The DLR ATRA research aircraft collects data during low-altitude flights over Saxony-Anhalt

Fuel efficiency with insect protection

09 August 2013

A windscreen full of insect remains is a familiar experience on the roads in summer. It is no different on the runway at the airport. On warm days, aircraft sometimes collide with entire swarms of insects as they take off and land. Researchers at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) are working in partnership with Airbus to investigate how the resulting large-scale contamination disturbs the airflow over new wing designs in particular, thus putting targeted fuel savings at risk. Extremely low-level flights by the DLR ATRA research aircraft over Magdeburg-Cochstedt Airport have shown experts in flow patterns how small flying animals affect aircraft. The aim is to create hi-tech wings that incorporate insect protection for the future.

“As part of our research work on laminar-flow technology, we are working with Airbus to pursue the aim of improving commercial aircraft in terms of environmental sustainability, noise emissions and cost-effectiveness,” says Dominic Gloß from the DLR Institute of Aerodynamics and Flow Technology. “The numerous insects that encounter the front portions of the wings hinder the development of large laminar-flow, low-friction areas on the wing, rendering the effort to save fuel by using laminar flow ineffective.” Modern wings made of carbon fibre are being investigated in the area of laminar-flow technology. The wings of the future will need to have particularly smooth surfaces for the laminar flow, so that significantly lower drag can be achieved than with current wings.

“In future, special front flaps that are extended during take-off and landing to increase lift are also expected to protect the wing from insect contamination," says Gloß. The DLR ATRA, an Airbus A320 airliner that has been converted into a research aircraft, has become the researchers’ flying laboratory for new technology: “We are using the ATRA for the tests in circling flights. Each test point involves some ten flights over the airport at low altitude,” explains the Braunschweig-based researcher. “Insects typically fly very low, which presents a particular challenge for in-flight research. They are rarely found above an altitude of 200 metres. Their numbers diminish drastically as the altitude increases."

Low fly-bys instead of take-offs and landings

“From the DLR site in Braunschweig, we set a course for Magdeburg-Cochstedt Airport with the ATRA,” reports test pilot Stefan Seydel. “The individual fly-bys over the airport were exciting – we used them to simulate the take-offs and landings of a commercial aircraft,” continues the head of the DLR flight department in Braunschweig, adding: “The aim was to fly at around 15 metres above the ground, so that, in as short a time as possible, we could induce the undesired negative effects of insects, which are actually an everyday occurrence in typical take-off and landing configurations.” The test pilots carried out up to 30 such low-altitude flights and subsequent touch-and-go landings in a day. The test flights took place between 23 July and 6 August, on a total of four days specially selected for the numbers of insects to be expected.

Adhesive film with insect patterns

“The numerous low-level flights gave us a good picture of where the insects were sticking to the aircraft,” says DLR researcher Gloß. Gloß and his colleagues captured the insects on a series of adhesive films and are now storing the insect patterns in their computer models. “We will use

the computer results for future aerodynamic wing designs, for further developments in laminar-flow technology."

Gliders as examples

The scientists' perspective goes beyond the development status of today's commercial aircraft. Numerous surface bumps caused by rivets, layers and joints have been affecting the wings to date. To develop the laminar-flow wing, the researchers must first eliminate these flow disruptors from the design: "The development of wings with a less flow-disruptive surface quality is a major challenge, but it is technically possible," says Gloß. Future laminar-flow wings are based on the smooth, flow-optimised wings of modern gliders, but they will be significantly larger.

The carbon-fibre reinforced composite wings of the future, with no disruptive irregularities or contamination by insects, will reduce fuel consumption. The leading-edge flaps on the new wings will provide the necessary protection – insect protection to save fuel, as it were, the design of which is being influenced by the test flights being carried out now.

The impressive test flights at Magdeburg-Cochstedt Airport are an initial step in the ProWinGS (Performance Development for Wing Design, Ground Test and Simulations) project, funded by the German Federal Ministry for Economics and Technology under the 4th Aviation Research Programme. Further occasional test flights are planned for the end of August.

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ATRA above Magdeburg-Cochstedt Airport

At about 15 metres above ground, ATRA flew over Magdeburg-Cochstedt Airport many times. The aim was to examine insect contamination of the wings in typical takeoff and landing configurations in the shortest possible time.

Credit: DLR (CC-BY 3.0).

ATRA wing with adhesive film

Using a number of adhesive films, researchers have documented the frequency and distribution of insects on the wing. The insect patterns can now be loaded by the researchers into their computer models for the development of future wing models.

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ATRA nose with insect traces

After the test flights, insect remains were also evident on the nose of the aircraft.

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