German Aerospace Center

Future of flight - DLR research with ATRA

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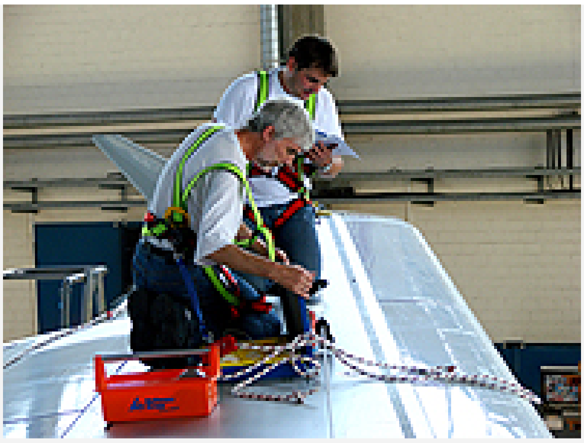
It is the largest member of the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) research fleet: the ATRA (Advanced Technology Research Aircraft), a modified Airbus A320, has supported research since it was brought into use in the end of 2008. From new types of vibration tests through the 'Competitive Airport' project to low-emission flying, all experiments with ATRA were successful.

Mobile vibration tests save costs and time

Vibration test: ATRA bumps over a test track prepared with wooden boards

During Spring 2009, ATRA, equipped with its 140 acceleration sensors, taxied at the airport in Manching near Ingolstadt. The DLR Institute of Aeroelasticity in Göttingen tested the ATRA using the hitherto globally-unique taxi vibration test (TVT). The mobile TVT is a further development of the long-standing stationary vibration test, called the ground vibration test (GVT). These tests for aeroelastic stability analysis are prescribed by the regulatory authorities before the first flight of a new commercial aircraft. The main interest of the tests lies in recording vibration frequencies and shapes, such as the bending and twisting of the wing. In flight, the overlay of these modes of vibration can cause flutter which, in extreme cases could lead to the aircraft structure breaking apart.



ATRA is equipped with 140 sensors for acceleration measurement

As in the GVT, the researchers record important vibration data in the TVT. In the mobile tests this happens as the aircraft slowly taxies over the runways of an airport, which are uneven in most cases. The advantage of the TVT is that it does not require the large scale measuring equipment which is required for the stationary GVT. Just the motion of the aircraft over the uneven runway gives the researchers important basic information about its dynamic characteristics. Using this method, they identified three different forms of vibration during the tests.

In contrast to the current stationary test, the mobile test saves costs and time. A GVT for example can take several weeks, whereas the TVT can be carried out in a few days or even hours. The mobile tests cannot replace the stationary ones completely, but they can supplement them in an optimum way and reduce their length considerably.

ATRA deployed for the 'Competitive Airport'

ATRA during taxi tests for the 'Competitive Airport' project

In order to be able to meet the current growth forecasts for air traffic, the 'Competitive Airport' project (Wettbewerbsfähiger Flughafen; WFF) was set up as part of the German government's fourth aviation research programme (LuFo IV). One of the goals of this project is an improved planning system for the taxi procedure of aircraft at airports, both before and after landing. In order to maintain the capacity of German airports during unfavourable weather conditions, improved management and optimisation systems will be used in future. While the monitoring and identification of taxi traffic by air traffic controllers is already optimum, there are still gaps in the areas of planning, control and information presentation.

Cockpit of ATRA, showing the taxi guidance display developed by Diehl Aerospace GmbH

ATRA was deployed at Frankfurt airport for the Roll:MOPS (taxi guidance: management and optimisation systems) subproject, run by the DLR Institute of Flight Guidance in Braunschweig. The study focused on the development of a planning system (Surface Manager – SMAN) for the taxi process and the transfer of the required control information to the cockpit. SMAN automatically generates the taxi paths of aircraft and transmits them to the pilot by two methods; firstly, the pilot is shown where to taxi through the switching of the lighting on the taxiways. Secondly, the taxi route is transmitted directly by datalink to a display installed in the cockpit and shown on a digital map of the airport. This process will, in future, integrate the pilots even more actively into the taxi guidance process. Planning precision is increased, taxi times are reduced and the pilot is better able to assess the situation on the taxiway.

The field test at Frankfurt airport was preceded by a series of simulations at the DLR Institute of Flight Guidance and initial tests with two specially equipped buses which also took place at Frankfurt airport. In the field test with the ATRA, researchers tested the interaction of all the systems for the first time– from the planning system through the control of the taxi strip lighting and the datalink to the display in the cockpit.

Low-emission flying: the FAGI project

The ATRA being prepared for Future Air Ground Integration (FAGI) project tests

Also in October, DLR Braunschweig deployed ATRA for the first time for flight tests under the FAGI (Future Air Ground Integration) project. Using its AFMS (Advanced Flight Management System) flight path planning system, FAGI plans new, quieter and more fuel-efficient approach procedures and thus reduces emissions during flight.

The ATRA repeatedly made approaches to Braunschweig-Wolfsburg airport and immediately took off again during the flight tests. These tests were intended as a first step in adapting AFMS to the flight performance of the A320. The ATRA will implement fuel-efficient and quieter approach profiles very precisely in future using the AFMS, as did its predecessor, the DLR ATTAS (Advanced Technologies Research Aircraft) research aircraft. In conventional approaches, the altitude of the aircraft is reduced at an early stage. In contrast, AFMS is able to plan the complete approach profile, such as speed and the configuration of flaps and landing gear, in advance, taking account of the weather conditions at the time. Then, the pilot allows the engines to idle through the whole of the descent and increases thrust only shortly before landing. An increase in thrust during the final approach is necessary in order for the landing to be aborted if necessary. This future approach procedure, called ACDA (Advanced Continuous Descend Approach), cannot yet be implemented with today's standard flight planners.


FAGI workstation in the ATRA cabin

The cabin and cockpit of the ATRA were equipped with computers and a special display. The computers and displays were partly systems that had already been tested using ATTAS and also some supplied with comprehensive data from the Airbus flight data measurement system. The performance of the aircraft plays an important role in the FAGI AFMS approach manager. Adaptations for the A320 were made for the flight tests.

Following successful deployment of the AFMS with the standard A320 autopilot, the DLR pilots also manually flew the route specified by the AFMS and shown on the display installed in the cockpit.

In all the tests, the researchers succeeded in adjusting the parameters for the AFMS during the flight test in such a way that the calculated and actual flight path coincided precisely to within a few seconds. In the long-term, it should become possible for approach profiles to be flown automatically. For this purpose, the AFMS must have an electronic interface with the autopilot so that speed, height and course information can be accessed directly by the autopilot.

Following the successful first test flight under FAGI, the use of the AFMS for future projects in ATRA is guaranteed.

The excellent collaboration with Airbus particularly contributed to the success of all the ATRA experiments in 2009. DLR plans several more experiments with ATRA in 2010, again with the support of Airbus.

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