Integrated FEA/RANS simulation of high-speed hingeless tiltrotors

written at the Department of Aerospace Engineering at the University of Maryland

Background / Motivation
The speed of current tiltrotors / tilting prop-rotors are limited by compressibility drag of their thick wings (24% t/c compared to 14% t/c of fixed-wing turboprop aircraft). The thick wings are required to prevent whirl flutter of the large rotors, which because they are gimbaled are very heavy. Gimbaled rotors were desired earlier because they transmit no hub moments. Today with advanced hingeless rotor technology this is no longer the case. The hub moments can be absorbed, and can perhaps be in fact utilized to remedy whirl flutter. The mechanism of whirl flutter involves kinematic and dynamic couplings at the rotor hub, with a hingeless hub these couplings can be influenced by introducing tip sweep. However none of these are clear at present. There is a significant need for verifying these conjectures with Mach-scale wind tunnel testing complemented by high-fidelity aeromechanics analysis (RANS/FEA) that can actually capture the principal nature of the flow field and structural couplings. This is an unknown and uncharted territory but of significant importance to Future Vertical Lift. This is an on-going multi-year effort at the U Maryland involving blade fabrication to simulation to wind-tunnel testing. The purpose of Johannes's research will be to simulate and understand as much of the swept tip phenomena as possible within the time he has.

Work Packages
- Mesh two tilt rotor blades: baseline (-45 deg twist) and swept tip (-45 deg twist +20 deg sweep back). The blade is fabricated in-house so definitions are all available.
- Simulate the flow field in propeller / cruise mode. Use in-house RANS tools.
- Extract sectional airloads: lift, drag, pitching moments.
- Couple with structural dynamics. Use in-house dynamics code.
- Understand a tilt rotor aircraft. Understand what is whirl flutter and air-resonance instabilities in high speed (he will take my ENAE 633 graduate class in Fall semester).

Starting Date: XX.YY.2018
End Date: XX.YY.2012

Student: ____________________________

Examiner: Prof. Dr.-Ing. Ewald Krämer
External Examiner: Anubhav Datta, Associate Professor