Background

Reduction of gaseous pollution (CO_2, NO_x) and reduction of aerodynamic noise belong to the main objectives of the ITD Green Regional Aircraft. Improved aerodynamics of lifting surfaces by means of advanced leading edge solutions and active flow control can concretely contribute to these goals. Fraunhofer attention has focused on the analysis of the wing of a regional aircraft: For this a 3D morphable leading edge has been designed, realised and validated under different conditions. The full scale Droop Nose (DN) demonstrator has been thought as platform able to integrate different technologies developed in GRA. The relevant DN architecture based on a smart morphing structure concept has been conceived as a seamless/gapless high-lift device. Its advantage with respect to conventional high-lift systems is twofold, showing lower noise emission with respect to a conventional solution and it is suitable for high-lift solution enabling Natural Laminar Flow capabilities. A CFD and CAA analysis of the 3D wing have been performed for assessing the effects of the morphing leading edge on the aerodynamic field in terms of lifting properties and noise emission.

The droop nose demonstrator represents a multi-purpose platform for integrating different technologies. Morphing capabilities have been numerically assessed by designing internal kinematic and layout of the composite skin, taking also into consideration aerodynamic loads. Shape Memory Alloy based patch actuators have been integrated within the structure as smart support to the main actuator. The ice-protection system based on CNT (Carbon Nano Tubes) has been embedded in the skin along with optical fibres as sensor for strain and temperature measurement, considering also temperature compensation. Temperature sensors have been applied on the surface of the leading edge for temperature monitoring. The demonstrator has been completed by integrating a series of Synthetic Jets for Active Flow Control.

Main Contribution to Clean Sky Project

Here at the Clean Sky boot Fraunhofer shows the 1:1 Droop Nose structure after its validation. The full-scale demonstrator has been first tested in the laboratory environment: The results have shown outstanding performances of all systems. Further tests have been performed in an appropriate climatic wind tunnel. The results of the tests are very promising: All systems have worked as expected also under these severe conditions. The ice-protection system has shown brilliant results also under deformation, which is so far a new result. The 1.1 Droop Nose demonstrator developed in GRA clearly shows the possibility of realising a morphing leading edge as mechanical solution for improved high-lift surface. Additional features can be integrated in the morphing structure like CNT-based ice-protection and strain/temperature monitoring. Active flow control based on synthetic jets can also be integrated as further support to laminar flow solutions. The work performed so far represents a solid basis for the technical challenges still to face for the integration of this solution in a regional aircraft.