BACKGROUND AND RECENT RESULTS OF THE EUROPEAN PROJECT 'SMART HIGH LIFT DEVICES FOR NEXT GENERATION WINGS' (SADE)

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Abstract

Recent aerodynamic concepts for significant reduction of drag call for laminarization which requires slim high-aspect-ratio wings and increased surface quality. As consequence of these demands state-of-the-art high lift systems prove not to be feasible any more. Thus, the European project "Smart High Lift Devices for Next Generation Wings" (SADE), which started in May 2008 and has a duration of 4 years, brings together an interdisciplinary research team comprising reputable research institutes and universities, OEMs and SMEs to develop suitable morphing high lift devices: The seamless 'smart leading edge device' is an indispensable enabler for laminar wings and offers a great benefit for reduction of acoustic emissions, the 'smart single slotted flap' with active camber capability permits a further increased lift. Thanks to their ability to adapt the wing's shape, both devices also offer aerodynamic benefits for cruise flight. The technological realization and optimization of these concepts towards the special requirements of full scale systems is the main objective within SADE. This requires a detailed study of the aeroelastic condition the structural system has been optimized for. Hence, a realistic full scale section of a morphing wing will be manufactured and tested in the TsAGI T101 wind tunnel for an investigation of these effects. An overview of the project's objectives, its structure and first results will be given within this paper.

Keywords morphing; high lift; laminarization; smart structures; leading edge; trailing edge.

1. Introduction

Commercial airplanes need to adapt their wings in flight to meet the different requirements such as safe high lift performance during take-off and efficient cruise flight. State-of-the-art high lift systems consist of movable control surfaces which increase high lift performance in their extended position. Typical devices are slats and fowler flaps which are supported and driven by intricate mechanical systems. This concept offers the required aerodynamic performance and relies on proven technology. But the discrete structural attachment infringes upon principles of light weight design and the necessary drives and gears lead to complex systems. Fig. 1 shows the state-of-the-art high lift system of the Airbus A320.

To meet the ambitious goals defined in the VISION 2020 (ACARE, 2002, 2004), technologies to consequently reduce drag will be necessary. Thus, it is probable that the next generation of wings will employ high aspect-ratios with slim profiles like already investigated e.g. within the FP6 Project TELFONA under the acronym HARLS (High Aspect-Ratio Low Sweep) (Horstmann, 2006). This trend goes in line with a reduction of construction space and will therefore require more intricate mechanical systems with conventional high lift concepts. Obviously the current state-of-the-art in high lift systems will lead to increased complexity and reduced efficiency if applied to future wings.

Further, most experts agree that laminarization is the only technology which has the potential for step changes in drag reduction within a suitable timeframe. But conventional high lift devices do not provide the required high quality continuous surfaces that laminar flow relies on. Alternatively, seamless high lift devices are a mandatory enabler for future wings of significantly increased aerodynamic efficiency (Horstmann, 2006).

The optimum aerodynamic wing shape varies not only between high lift and cruise flight but also during the cruise flight phase with the aircraft changing altitude, velocity and mass. High lift devices of versatile usability can be used to adapt the wing shape in the varying boundary conditions (Renken, 1995).