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EREA NEWSLETTER

Association of European Research Establishments in Aeronautics

June 2011

REAL-TIME OVERVIEW OF FIRES ASSISTED BY UNMANNED AIRCRAFT AND HELICOPTERS

When fire fighters arrive at the scene of a major forest or heath fire, they need to obtain situational awareness information as quickly as possible: what is the exact location of the fire and where are fellow fire-fighters located? At present, this information is either lacking or fire department commanders receive this information relatively late.

To solve this problem, the National Aerospace Laboratory (NLR) and its partners initiated the Fire-Fly project, in which fire department commanders are presented with real-time overview imagery of the area where the forest fire is located. This information can then be disseminated to crisis centres, the police, and other fire departments and fire-fighters in the field. On Wednesday, 11 May, the fire departments of Safety Region North and South Gelderland, together with the Fire-Fly project partners, demonstrated remote controlled aircraft and helicopters that allow fires to be more effectively fought.

The fire departments of Safety Region North and South Gelderland are studying the possibilities for unmanned aerial observation systems and determining if these can be integrated with the fire departments' information systems. The Fire-Fly project presents fire department commanders with a real-time overview of incidents. A camera on board sends images to crisis centres, the police, and other fire departments and fire-fighters in the field, so that the fire can be more effectively fought. Thanks to Fire-Fly, the fire department performs more efficiently and people and resources can be more effectively deployed.

In this project, NLR is responsible for the technical implementation of the observation system, which includes system design and data storage. Also participating in the project are Nieuwland, Delft Dynamics, Geodan and VNOG.

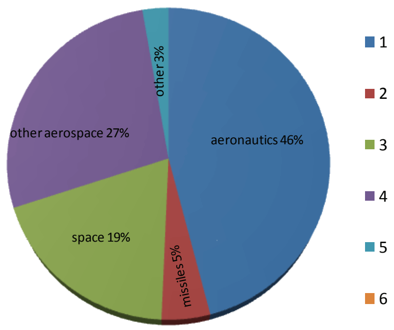
The consortium of NLR, Nieuwland, Delft Dynamics, Geodan and VNOG will demonstrate the final product.

The project falls under the auspices of the Social Innovation Agenda (MIA) Safety. NL Agency is implementing this scheme on behalf of the Dutch government.

BREAKDOWN OF EREA 2009 EXPENDITURES FOR INTRAMURAL R&T,D

total expenditures for Intramural R&T,D	aeronautics	missiles	space	other aerospace	other
1190	547	56	229	326	32
	46%	5%	19%	27%	3%

TOTAL: 1 190 M€



aeronautics: means Airframes for aeroplanes, helicopters and gliders, ground installations, piston engines, turboprops, turbojets, jet engines, equipment for test, ground training equipment, systems to be installed in aircraft, their subsystems and parts.
Missiles: means airframes for tactical and ballistic missiles, ground installations, engines, equipment for test, ground training equipment, systems to be installed in missiles, their subsystems and parts.
Space: means airframes for space vehicles, satellites, launchers, ground installations, rocket engines or other, equipment for test, ground training equipment, systems to be installed in space vehicles, satellites, launchers, their subsystems and parts.
Other Aerospace: means consulting Assessment excl. R&T, Dev activities.
Other: means other sectors like energy, armament, ground transportation etc.

EREA IN NUMBERS - COMPARISON 2007, 2008, 2009

year	2007	2008	2009
employees	4,500	4,360	5,000
internal aeronautics research	366M€	375M€	625M€ *
annual investments	160M€	175M€	178M€
annual revenues from EU projects	44M€	45M€	52M€
number of PhD thesis/year	190	170	175
number of publications	6,500	6,260	7,000
published in refereed journals	880	1,080	1,088

With almost 5 000 scientists and engineers EREA research establishments represent a major player in the supply chain. The scientific excellence of EREA members is shown through the massive number of more than 7 000 publications and almost 200 number of yearly PhD thesis. Annual investments to RT&D and annual revenues from EU projects are inter-yearly equally increasing.

* *institutional support*

EREA CONTRIBUTION TO THE "COMMON STRATEGIC FRAMEWORK FOR RESEARCH AND INNOVATION FUNDING"

Air transport, a fundamental element of the Union's Lisbon strategy, has proven itself a major contributor to the European economy, supporting industry as well as research, academic and political communities. Furthermore, technological leadership is becoming a key issue to maintain competitiveness in a global economy with emerging countries playing an increasingly relevant role.

EREA Research Establishments, through high investments in research, highly skilled researchers and engineers in good cooperation between industry, research and academia, contribute in sustaining the European technological leadership in Aeronautics that is becoming more and more a key issue to maintain competitiveness in a global economy with emerging countries playing an increasingly relevant role.

Moreover EREA Research Establishments, with their research and test Infrastructures represent an essential asset in the Research and Innovation cycle, being able to transform basic scientific research knowledge into competitive products.

The EREA Study on Air Transport System, completed in the last year and presented to the Aeronautics Community during the Aeroweek, and well received by the Commission, was a first significant contribution to the development of the guidelines of the new Common Strategic Framework for Research and Innovation, and the Commission Officers are looking with some interest to the outcome of the follow on study EREA is producing in these months.

After the Commission published on February, the 9th the Green Paper – "From Challenges to opportunities towards a Common Strategic Framework for EU Research and Innovation funding" and opened a public consultation on the key issues to be taken into account for future EU Research and Innovation programmes, the Research Establishments have been discussed their ideas in the "ad hoc" Workshop organized in Madrid, and agreed a common position that was filed both answering the questionnaire and sending to the Commission the "EREA Position Paper on future Common Strategic Framework for Research and Innovation funding".

The EREA common position document, highlights the need for long term political agendas whenever developments have long cycles from ideas to market (as for Aeronautics and Air transport) and the importance to build the future CSF upon assessment of achievements in FP7 and ongoing research programmes to guarantee progress and success of European policies, suggesting to extensively apply the "ACARE-like approach" to other Industrial sectors, based on the quite important results obtained.

In order to maintain European leadership in research and innovation, it is important that the entire innovation process, from basic research, up to system demonstration will be supported, EREA recommendations are to maintain a balanced approach between top-down and bottom-up research projects, and also to keep the successful instruments (from Collaborative Research projects, to JTIs and other PPPs) that guaranteed good success and established close cooperation between all research stakeholders (University, Research, Industry including SMEs); moreover in the aim to support higher technology readiness levels (TRLs), a new and more technically oriented focus needs to be used under ESFRI to identify, develop and upgrade infrastructures devoted to testing and technical development.

Last but not least EREA could have a key role In case EU will fund Joint Programming Initiatives between groups of Member States: an EREA Joint Technical Programme, as laid down in the EREA Joint Position Paper and the association agreement (joint managing of programmes and facilities), would be a way to efficiently exploit human resources, technical expertise, research and demonstration infrastructures to achieve optimisation of research and innovation results, reinforcing cooperation between Research Establishments and achieving national and European funds going in the same direction regarding research and innovation goals.

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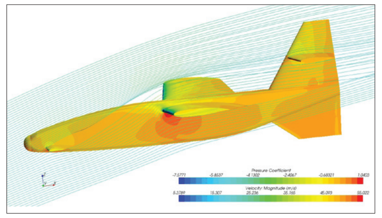
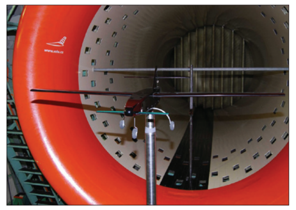
FULL AERODYNAMIC DESIGN AND TESTING



CFD result of flow separation on the canard

Nowadays, the estimation of aerodynamic coefficients is possible to do by a few manners with usage of various empirical, computational methods (panel methods, CFD), wind tunnel tests and flight measurements. At the present time is possible to observe the trend of the substitution of the major part wind tunnel testing by the advanced CFD methods. Only a final geometry is measured in wind tunnel. This geometry was designed and optimized by the CFD methods which reduce time and the financial demand on the development. The final part of development procedure is a validation of previous project phases by flight test.

Defining the stability and control characteristics of an airplane are probably one of the most difficult and most expensive aspects of an aircraft development. The difficulties are partially due to the fact that the stability and control phase of design is extended to the very end of the development process and sometimes even beyond it, causing occasionally unexpected and expensive twists along the project paths requiring changes on the aircraft. Since these can occur in the very late stages of the project, they are very expensive and often come with detrimental effect to the expected performance. It is therefore of utmost importance to be able to predict Stability and control characteristics of the aircraft in the early stages of its development.



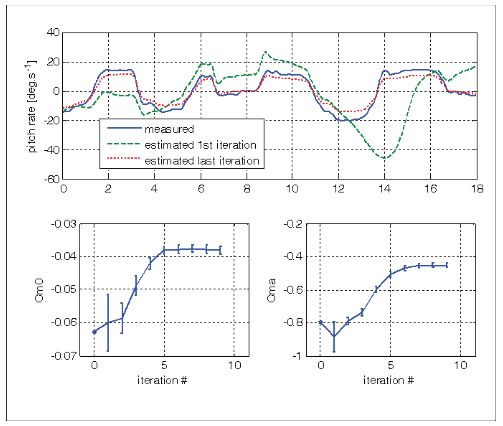
aircraft model in the wind tunnel

model during flight test

Individual types of methods were step by step applied on the development of the small unconventional aircraft (from handbook method up to flight test). The handbook and panel methods provide very quick response on any geometrical changes of preliminary design of the aircraft. The accuracy of this method is lower than CFD method or wind tunnel test. On the other hand is sufficient on this early stage of this process. With ongoing stage of the project it is needed to improve current results. CFD methods were used for improving inputs for flight mechanic calculation. Following step is usually wind tunnel measurement which provides the most accurate results of static aerodynamic coefficients and damping derivatives as well.

Flight test is a branch of aeronautical engineering that develops and gathers data during flight of an aircraft and then analyzes the data to evaluate the flight characteristics of the aircraft and validate its design. Flight test was focused on estimation of aerodynamic parameters and determination of flying qualities.

Software for calculation of nonlinear flight mechanics was developed on basis of aircraft design procedure. This program solves flight stability and controllability using results from other stages of process. If this procedure is followed step by step it will reduce time and financial demands on the development.



comparison of flight measured and estimated parameters; aerodynamic derivations vs. steps of optimization

DGV, DOPPLER GLOBAL VELOCIMETRY OR THE PHOTOGRAPHY OF VELOCITY BY LASER

Over the past few years, ONERA has performed DGV (Doppler Global Velocimetry) measurements in wind tunnels, testing different configurations with the aim of improving the technique and making it available in an industrial context.

To render the air movements visible, the flow in the wind tunnel much be seeded with very fine submicronic particles, and illuminated by a laser light sheet. These particles follow the stream lines of the vortex, and scatter the laser light reaching the camera detector.

The raw image photography (figure 1) was obtained while developing the Doppler Global Velocimetry technique (DGV). DGV can be used to establish the flow velocity at all points of the zone illuminated by the laser and to draw a map of velocity (figure 2).

Doppler Global Velocimetry is a planar laser velocimetry technique based on the Doppler Effect. The measurement area is materialized by a laser sheet, the light scattered by seeding particles is frequency-shifted with regard to the incident light. The particle velocity is then calculated from the simplified Doppler formula:

$$\Delta f = f_0/c\ (V)$$

where f_0 is the laser emitted frequency, V the speed of the particle and c the speed of the light.

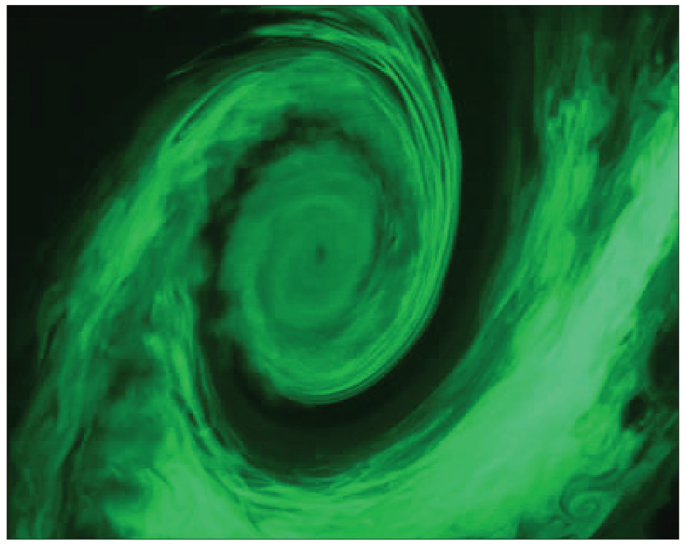


Figure 1 - Photograph, taken in F2 wind tunnel, of the wake vortex of an aircraft at the end of the airfoil. Doppler Global Velocimetry is used to measure the velocity of flow at each point of a plane, illuminated by laser.

This optical technique has been used successfully in the subsonic F2 wind tunnel for the investigation of wake vortex of a wing model.

Another experiment has been carried out in the F1 subsonic wind tunnel for wake vortex characterization of an aircraft in landing configuration.

The comparison of the results obtained by DGV to those obtained by classical optical methods such as LDV is very satisfactory and has demonstrated the good accuracy of DGV.

DGV today

Today, DGV is getting more and more mature in wind tunnel applications, but it is also in competition with another velocimetry optical method, the Particle Image Velocimetry. (PIV), which does not use the coherence properties of laser light: and which is, more economical and less complex to implement, while requiring powerful computers. However, for some uses, DGV has decisive advantages, such as: point measurements at high rate, measurement of the velocity of droplets in a spray, three-component at high supersonic, etc…

Moreover DGV is a technique with great educational value and is still popular with students.

PART OF THIS ACTIVITY HAS BEEN PERFORMED IN CLOSE COOPERATION WITH DLR.

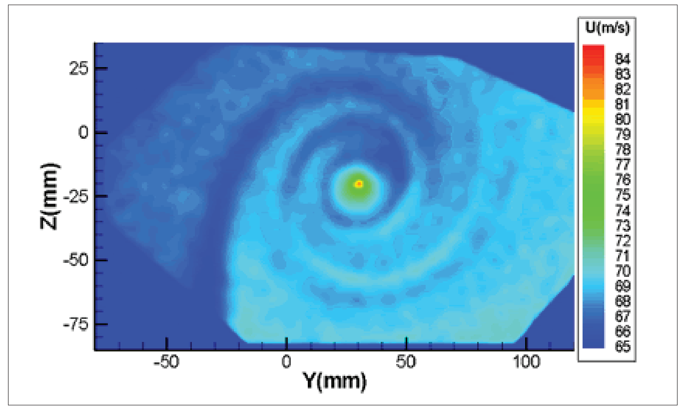


Figure 2 - Map of the intensity of the velocity of the wake vortex obtained by DGV. The velocity gets higher toward the centre of the vortex.

THE INFLUENCE OF WING TRANSVERSE VIBRATIONS ON DYNAMIC PARAMETERS OF AN AIRCRAFT

There are several forces and moments acting on the structure of the airplane during its flight in disturbed earth's atmosphere. Because of the nature of the interactions, they can be divided into two groups. First group of airframe loadings is connected with the influence of the medium surrounding and affecting the external surfaces of the airplane. Second one, speaking generally, internal interactions of the airframe and elasticity forces. Both they create aeroelasticity.

Varying loadings from flow disturbances cause changing aerodynamic loads. This lead to lifting surfaces vibrations (wings, tailplane) as well as bigger assemblies like aircraft tail with tailplane. Farther more, forces produced by wing vibrations are transferred through joints to the fuselage inducing its bending or/and twisting causing premature wear and tear of elements and assemblies. Deflections of wing along the airplane normal axis *Oz* can produce additional forces on ailerons which may deliver bigger wing deflections and loads in lateral control system. Exceeding permissible loads during flight may lead to permanent airframe deformation. Loads surpassing maximum permissible loading cause airframe failure and crash.

Spatial motion of the airplane treated as a 6DOF rigid body is described by a system of twelve nonlinear ordinary differential equations. Solving it employs approximate methods based on computer technology. An assumption is made that all of the airframe elements occupy invariant position toward one another through the whole time of the analysis. This is one sufficient condition to determine mass and aerodynamic forces and moments coefficients acting on the aircraft during steady flight.

In order to analyze the influence of wing transverse vibrations, using the computer code solving motion equations, many cases of lifting surfaces vibrations may be simulated. Because of complex structure of the wing causing difficulties in estimating vibrations frequencies and amplitudes and a lack of airplane in-flight experimental data, some of mentioned above values were evaluated.

During conducted simulations, originally airplane performs rectilinear steady flight with given constant speed in smooth configuration. The initial turboprop engines thrust in analyzed time was determined on the base of steady flight condition. Static pitching moment is compensated by the horizontal control surface deflection depending on the flight speed. The system of twelve nonlinear ordinary differential equations was used to perform analysis.

In the wing vibration simulation the model of M28 "Bryza" Polish medium utility airplane with strut-braced wing was used. Along the span, the wing has varying cross-section areas (different moments of inertia), mass as well as varying aerodynamic loads. Some assumption were made in order to simplify the model of wing vibrations. Bending moment causes wing „parabolic like" deflection. The wing oscillates with given frequency and amplitude. In each iteration, a vertical component zel of wing element position and vertical velocity Vz are evaluated. For each wing element the coefficients of drag, lift, pitching moment are determined.

On the basis of the numerical simulation results, it is possible to state that disturbed numerical model of M28 "Bryza" airplane remains stable because the motion parameters return to theirs primary values: longitudinal stability → velocity, AOA and pitch angle return to fixed values; lateral stability → roll angle returns to *"0"* and yaw angle is stabilized at the certain level.

It can be found that the "in counter-phase" wing vibrations have considerable influence on flight parameters. Because of the longitudinal and lateral motions coupling, arising side-slip angle produce bigger parameters variations. In both cases, a little altitude loss is noticed. During the wing vibrations, there are oscillations of all motion parameters, resulting in unfavourable work conditions for many onboard systems, for instance autopilot system.

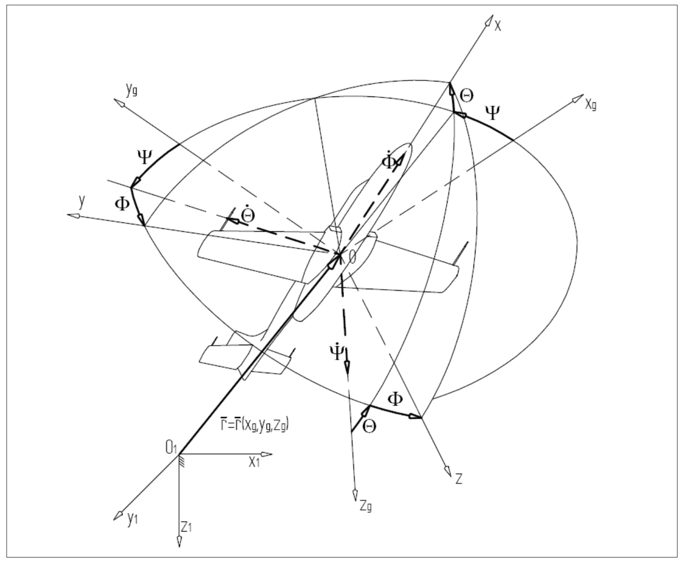


Figure - System of coordinates