EREA NEWSLETTER
Association of European Research Establishments in Aeronautics
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■ Rolf Henke - new DLR Executive Board Member for Aeronautics

On 2 November 2010, Rolf Henke took up his new post Member of the Executive Board responsible for Aeronautics research at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR). Henke is the successor to Joachim Szodruch, assumed office in October 2002 and, having reached retirement age, left the Board in October 2010. Henke was previously Director of the Institute of Aerospace Technology (Institut für Luft- und Raumfahrt; ILR) at the Technical University of Rhineland-Westphalia (Rheinisch-Westfälische Technische Hochschule; RWTH) in Aachen. Prior to that, he held various positions at Airbus over a period of more than 20 years.

Henke views his new position as one that offers a range of challenges. "First, of course, I want to maintain and build upon the high standards set by my predecessor, Professor Szodruch. The aviation sector is going to develop further over the next few years, and is also facing major changes – one example being unmanned aircraft – and I see my role as helping to shape these changes. DLR is strongly positioned in all relevant areas of the aviation sector, and working with universities and industry, we can help to shape the future of aviation. Having said that, every systemic approach must put methods and processes centre stage," explains Henke. In this context, he is also committed to building consistently upon the goal of his predecessors: interdisciplinary cooperation between DLR institutes

Intensive career development for new talent is another area where Henke firmly intends to follow the footsteps of his predecessor. He wishes to use the experience he has gained over the last few years at RWTH Aachen and to foster even closer links between DLR and the higher education sector. This will enable urgently needed fundamental new technologies to be developed and will also assist the German aviation industry in its efforts to attract skilled employees.

In addition, Henke believes that European aeronautics research efforts are going to grow even closer over the next few years. "This development will apply primarily to large research facilities. The German-Dutch wind tunnels already collaborate with one another, and this is going to extend to other facilities. DLR is at the forefront of this development because it has core skills in the 'overall system' of aviation – from research and aircraft to air traffic control," says Henke.

Henke intends to continue to teach through a special professorship at RWTH Aachen, thereby retaining his links with the University.

■Guest researcher at NLR receives prestigious ICAS-award

Dr. Eri Itoh (ENRI, Japan) recently won the 'ICAS John J. Green Award'. She received this impressive award for her international activities and scientific contribution in aviation, specifically in Air Traffic Management. The award was presented at the 27th Congress of the International Council of the Aeronautical Sciences (ICAS) in Nice (France) on September 24th 2010.

Itoh, together with her Dutch colleagues at NLR-ATSI, studied the efficiency and safety of Airborne Separation Assistance System (ASAS) based Continuous Descent Approaches (CDA). These CDAs are introduced to reduce noise but have as drawback that aircraft speeds are more varied; therefore, aircraft need to keep larger distances than during normal approaches. One way to improve this is to give each aircraft ASAS, which is a tool that gives surrounding traffic information and visualises it on the cockpit display, thus helping pilots to keep a particular distance from each other with less guidance from air traffic control. To study the efficiency and safety of ASAS-based CDA operations, Itoh - supported by NLR-ATSI - developed a mathematical model of the operation, and performed large scale simulations based on this model. The model included variations in aircraft position, airspeed, timing errors, wind speed, and the interactions between different aircraft. The simulation results also showed how safety and efficiency was affected if ASAS or its input information is temporarily failing during the operation.

This project is a partnership with NLR and the Electronic Navigation Research Institute (ENRI, Japan) where Itoh works. From 2008 onwards, she has visited NLR regularly as a guest researcher. Itoh is very enthusiastic about NLR: "At ENRI, we receive almost 100 % of research budget from the government. My first impression was that NLR was very businesslike comparing with ENRI. I enjoy our collaboration a lot, and have been learning how to work efficiently as a professional researcher. NLR colleagues are the real experts in research projects."

ICAS is a global organisation that offers a platform for aeronautic researchers, for example by organising a major biennial congress.

The ICAS John J. Green Award was established by ICAS in 2001 in memory of John J. Green who was one of the Founding Members and President of ICAS. Its purpose is to honor young persons of distinction who are demonstrating an exceptional record in fostering international cooperation between scientists by their personal participation and involvement in aeronautics.

In 2009, NLR hosted the ICAS symposium 'Aviation and the Environment', in preparation for the ICAS 2010 Congress.

Picture: Eri Itoh and Michel Peters, general director NLR

■Arkefly tests alternative departure procedure from Schiphol

ArkeFly, in collaboration with Amsterdam Airport Schiphol and the National Aerospace Laboratory (NLR), has developed an alternative departure procedure for its aircraft departing from Schiphol Airport. Aircraft can fly faster when using this alternative departure procedure than they can when following the traditional departure procedures. The alternative procedure allows aircraft to retract their flaps and slats earlier, resulting in less wind resistance, which saves ArkeFly fuel and time, and consequently results in less CO2 emissions.

Comprehensive tests will now be conducted over the next six months. On June 21 the first ArkeFly flight departed from Schiphol using this new departure procedure. In addition to saving fuel and reducing CO2 emissions, the tests will also map the effects this new procedure has on noise levels in the areas around Schiphol Airport. ArkeFly's existing flight routes will remain unchanged.

During the experiments, the NLR and Schiphol are jointly responsible for the research of the environmental effects, particularly noise impact, emissions and CO2 emissions. NLR will therefore contribute to the analysis of the noise measurements data derived from the NOMOS ('Noise Monitoring System' used at Schiphol Airport) measurement stations. Based on NOMOS data the effects on noise impact will be determined. In addition, NLR researchers will analyze the flight data (from the flight recorders) of the ArkeFly aircraft and also the flight data from flights conducted during simulator tests.

Alternative departure procedure in detail

ArkeFly has already been using this alternative departure procedure at various other international airports. TUI's large international fleet – of which ArkeFly aircraft is part - will also adopt this alternative procedure. The alternative departure procedure works as follows: each aircraft has an optimal climbing speed at which it can ascend using the lowest amount of fuel possible. Currently, aircraft departing from Schiphol reach this optimum climbing speed at around 3,000 feet (approximately 900 metres). The tests that started on June 21 will determine what the effects will be if an aircraft accelerates at a lower altitude to reach its maximum climbing speed. Passengers in ArkeFly aircraft will not notice that tests are being conducted.

■LAGOON: a study for a quieter landing gear

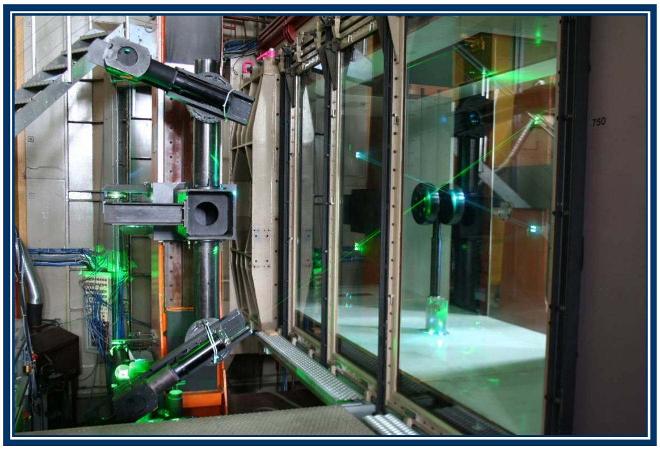
Through the "Lagoon" program (LAnding Gear NOise database for CAA validatiON) launched by Airbus, Onera has refined its tools and methods for analyzing noise in wind tunnels. These innovations have enabled Onera to make aeroacoustic measurements in a wind tunnel designed for aerodynamic studies.

The landing gear is still a relatively noisy part of an airplane, especially during landing. Until now, the efforts to reduce noise have mostly focused on the engines. Which means that the landing gear is still a relatively rudimentary object, in terms of acoustic design and analysis. That is why Airbus has carried out the Lagoon program, along with Onera, its German counterpart DLR and the University of Southampton. Its aim is to carry out wind-tunnel tests using a generic landing gear model. This project allowed building up an unprecedented aerodynamic and acoustic database, which will help Airbus and other airplane-makers accelerate the design and development of quieter landing gear.

These developments demand heavy computing power. To numerically simulate a model with characteristics close to that of the real object, data generated by wind tunnels is mandatory. Two series of tests were carried out to ensure that these data were as pertinent as

possible, one in the F2 subsonic wind tunnel at Fauga-Mauzac, for aerodynamic data, and the other in the CEPRA19 facility at Saclay for the aeroacoustic data.

This marked the first time that two types of data were generated for the same object, enabling to validating, and if need being revise the computation codes. Through these tests, Onera was able to precisely measure both airflows and noise.



Laser velocimetry setup in the F2 wind tunnel at Fauga-Mauzac

These tests will allow making substantial progress. Drawing on the results of the Lagoon program, Onera also developed new arrays of microphones that can be used in closed circuit wind tunnels such as the F2 facility. New methods to eliminate noise and reverberations were also developed. Thanks to these innovations, aeroacoustic and aerodynamic measurements could be performed at the same time – a major first! These techniques will be eventually extrapolate for use in the wind tunnels at Modane, in order to assess noise generated by aircraft at cruise speed without having to use a specialized wind tunnel, that would reduce the time needed to develop a specific part, or even the entire aircraft.

In-flight loads monitoring of an UAV

Structural load monitoring of unmanned air vehicles, UAVs, is suitable not only to evaluate the flight loads and estimate with the data acquired the remaining life time of the structure, but also for a fast and reliable assessment of structural impacts due to unexpected events, like hard landings and gusts, that can produce significant loads on the structure. This is of especial interest for composite structures where damage is quite often only barely visible. In-flight monitoring enables fast turn around times and increases the availability of the UAV.

To study the possibilities of in-flight loads monitoring, a UAV, named SIVA, a complete aerial robotic electro-optic surveillance system designed, developed and assembled at INTA, has been instrumented with fiber optic Bragg grating sensors, FBGS, that measure strain and temperature. The sensors are surface bonded in 20 locations of the UAV, the outer wing, the central wing attachment, the fuselage, an elevator and the landing gear as it can be seen on the following figure where the sensor position and the harness are indicated. The structure of the UAV is made of high strength carbon fiber reinforcing toughened epoxy matrix. The fuselage is a monolithic design and the central wing and the outer, foldable, wings are combined monolithic and sandwich composite constructions. The wingspan is about 6m.

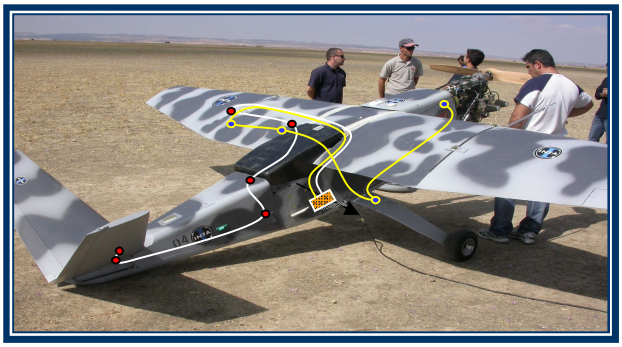


Figure: UAV SIVA during flight tests. The colored dots indicate the position of the 20 optical sensors and the white and yellow lines the optical harness. The orange box indicates the interrogator location

Flight loads of the composite structure can be calculated with the measured data and the temperature induced thermal strains can be compensated. The on-board FBGS interrogator is a small, robust two-channel equipment from the company INSENSYS that uses time-domain sensor identification at 500Hz sampling frequency. Every sensor is identical and can work in a strain range of ± 4500 microstrain. The sensors need to be placed at a minimum distance of 2,5 m to each other. The fiber interrogator is equipped with a memory card that allows more than 3 hours of autonomous in-flight data acquisition. After the flight, the memory card can be extracted and the flight data can be evaluated on ground. Real time in-flight data transmission to the ground station is foreseen.

REStARTS – aeronautical education starting from early age

Raising European Students Awareness in Aeronautical Research Through School-Labs, REStARTS, is an EC founded project through the Aeronautics and Air Transport theme of the FP7and it is lead by Von Karman Institute for Fluid Dynamics.
Developments in Science and Technology have always been an essential part of the progress of all societies. In the past decades, the attraction towards Science and Technology has significantly decreased, although our society is more dependent on Science and technology than ever.
In order to improve the current situation, specific actions are needed at all levels in the educational process, starting from early stages up to universities.
Few major European aeronautical institutes felt the need to do something to put an end to this drop of interest among young people.
The partners of REStARTS are aeronautical research institutes in Europe (VKI in Belgium, CIRA in Italy, DLR in Germany and INCAS in Romania) which have considerable experience in this field. Additionally, an educational partner, the School of Education University of Leicester in UK, will supervise the accessibility and the impact of the resulting product toward teachers and students.
The concept of the REStARTS project is to establish a well co-ordinated link and work plan among the research organizations in aeronautical sciences and academia for sharing the know-how, special/dedicated research infrastructure, and the latest research results in order to improve the educational process of a new generation of engineers for the European aeronautics industry.
The objective is to make a significant impact on the educational process and to raise the public awareness from a very early stage to the technological challenges in aeronautics. The activities are focused on dedicated labs, where young students can benefit best from the research infrastructure and knowledge accumulated in complex research projects.
The activities are focused on experiments in class and dedicated labs and visits at the research institutes, where young students can benefit best from the research infrastructure and knowledge accumulated in complex research projects.
The long-term objective of the present project is to establish a European platform, with a pilot experience, that will result in teaching material on aeronautics. Beyond this pilot phase, we want to demonstrate the efficiency of school-labs to motivate young people and in particular girls towards aeronautics. At the end of the project didactic material will be available in five languages, ready to be shared and translated for other European countries.

■Health Monitoring of Turbomachinery Based on Blade Tip-Timing and Tip-Clearance

Fan and compressor blade tip sensors

Inexpensive and reliable inductive sensors (based on Variable Reluctance effect - VR) are used by ITWL for about twenty years to measure vibration of steel-made compressor blades (fig. a). They typically survive more than five years in fan environment and generate falling-slope pulses, convenient to trigger digital counters. They cannot sense blades made of paramagnetic materials like titanium alloys, which is serious drawback.

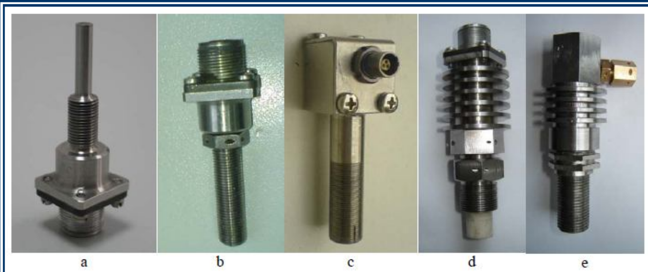


Figure: Tip-timing sensors developed and tested in ITWL: a) inductive (VR) for steel SO-3 fan blades, b) passive EC for titanium K-15 fan blades, c) passive EC for titanium RD-33 fan blades, d) passive EC for SO-3 turbine, e) microwave for SO-3 turbine

Efforts focused on adequate materials selection, magnetic field modeling, amplifier design optimization, resulted with improved VR sensor signal in low speed range or with high tip clearance. Sensors developed afterwards (fig. b, c) were able to sense weak eddy currents (EC) fields, generated on the tip of titanium blade. These sensors were tested in laboratory test rig and during bench test of RD-33 engine with satisfactory results. Passive EC sensors are optimal for fan and compressor stages, where air temperature is below 200°C. The sensor design is customized to the planned installation location.

Signal from passive EC sensors is similar to that generated by inductive speed pickups. Circumferential and radial tip position is described by the phase and amplitude of blade-related pulse, respectively. Signal amplitude of passive EC sensor is speed dependant and has to be dynamically calibrated to measure absolute tip clearance. Amplifier characteristic is adjusted to get preferred working range, defined by maximum clearance and rotor speed.

Turbine blade tip sensors

Gas turbine is extremely harsh environment for any kind of measurements and requires sensors manufactured using materials and technologies, resistant to high temperature. For a few years ITWL was involved in development of microwave tip-timing sensor. Several prototypes were manufactured (e.g. fig.e) and tested in laboratory and during engine runs. Metal-ceramic probe structure was optimal for gas temperatures exceeding even 1000°C. The sensor performance was acceptable but it was difficult to guarantee stable operation of the integrated electronics in flight condition.

Accumulated experience with temperature-resistant materials especially ceramics, was used to develop passive EC sensor (fig. d), resistant to the turbine environment. The prototype with integrated passive cooling (radiator) successfully passed tests on SO-3 turbine (800°C). There are plans to test the sensor on low pressure turbine (LPT) of RD-33 engine (1000°C). In case of unstable operation in these conditions, air cooling will be considered.

High pressure RD-33 turbine (HPT) is very difficult to reach and measure tip deflection, not only due to extreme temperature (>1200°C), but also there is no access to the blade tip. The expected tip deflections are quite low, requiring high resolution sensors (optical). Most probably HPT blade deflection will be not measured in the final version of the system.

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