Flying low – collecting insects in the interest of research

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The flight plans of the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) until 23 July include some unusual flight tests. During extremely low-level passes across the grounds of Magdeburg/Cochstedt Airport, the A320 ATRA (Advanced Technology Research Aircraft) will collect insects for aerodynamic research. Scientists involved in the InCoVal (Insect Contamination Validation) project are investigating the extent to which insects contaminate the leading edges of wings, despite the shielding provided by their slats. While this is not a problem for current aircraft, future generations of ultra-smooth high-tech wings will encounter difficulties. Insect contamination on their surfaces would lead to an increase in fuel consumption, so a new flap system is envisaged to prevent this from occurring. The flight experiments will deliver information for use in such a development. The researchers will conduct additional ATRA flights to test a pilot assistance system and methods designed to optimise flight trials.

Smooth wings for fewer carbon dioxide emissions

Researchers around the world are working on the development of laminar flow wings. Among other features, these are substantially smoother than current wings and therefore produce less drag. The largely undisturbed, turbulence-free airflow is what gives these high-tech wings their name. In future, they may substantially reduce carbon dioxide emissions from air transport. However, insect contamination disturbing the laminar flow would eliminate these reductions. "Modernising future commercial aircraft by fitting them with laminar flow technology gives rise to particular challenges in terms of the surface quality of the wings, quite similar to those encountered with gliders," explains DLR researcher Dominic Gloß from the Institute of Aerodynamics and Flow Technology in Braunschweig. "Gliders are commonly fitted with 'bug scrapers'; in the same way, we have to avoid surface contamination as well," Gloß continues. To this end, the researchers are using ATRA to conduct flight tests in a variety of flying conditions to see how insect contamination is distributed across the wings.

Subsequently, the aeronautic engineer and his DLR colleagues will calibrate and continue developing flow models based on the data acquired. The flaps fitted to the leading edges of the laminar flow wings are extended during take-off and landing. They must be of such a size that they shield the wing from insects without reducing the high-lift performance. The enhanced lift provided by the flap system is crucial for ensuring stable flight during the comparatively slow flight regime used for take-off and landing. The insect protection flaps are retracted once the aircraft reaches faster speeds at greater altitudes, meaning that the air will then flow over the clean leading edges of the wings. The insect contamination is contained within the laminar flow wings, which are made of modern, ultra-lightweight composite materials.

Detector films to show insect patterns

Over the course of the flight tests, researcher Gloß collects insect contamination on adhesive foil stuck behind the leading edge flaps on the wings. The foils are taken directly to the laboratory at the end of the day's flights, where they are digitised using a scanner. “Our flow models then help us design future flaps specifically to deal with insect contamination,” says Gloß.

Fifteen metres above the ground with landing gear retracted

The DLR ATRA research aircraft takes off from its home base in Braunschweig, and charts a course for Magdeburg/Cochstedt Airport to conduct the tests. "In total, we plan between eight and 10 test flights, each involving 10 low altitude overflights," reports DLR test pilot Hans-

Jürgen Berns. "These manoeuvres are particularly challenging, since we fly around 15 metres above the grounds of the airport with our landing gear retracted," Berns continues.

The researchers had already gathered initial ATRA data on insect distribution across the wings during low altitude flights conducted in the summer of 2013. The current set of flight tests will be used to continue acquiring a full dataset on insect contamination. From August on, Dominic Gloß and his colleagues will be evaluating the results of the flight tests. Initial results are scheduled for publication in spring 2015. In addition to analysing insect spread across the wings, the DLR Institute of Flight Systems is using the ATRA at Magdeburg/Cochstedt Airport to test a new pilot assistance system and examine new methods of optimising flight trials.

Experiments on a pilot assistance system and flight trial optimisation

A newly developed DLR pilot assistance system, produced as part of the EPEVA project (Energy-Based Pilot Support System for Precise Adherence to Vertical Approach Flight Profiles) helps pilots execute quiet approach flights that are precise and safe, and also reduce fuel consumption. For this to work, a pilot must adhere precisely to a sequence of actions calculated in advance for the landing phase. Tests have already been conducted in the DLR flight simulator; now the system is set for its first round of in-flight testing at Magdeburg/Cochstedt Airport.

Additionally, ATRA will be used at Magdeburg/Cochstedt Airport as part of the OPIAM (Online Parameter Identification for Integrated Aerodynamic Modelling) project, which deals with innovative methods that permit identification of the aerodynamic properties of an aircraft while in flight. To this end, the DLR test pilots will use ATRA to execute a series of complex manoeuvres. The researchers will then use the flight test data to analyse the accuracy of the flight dynamics model. This will be an important tool for testing and certifying new aircraft. The computer model created based on the flight test data is needed for flight simulators and to design flight control systems.

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Fifteen metres above the ground: ATRA collects insects

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Credit: DLR/Marek Kruszewski (CC-BY 3.0).

Putting adhesive foil behind the leading edge flaps on the wings

Over the course of the flight tests, researcher Gloß collects insect contamination on adhesive foil stuck behind the leading edge flaps on the wings. The foils are taken directly to the laboratory at the end of the day's flights, where they are digitised using a scanner.

Credit: DLR/Marek Kruszewski (CC-BY 3.0).

ATRA at low altitude over the Magdeburg Cochstedt Airport

The DLR ATRA research aircraft flies at around 15 metres above the airport grounds with its landing gear retracted.

Credit: DLR/Marek Kruszewski (CC-BY 3.0).

A view of the measuring system in ATRA's cabin

Flight test engineer Adrian Müller monitored the flight trial from the ATRA measuring system.

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