Delft University of Technology

Aerospace Structures & Computational Mechanics
**Ph.D. Seminar Series**

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# Warping wing as an application of Morphing structures

Without doubt wings are the primary, core lifting surface of any aircraft, however wings are not just used to achieve lift, the shape of the wing can be controlled and changed in a process called wing warping or morphing to affect an aircraft's trim. The Wright Flyer, built over one hundred years ago, provides an early example of wing morphing. In the Wright Flyer the wing shape was controlled with pulleys and cables to control the aircraft rolling motion. Since this time wing morphing has moved on and today wing morphing systems are normally broken down into three types, planform modification, out of plane change and airfoil adjustment. One, in wing morphing of planform modification, wing parameters' span, chord and sweep' are changed to improved performance. In two, wing morphing results from changing the twist of the wing to controlled rolling motion. In three, wing morphing airfoil adjustments due to changes in wing camber are used to improved aircraft performance. The focus of research reported here was type two wing morphing: out of plane, twist, caused by a warped wing cross section with a slit at the trailing edge. A modeling study of the wing parameters for various wing morphologies, numerical and experimental, was made of a warping wing to determine the effects of wing parameters on tip rotations. It was found that a taper ratio of less than 0.8 improved the twist, tip rotation, of the wing model. Modeling the warping wing numerically using Patran or Matlab and testing the model using Nastran, the warping mechanism is achieved using multi-point-constraint, MPC, at the trailing edge of the wing and by the leading edge. Experimentally, the warping motion is controlled by a thread rod running along the span near the trailing edge thru a set of aluminium blocks attached to the upper and the lower skin. The thread rod is kept in place with the help of counterlocked nuts. A linear relationship between the relative displacement, of the upper and lower wing skin, at the trailing edge with tip rotation 'twist' for a straight warped wing was found. It was also found that wing parameters such as the taper ratio had more effects on the wing twist than the sweep angle of the wing.

time: **Thursday, March 6th, 2014, 16:00**
location: **meeting room 7**
organization: **Dr. Martin Ruess ‹m.ruess@tudelft.nl›**