EUROLIFT II

European High Lift Programme II

Funding: European (6th RTD Framework Programme)
Duration: Jan 2004 - Jun 2007
Status: Complete with results
Total project cost: €7,326,041
EU contribution: €3,738,542

Call for proposal: FP6-2002-AERO-1
CORDIS RCN : 72817

Background & policy context:

The design of high lift systems for commercial aircraft has a considerable potential to contribute to the achievement of the demanding goals formulated in the European Vision for 2020. Basically, efficient innovative high lift devices are a prerequisite for improvements in two fields: the first is the reduction of the perceived aircraft noise, as nowadays efficient low noise high bypass ration engines the airframe, more precisely the slat, is becoming the main source of noise during the landing phase. The second field is the strong reduction of CO2 emissions. Although this goal is primarily related to improved aerodynamic cruise performance, there is a close relation to the high lift system.

The assessment and eventually improvement of the high lift properties of an aircraft configuration requires the identification, localisation, and understanding of the effects and features that determine the maximum attainable lift. The maximum lift behaviour can be improved by modifications of the slat end, like slat horns. Concerning the nacelle mounting modern commercial aircraft are equipped with high to very high bypass ratio engines mounted closely coupled to the wing.

The close coupling requires a cut-out in the leading-edge high lift device. The shaping of the cut-out edges and the pylon/wing junction is essential to improve the high lift capabilities in this area. So-called nacelle strakes are often mounted at the forward upper part of the nacelle to improve the local maximum lift behaviour. In both areas, at the wing/fuselage junction and at the wing/pylon junction vortices are generated, that interact with the local wing boundary layer by inducing additional velocities.

This scenario forms the basis to assess and improve the simulation tools in the framework of the EUROLIFT projects.

Objectives:

The European High-Lift Project EUROLIFT II is started in January 2004 under the coordination of DLR as a Specific Targeted Research Project (STReP) of the 6th EU Framework Programme. The Project continues the successful work of the predecessor project EUROLIFT I under the leadership of Airbus-Deutschland. In view of the realisation of the demanding targets of the European vision 2020, high lift systems will deliver a substantial contribution, to make the aircraft system more efficient and environmentally friendly.

Corresponding potentials of the high-lift system are the aerodynamic efficiency-increase with reduced maintenance effort, the development of more efficient theoretical and experimental methods for the industrial design process, and the reduction of the noise emission in the start and landing phase by advanced high-lift concepts. This can only be achieved, when modern numerical and experimental methods are available, which can be used for the analysis of the dominant aerodynamic phenomena as well as for the high-lift design and optimization in real flight conditions.

With the EU-project EUROLIFT II, these methods and the physical understanding of the dominant aerodynamic phenomena should be brought to a level, which guarantees the solution of the envisaged...
tasks. The following objectives are set:

- Validation of numerical and theoretical methods for exact prediction of the aerodynamics of a complete aircraft in high-lift configuration at flight Reynolds numbers.
- Numerical and experimental analysis of the physical interaction of the different, vortex dominated aerodynamics as well as their effect on the aerodynamic performance. This will be accomplished by using state-of-the art RANS-methods (Reynolds-averaged Navier-Stokes) and also the wind tunnels ETW (European Transonic Wind Tunnel) and LSWT (Low Speed wind tunnel) of Airbus Germany.
- Specification of progressive high-lift systems including numerical as well as experimental demonstration.

**Methodology:**

The project was subdivided into three major work packages (WPs).

Each WP had three tasks:

**WP0 Management and coordination**

**WP1 Improved validation based on EUROLIFT I data**

- T1.1 Geometrical model installation and deformation effects
- T1.2 Boundary layer and transition impact
- T1.3 Study of flap setting and modification effects

WP1, led by DLR, covered numerical investigations which were based exclusively on existing experimental data from EUROLIFT I. Task 1.1 was coordinated by NLR. The objective was to determine wind tunnel and model installation effects. In this context, in-tunnel simulations were carried out with the KH3Y in stage 0 configuration for low and high Reynolds number tests in the B-LSWT and the ETW. Task 1.2, coordinated by ONERA, dealt with the analysis of transition phenomena based on experimental data of the EUROLIFT I project. Task 1.3 was concerned with the simulation of setting effects of the high lift devices. The task was coordinated by Airbus-Deutschland. The objective was to show the potential of CFD methods to predict 3D flap setting effects on lift and drag for model and full-scale Reynolds numbers.

**WP2 Realistic high lift configurations**

- T2.1 Realistic aircraft configuration
- T2.2 Advanced high lift design
- T2.3 Novel devices for flow control

WP2, coordinated by Airbus-Deutschland, was devoted to detailed analysis and optimisation of high lift configurations. Due to its importance Task 2.1, which was also led by Airbus-Deutschland, was subdivided into three subtasks. The first one was coordinated by Airbus-Deutschland and covered detailed flow field analysis on the three complexity stages of the KH3Y high lift configuration in the BLSWT for low Reynolds number conditions. Complementary to the experimental and numerical analysis activities in Task 2.1, Task 2.2 addressed the topic of numerical optimisation of high lift configurations. The common activity, which was coordinated by DLR, focused on the setting and shape optimisation of a 2D section of the KH3Y wing / fuselage configuration without engines. Task 2.3, coordinated by Airbus-UK, has been introduced to assess the potential of an active flow control concept on a multi-element wing configuration when replacing the slat. The task consisted of preparatory numerical investigations and a demonstration test using the accordingly modified AFV configuration in the F-LSWT. A

**Parent Programmes:**

- FP6-AERO-1.1 - Strengthening competitiveness

**Institute type:** Public institution

**Institute name:** European Commission

**Funding type:** Public (EU)

**Lead Organisation:**

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Organisation Website: http://www.dlr.de
EU Contribution: €0

Partner Organisations:

European Transonic Windtunnel Gmbh

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### Icaros Computing Ltd

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**EU Contribution:** €0

### Dassault Aviation

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**EU Contribution:** €0

### Technologies:

- Aircraft design and manufacturing
- Improved aerodynamic design tools

**Development phase:** Research/Invention

- Information systems
- Transport research and innovation strategies

**Development phase:** Research/Invention

### Key Results:

The EUROLIFT II project addressed a variety of issues considered essential for the successful experimental and numerical simulation of high lift commercial aircraft configurations. One of the most important issues is the capability of RANS methods to predict maximum lift determining effects and their Reynolds-number dependency on complex configurations with deployed high lift devices. A comprehensive validation database for high lift commercial aircraft configurations has been generated covering low as well as flight representative Reynolds-numbers.

Maximum lift determining effects could be isolated by investigating configurations of different complexity levels. The experimental studies are accompanied by extensive CFD studies making use of various hybrid-unstructured as well as structured grid codes. Whereas these studies have been carried out assuming fully turbulent free air flow, dedicated investigations are devoted to identifying the influence of wind tunnel walls and model mounting effects deemed necessary to assess the impact of these effects for the reliable validation of the RANS codes. Numerical optimisation of the shape and setting of a trailing edge flap is also addresses in the project.

The resulting optimised flap shape has been tested under cryogenic conditions in order to verify the aerodynamic potential of the numerical optimisation. Studies on transition phenomena, transition location prediction, as well as investigations on physical modelling and grid generation approaches complete the range of topics, which is covered by the EUROLIFT II project. The experimental database and the numerical results and experience gathered in the project including the areas of code
improvement will be the basis to approach the final target of the predicting maximum lift on a complex high lift configuration with a pre-defined high accuracy.

**OTHER IMPORTANT RESULTS:**

Based on the work implemented and the results achieved under the EUROLIFT II Project the following papers and presentations were published or presented on international conferences:

- J. van der Burg, et.al., 'Geometrical Model Installation and Deformation Effects in the European project EUROLIFT II', AIAA-2007-4297, 2007;
- Eliasson, P. 'Numerical Validation of a Half Model High Lift Configuration in a Win

Documents:
- [Final Publishable Report (Final report)](#)
- [Final Report Summary - EUROLIFT II (European High Lift Programme II)](#)

**STRIA Roadmaps:** Vehicle design and manufacturing

**Transport mode:** Air transport

**Transport sectors:** Passenger transport, Freight transport

**Transport policies:**
Societal/Economic issues, Environmental/Emissions aspects, Safety/Security, Other specified

**Geo-spatial type:** Other