Natural laminar flow for fuel-efficient airplanes

Long considered as the Holy Grail of aerodynamicists, natural laminar flow is hoped to help aircraft manufacturers decrease their environmental impact. Work under the ALFA project is aiming at commercialisation of this technology within the next six years.
Turbulence can be stressful the first time you experience it, but it’s generally of little consequence. What is less known, however, is that better wing structures can reduce incidents and thus reduce the impact of turbulence on fuel consumption.

This is the principle of laminar flow airfoil: the air follows a smooth and regular path around a plane’s wings, resulting in minimum drag. As Dr Peter Kortbeek, Manager Technology Office at Fokker Technologies, explains: “The drag in the case of laminar flow is close to proportional to the plane’s speed to the power of 1.5 whereas the drag of turbulent flow is close to proportional to the square of this speed to the power of 1.8 which is substantially higher.”

There is one major problem: so far, no aircraft manufacturer has been able to achieve natural laminar flow (NLF) over the complete airfoil. This requires the engineering and manufacturing of a perfect airfoil shape with a smooth surface devoid of steps, gaps and waviness under all flight conditions, which is easier said than done. The only existing alternative lies in hybrid laminar flow (HLF), but this requires systems with many tiny holes in the airfoil and a pump to suck air from the boundary layer and prevent transition to turbulence. But these are often complex, costly and tend to negatively impact weight.

Through the ALFA project, Dr Kortbeek and a team from GKN Fokker, together with the Royal Netherlands Aerospace Centre (NLR), aimed to develop, design and manufacture a full-scale NLF horizontal tailplane demonstrator with superior surface quality. More than a proof of concept, they wanted their technology to be competitive in terms of weight, production cost and time, maintainability and repairability.

Getting there is no easy task. Perhaps the biggest challenge consists in designing and manufacturing the horizontal tailplane while meeting requirements for steps, gaps and waviness under realistic load conditions. The team is currently looking into ways to reduce the step between the leading edge and the tail body.

“Steps are typically the result of fasteners, connecting a skin to the box structure. Eliminating fasteners by co-bonding or welding is one of the options to overcome this problem. Another solution would consist in masking the fasteners,” Dr Kortbeek explains. “Likewise, waviness results from design and from manufacturing assembly processes, but also from the loads under flight conditions. Meeting NLF requirements calls for a lot of know-how, supported by simulations.”

Now, three years since the project was kicked off and a year ahead of its completion, Dr Kortbeek is already confident that its objectives will be reached. “The most important outcome of the project will be a 1:1 demonstrator that meets all NLF
requirements, but most importantly, this technology will be ready for application on future aircraft platforms. We anticipate that the NLF technology will fly within five years from now,” Dr Kortbeek says.

The demonstrator will be delivered at the end of 2020. Its commercialisation is already being discussed with an original equipment manufacturer (OEM).

NLF horizontal stabilisers are expected to reduce aircraft fuel consumption by about 1 %, while NLF wings have the potential to save 5 % or more. These savings, which may seem modest at first sight, are in fact significant when considering the total fuel consumption of an aircraft.

**Keywords**

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