Semester Thesis
Working Student Job
Master Thesis

Aerodynamic Flow Analysis on Electric Propulsion Systems

Background & Content

The electrification of aviation is a potential game-changer for our societies. With the continued growth of populations and mega-cities around the globe, we have an opportunity to connect people sustainably. At Rolls-Royce, we're developing, testing, and innovating the technologies and systems to create the electric propulsion and energy systems of tomorrow. Within the research project ETHAN the thermal and structural integration aspects for the development of electric propulsion systems are being investigated at Rolls-Royce and the Technical University of Munich. There is a demand for a better understanding of a non-conventional integration of propellers onto innovative aircraft vehicles especially regarding the surrounding flow-fields. For example, the impact onto the cooling system for electric propulsion systems is investigated. This is done by means of Computational Fluid Dynamics (CFD) as well as wind tunnel experiments.

Figure 1: Conceptual Future Aircraft; https://www.rolls-royce.com/products-and-services/electrical.aspx#urban-air-mobility

Description of the Work

Within this work, a parametric aircraft configuration (or partially a wing-boom configuration) shall be investigated by means of CFD using Star-CCM+. The propeller(s) shall be modelled using source terms to get a larger flexibility for the analysis due to lower computational effort. Additionally, at least some reference points shall be investigated by resolving the rotor blades in a transient approach to confirm the models. Existing wind-tunnel data TUM campaigns (see figure 2 left) shall be used to verify and validate the numerical approach. A broad parameter study including different operation conditions shall be performed to explore the flow characteristics and design space especially for electric aircraft cooling systems.

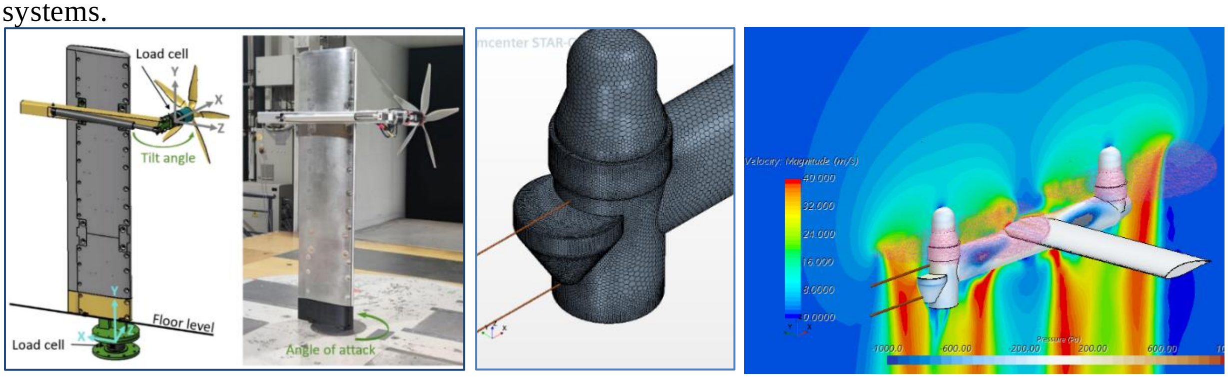

Figure 2: Wind tunnel model (left) for verification of the numerical approach [1]; Impression of a CAD model with a surface grid (middle) and an exemplary vertical section view onto the velocity field of a former study (right).

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Gefördert durch:
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aufgrund eines Beschlusses des Deutschen Bundestages

Work Packages

WP1:

- Literature research and summary of state-of-the-art numerical and experimental analyses on cooling flows for electric aircraft propulsion systems.

WP2:

- Familiarisation with Star-CCM+.
- Run simulations using the TUM wind tunnel model geometry as a reference configuration using source term approaches and at least some fully resolved cases.
- Verify and validate the used modelling approaches.

WP3:

- Extend / Rebuild the CAD model for the cooling flow analysis including the whole surface preparation and meshing pipeline for a parameter study within Star-CCM+.
- Run parameter studies using the Design Manager Suite or Java Macros.
- Analyse and compare typical eVTOL cooling system integrations on different configuration variants using the parametric model and derive general recommendations for the cooling system design.

WP4:

- Summarize the calculated data basis by visualisation of the obtained results.
- Write a code documentation and store the simulation setups in a meaningful way.
- Write a conclusion and outlook.

Required Skills

Theoretical background

- Aerodynamics
- Computational Fluid Dynamics
- Propeller/Rotor flows and aerodynamic interactions
- Heat transfer and cooling systems
- eVTOL aircraft design

Extensive practical experience

- CFD using Star-CCM+ or very good experience in ANSYS Fluent
- 3D-CAD design within NX or the Star-CCM+ CAD modeller

Nice to have skills

- Matlab, java, python
- Tecplot

Literature

[1] Moreira C., Herzog N. and Breitsamter C. - Wind Tunnel Investigation of an eVTOL Tiltrotor Test Bench, Aerospace Europe Conference 2023 Joint 10th EUCASS – 9th CEAS Conference 09.07 – 13.07.2023, Lausanne

If you are interested, please email your application including a CV and if you want to do a Semester Thesis, Working Student or Master Thesis to one of the email contacts below.

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