the more usual approach of computing transition with a separate boundary layer code which gets as input the pressure distribution from the RANS solver, our approach is more general and (at least for the e^N method) does not assume any particular similarity profile for the boundary layer. Several transition prediction methods were implemented, from empirical to linear stability method (e^N method). The prediction of the transition point coupled with the use of Spalart-Allmaras turbulence model with a transition trip point allows to get more accurate results for the computation of low Reynolds number airfoils. Interesting results have been obtained using either empirical methods or e^N method for the flat plate. Computations were also performed on a NACA0012 airfoil and on an Eppler 61 low Reynolds number airfoil. Interesting results, although less satisfying than for the flat plate, have been obtained but robustness problems were noticed and still have to be solved.

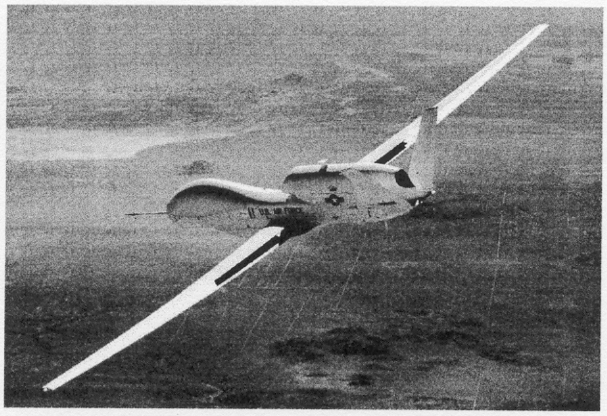

Figure1: Example of UAV

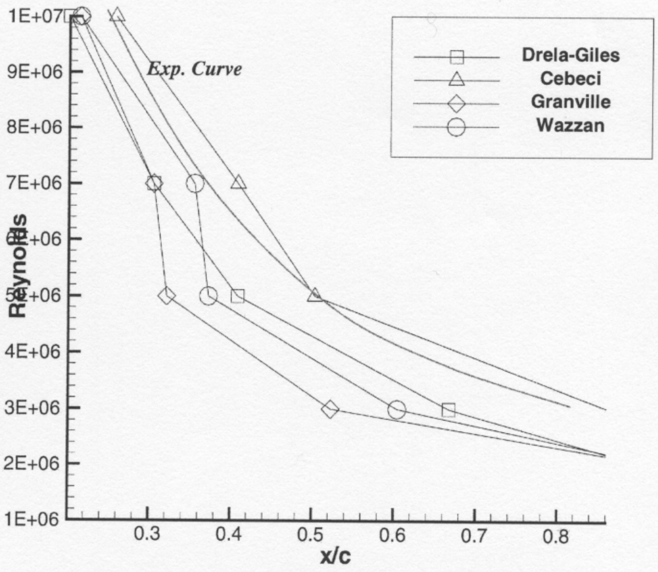

Figure2: $(x/c)_{trans}$ for a flat plate at different Reynolds number and for various prediction methods