Deutsches Zentrum
für Luft- und Raumfahrt

Handout

On Realizing High Lift Structures for Low Noise – Low Drag Aircraft Wings

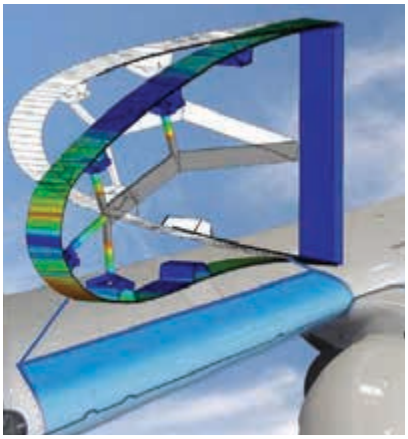
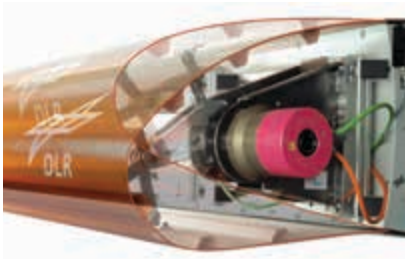


Illustration of a smart droop nose concept



Large scale demonstrator (side view), a superposition of high lift and cruise shapes

Morphing Driven Structural Design: Pioneering technology for less emissions and low noise

With the increase of the air traffic (expected 5 – 6% per year) the need for technologies to consequently reduce drag and airframe noise is rapidly becoming an issue of great economic- and social salience. Such innovative systems have to correspond to future aircraft requirements like lightweight design and increased wing surface quality. Today's conventional high lift configurations apply devices with open slots on leading and trailing edges to achieve additional lift for start and landing operations. However, such slots have been identified as dominant sources of airframe noise. Moreover, even a sealed slat gap is linked with a step on the wing surface, resulting in drag increase during the cruise flight. Morphing structures offer a way to eliminate these gaps and steps and enable a fully laminar wing design.

Maximum Flexibility and Maximum Stiffness: A challenge of contradictory design requirements

What is the best way to combine desired flexibility and necessary stiffness in one structure? The presented DLR concept is composed of an especially tailored glass fibre reinforced skin for maximum flexibility in the desired deformation mode and on the other hand for maximum stiffness to carry the aerodynamic loads in cruise flight and landing. EADS-IW developed a customized kinematic mechanism for the wing, which is attuned to the skin's deformation mode for the actuation of the system. The aerodynamic loads and actuation forces are transferred by longitudinal stiffeners in span direction which feature the well-proven design of omega shaped stiffeners.

Structural and Aerodynamic Proof of Concept: Verification of simulated results with full scale experiments

In order to test and to demonstrate the functionality of the developed system a full-scale segment of an A320-like wing was manufactured and successfully tested under wing bending in a ground test at CASSIDIAN Air Systems. The tests were especially focused on the measurements of the deformation behaviour and the strain in the flexible skin structure. Both, the deformations and strains, are found to be in good agreement with the simulation results. Moreover, the functionality and performance of the developed concept as well as the tools for the structural design could be demonstrated successfully.

2012 a full-scale demonstrator of 5m span has been tested under realistic aerodynamic loads in the wind tunnel test facilities of TsAGI, the T-101, one of the biggest wind tunnels in the world.

On the Way to a Real Wing Structure

Based on experimental data, further optimization of the so-called 'Smart Droop Nose' is underway. The scope includes a consideration of industrial requirements like lightning or bird strike protection and anti-icing.

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