Data-Driven Nonlinear Reduced-Order Modeling for Unsteady Aerodynamics and Aeroelastic Active Spanwise Lift Control: A State-Space Approach

The aviation industry is constantly pursuing more fuel-efficient airplanes to reduce operating costs. Today, lower fuel consumption is also required to reduce pollutant emissions, due to increasing concerns about the impacts of aviation on the environment. To address these concerns, organizations like NASA and the Advisory Council for Aviation Research and Innovation in Europe (ACARE) have proposed aggressive fuel-burn reduction goals for the coming decades.

The new goals set by NASA and ACARE represent a departure from the current trends. *If these reduction goals are to be met, some radical changes in aircraft design are required*; in other words, by using the current approaches for aircraft design, one should not expect to obtain a substantial performance upgrade required to fill the gaps between the current trends and desired goals.

These stringent goals motivated the development of new configurations during the last decade, which might be able to break the paradigm of the tube and wing configuration first introduced with the Boeing 707 almost 60 years ago. Two of the most promising designs are the Boeing Subsonic Ultra Green Aircraft Research (SUGAR) with hybrid-electric engines and the MIT D8.5 transport configuration with a double-bubble fuselage cross-section. The two designs rely on very distinct, disruptive technologies, but have one point in common. *To maximize aerodynamic efficiency, they exhibit a very large wing aspect ratio (AR)*. Whereas most current passenger jets have aspect ratios between 8 and 10, the Boeing SUGAR features an *AR* around 19 and the MIT D8.5 design has an *AR* around 25. *This is only possible because both configurations rely on active load alleviation systems to reduce the design loads, which ultimately size the wing structure*. Otherwise, the structural weight of the wing would become prohibitive.

In this talk we will discuss the relevance of the topic *active control of spanwise aerodynamic loads* for current as well as future aircraft generation. A reduction in structural loads can lead to substantial weight savings, which improves fuel efficiency. It is somewhat expected that all future aircraft will employ some degree of advanced propulsion and materials. Other than that, the one technology that will be added to all future aircraft configurations is *active load alleviation* because of its potential to provide structural weight savings and relatively high maturity level.