German Aerospace Center

Air travel of the future – aircraft with no leading-edge slats will be quieter and more environment-friendly

07 September 2012

Every year, there is a six percent increase in the volume of air traffic. To make air travel more environment-friendly and quieter, researchers at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR), together with partners Airbus, EADS Innovation Works and Cassidian Air Systems, have been carrying out research to reduce the aerodynamic drag of aircraft and have developed an alternative to the traditional leading-edge slat. A morphing leading edge is expected to replace slats to create an innovative high-lift system. This construction significantly reduces drag and noise during landing. Tests were carried out between 27 August and 7 September in one of Europe's largest wind tunnels at the Russian Central Aerohydrodynamics Institute's (TsAGI) Zhukovsky research facility south of Moscow.

In the wind tunnel, the system's operation and performance were tested under realistic conditions. "The measurements on the droop nose here at TsAGI are just one example of the exceptional collaboration between DLR and TsAGI. We are looking forward to future cooperation," said Sergey L. Chernyshev, Executive Director of TsAGI. Normally, the flaps on the trailing edges of the wings and the slats located on the leading edges are extended during take-off and landing to provide the necessary lift at low speeds. There is a gap between the wings and the slats, through which air can flow from the underside of the wing to the top – generating noise. With the development of the smart droop nose, a morphing wing leading edge, the researchers have solved this problem. "The smart droop nose morphs itself during take-off and landing in such a way that no separate slats are necessary. The leading edge can be lowered by up to 20 degrees with virtually no loss of lift," explains DLR project leader Markus Kintscher from the DLR Institute of Composite Structures and Adaptive Systems in Braunschweig.

Uniting conflicting requirements

The researchers also want to minimise drag to reduce fuel consumption. To do this, the wing surfaces have been made as flat as possible to achieve laminar airflow. This reduces the air resistance by up to 12 percent. "The particular challenge in this project was to unite conflicting requirements," explains DLR Department Head Hans-Peter Monner. "On the one hand, the structure needs to be very elastic, to enable it to morph to the required shapes, but on the other it has to be very rigid. Ultimately, the leading edge must bear around one third of the weight of the aircraft during landing." A suitable material was required to ensure that the leading edge of the wing is not too heavy. During their experiments, the researchers concentrated on the glass- and carbon-fibre reinforced composites that are typically used in the aviation industry. A glass-fibre reinforced material turned out to be the most suitable for meeting the requirements.

In the concept of the droop nose, the skin on the front edge of the wing is just curved, not stretched. This stresses the material as little as possible. The scientists position individual layers one on top of the other, in such a way that the skin creates a structure that has a customised rigidity distribution. The leading edge morphs into the desired shape via integrated actuators and support elements along the wingspan, thus achieving very high stability. Soon, the new wing leading edge will be further developed to meet industrial requirements such as lightning protection, de-icing and the ability to withstand bird strikes.

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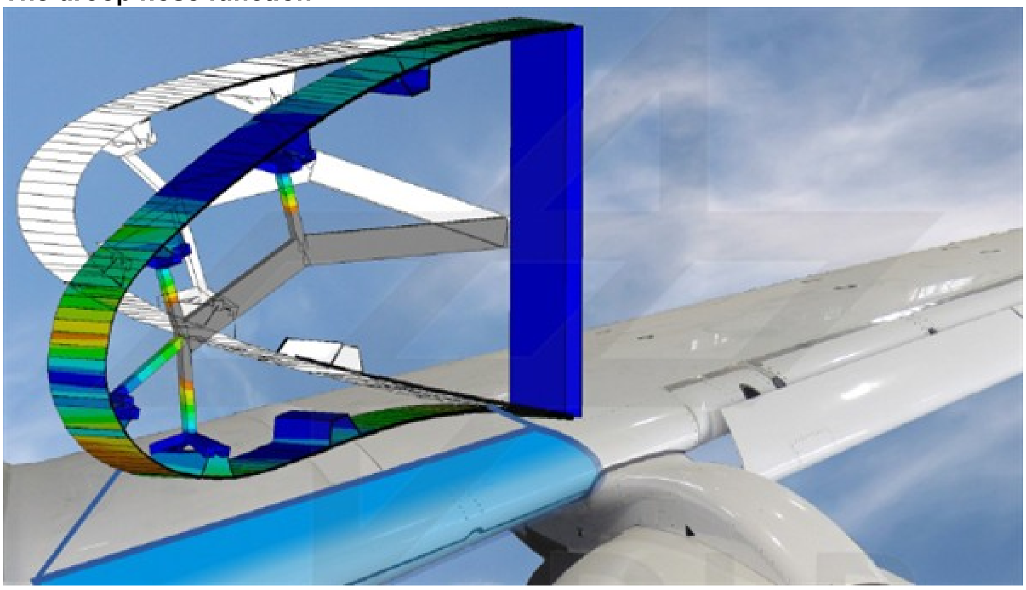
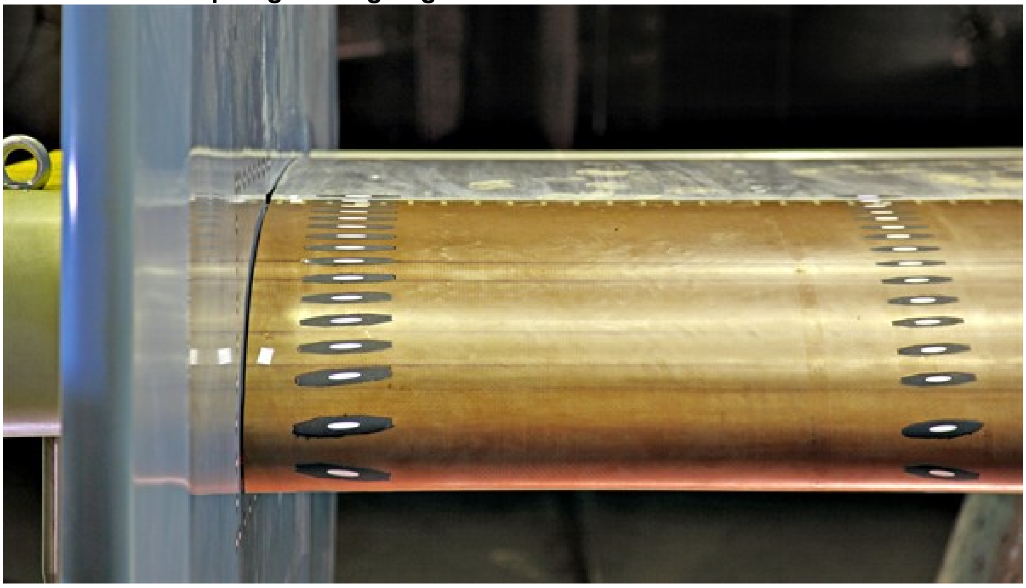
The droop nose function



Normally, the flaps and slats are lowered during take-off and landing to provide the necessary lift at low speeds. This creates a gap between the wings and slats, which can be seen on the right on the front edge of the wing. Air can flow through the gap from the underside of the wing to the top – generating noise. With the development of the smart droop nose (morphing wing leading edge), the researchers have solved this problem. The smart droop nose morphs in such a way during take-off and landing that the leading-edge slat is no longer needed. The leading edge can be lowered by up to 20 degrees with virtually no loss of lift.

Detail of the morphing leading edge

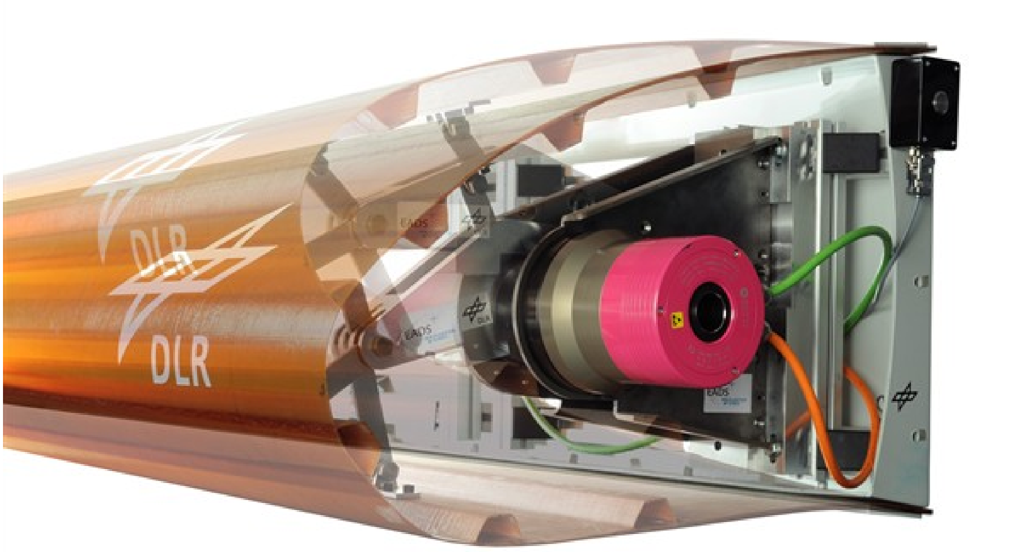


The smart droop nose morphs itself during take-off and landing in such a way that no separate slats are necessary.

The droop nose in the wind tunnel

The operation and performance of the smart droop nose were tested in the wind tunnel under realistic conditions.

Droop nose



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