AFLoNext

2ND GENERATION
ACTIVE WING

# NEWSLETTER N°6

August 2017

**Welcome to the sixth newsletter from the AFLoNext project!**

AFLoNext gathers forty European partners from fifteen countries for a period of five years, until May 2018. Our fundamental goal is to mature highly promising flow control technologies and to show their potentials for advanced eco-efficient aircraft design.

Our public newsletters keep you up-to-date on progress made within AFLoNext. Whats' more, you are given a possibility to discover how the consortium partners cooperate to achieve the project objectives. You can also find out how and when we disseminate the AFLoNext results. This is in case you feel like meeting with us!

## A WORD FROM THE COORDINATOR

*Our AFLoNext undertaking will be extended until May 2018. This is related to the maturation of results and intese flight test activities that will be performed in the upcoming months.*

*Our goal remains to show that flow control is a key technology for future aircraft drag reduction and other benefits. The outcomes achieved so far by the consortium let us believe that AFLoNext will produce outstanding results and benefits for the European aviation.*

*In this sixth issue of our newsletter, you will find out the latest results achieved by the project partners. We invite you to pay special attention to the work package "Multifunctional Trailing Edge Concepts" that has come to an end and presents here its final successes. As usual, the interview will let you discover the day-to-day life of the people involved in achieving the AFLoNext goals.*

*I wish you all a good reading!*

*Dipl.-Ing. Martin Wahlich*
*Flight Physics Research and Technology*
*Airbus Operations GmbH*

### News & Events

The 6th CEAS 2017 Air & Space Conference will be held on 16-20 October 2017 in Bucharest, Romania. Several AFLoNext partners will participate in the event through special sessions dedicated to WP2 "Active Flow Control On Airframe" and WP5 "Multifunctional Trailing Edge Concepts".

Read more >>>

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# WORK PROGRESS WITHIN THE PROJECT

## HYBRID LAMINAR FLOW CONTROL

The recent project phase of work package (WP) 1 is clearly driven by preparation work to make the flight test (FT) a success. This work covers both the testing of FT components that are already available but also manufacturing of further demonstrators for testing and training.

The complete internal Hybrid Laminar Flow Control (HLFC) installation downstream of the plenum consisting of piping, mass flow measurement device, passive outlet, four-stage compressor, bypass system with choke and active and passive outlets was assembled for testing at Airbus Bremen during the last months (see figure 1). Using realistic power supply as later on during flight, various functionalities of the different components but also the complete system could be analysed in detail to get good confidence into it prior to FT.

After the MINI-DEMO, described in the last newsletter, the A320 mould intended to house the HLFC leading-edge was shipped to Airbus Bremen by DLR to start the preparation of a full scale demonstrator of reduced span (see figure 2). Based on this, it could be tested and finally successfully proven that required jig and tools are available and suitable. Furthermore, the manufacturing teams received helpful training on the task as final dry-run before the FT components will be assembled during the next weeks.

Finally, the flight is planned to take place from end of October until beginning of November this year after several months working party at DLR Braunschweig.

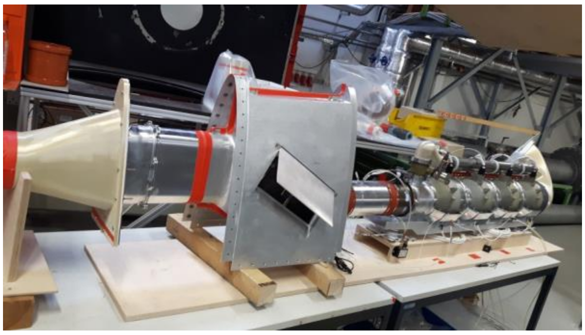

***Figure 1: Complete HLFC ducting set-up during testing on ground.***

***Figure 2: HLFC leading-edge demonstrator at full scale.***

## ACTIVE FLOW CONTROL ON AIRFRAME

During the past year, work package 2 concentrated on the preparation of multiple tests for assessing the maturity of active flow control hardware. Two types of actuators were prepared for detailed testing in harsh environments to prove their resistance on environmental conditions. The tests performed with the Piezo-driven synthetic jet actuators (SJA) included extreme temperatures (low and high), shocks and vibrations, contamination tests with rain, sand and dust, solid elements, and deicing fluids (see figure 3). The pressurized air driven hybrid pulsed jet actuators (HPJA) were prepared using different materials for manufacturing using 3D printing and are currently undergoing the tests at the Romanian research institute INCAS.

In parallel, the aerodynamic full-scale demonstration test has been prepared by completing the wind tunnel model of the generic wing/pylon/engine configuration (figure 4), where the active flow control actuation will be assessed for removing local flow separations in this area at high incidences. The model wing consists of a constant chord swept wing section with 3m chord and 6m span. The engine nacelle diameter of 1.8m represents an ultra-high bypass ratio engine (UHBR), which is promising a further benefit in fuel and noise reduction compared to recently introduced engines. The wind tunnel tests will start in September 2017 at the Russian research institute TsAGI in the biggest European wind tunnel, the T-101 facility with a test cross section of 24m x 14m.

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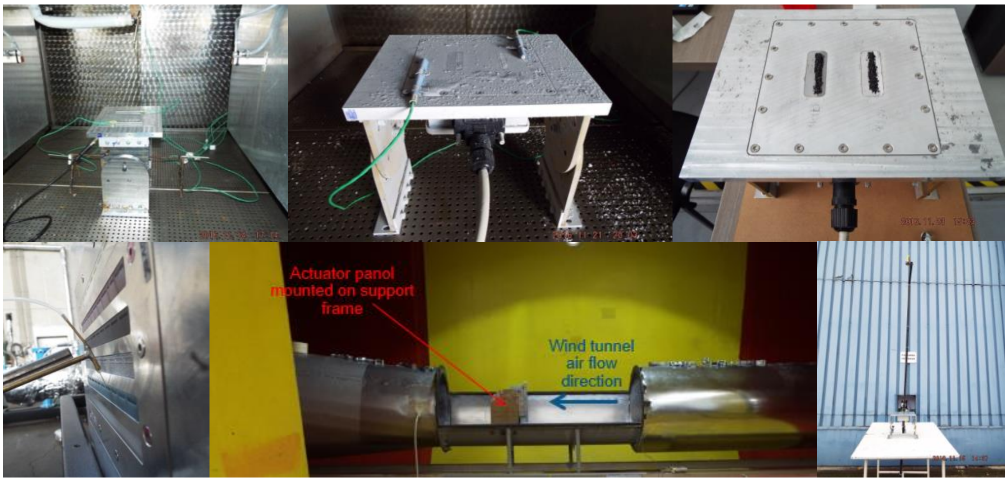


*Figure 3: Harsh environment tests with active flow control actuators performed at INCAS; top-left to bottom right: low/high temperature test in climate chamber, icing tests, solid element contamination, intermediate performance measurements, sand & dust , artificial rain.*

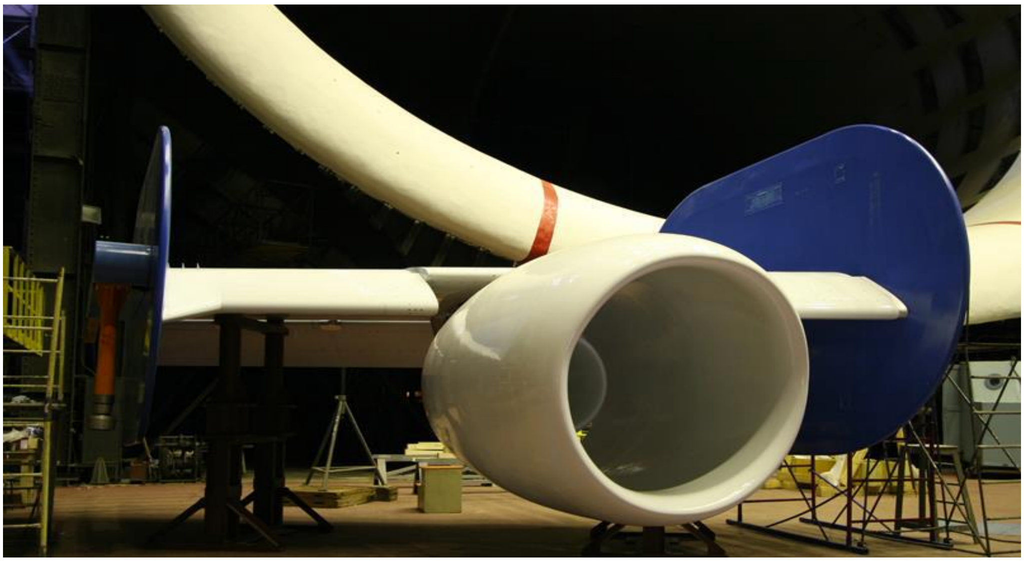

*Figure 4: Wind tunnel model of generic wing/pylon/engine wing section prepared for testing at the TsAGI T-101 wind tunnel.*

## CONTROL MEANS FOR VIBRATION AND AEROELASTIC COUPLING

Within the scope of defining devices (aero and structural) to reduce the vibration levels on the aircraft's main landing gear (MLG) doors, further steps towards the definition and design of such devices have been achieved.

In the past, the aerodynamic effect of devices such as vortex generators (VG's) on the MLG door displacement have been studied. As a result, e.g. VG's on the MLG door have been selected as appropriate means to reduce vibration levels. The dynamic Finite Element model (FEM) of the MLG door as a key component of the coupled fluid-structure (CFD-CSM) prediction chain has been updated based on the results from Ground Vibration Testing (GVT) on the DLR ATRA A320. Based on this model, structural devices have been investigated. The chosen devices are under design and are foreseen to be flight tested in 2017.

Regarding the nose landing gear door (NLGD), the first monolithic NLGD has been manufactured successfully. Last but not least, flight test matrix and flight test instrumentation (such as a camera to monitor the vibrations of the MLG door) for the AFLoNext flight testing in 2017 have been defined.

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*Figure 5: Camera position (top) and camara and fairing (bottom) on DLR ATRA A320. Courtesy of DLR.*

## NOISE CONTROL ON AIRFRAME

For the preparation of the noise reduction technologies in AFLoNext, a number of important steps toward the flight test were made. After the delivery of the modified flap CAD model, the Porous Flap Side Edge (PFSE) hardware design could be initiated. The interfaces for the Flap Side Edge (FSE) treatment design were clarified and agreed. Design teams were established by the partners and the final design work was launched. After passing the final Critical Design Review (CDR), all FSE treatment parts were manufactured and delivered, the set of outboard flaps was successfully modified according to the specifications. Based on the on-time delivery of all required documents, the technology was ready for testing and the corresponding permit-to-fly could be requested and was successfully received in July this year. Thanks to the achievement of this major milestone, the AFLoNext acoustic flight test of the PFSE technology on the ATRA was successfully performed mid of July. The data captured during flight test was collected and sorted by DLR, so that the data analysis can be launched soon. The hardware for the low noise landing gear activities – the second major part of activities in this work package – together with the required documentation, was not available for this first flight test campaign but will be part of the second campaign in spring next year. Here, design has been finished but some remaining manufacturing and documentation work is still ongoing.

## MULTIFUNCTIONAL TRAILING EDGE CONCEPTS

The last period has seen the final results and conclusion of the multi-functional trailing edge devices work package of AFLoNext. The technical activities were formally closed at a technical workshop, hosted by NLR Amsterdam in May 2017. This newsletter contribution summarises the main outcomes of this work package.

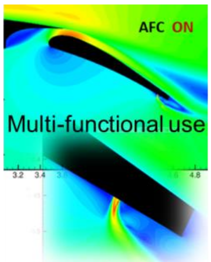



*Figure 6: CFD view of lower surface AFC TEDs.*

WP5.1 (multi-functional trailing edge devices) is a numerical assessment activity which began by defining both 2D and 3D Computational Fluid Dynamics (CFD) benchmarks for the study of various applications for different trailing edge Active Flow Control (AFC) concept devices. This benchmark was defined using results obtained during the previous FP6 "AVERT" project. During AFLoNext, the partners of WP5.1 have performed various CFD assessments against this benchmark, using several different test cases to predict the performance of fluidic Gurney flap and micro-circulation control devices. Iteratively, these results have been shared with other subtasks to identify the most promising application (buffet control) for experimental investigations. Similarly, the experimental results of WP5.2 were fed into the numerical assessments. As well as providing the aerodynamic requirements to generate aircraft-level architecture concepts to implement trailing edge control on a single aisle airliner. The overall results of WP5. 1 have been concluded via two reports; (i) Report on the parametric investigation of circulation control using a fluidic Gurney flap and (ii) Report on the identification of a reduced order model and the closed loop control of buffet by a pulsed fluidic TED.

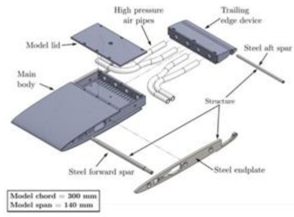
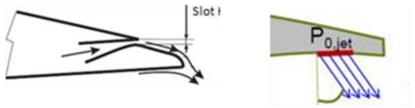



*Figure 7: Exploded view of Coanda device test model.*

WP5.3 (hardware and systems implementation concepts) produced five conceptual architectures for installing the most promising TEDs for use in buffet control at the trailing edge. These were informed by the numeric and experimental results performed earlier in the work package and were based on two different slot configurations, upper surface blowing and lower surface fluidic Gurney flap. Buffet control (specifically mach buffet margin reduction) was agreed by the project team as the best application for the purposes of the AFLoNext goals. Increased lift, drag reduction and gust load alleviation are also deemed to be appropriate applications for further research.



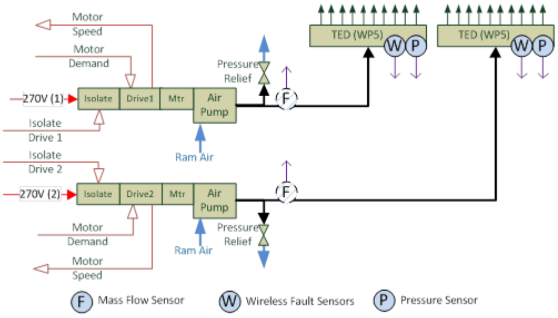
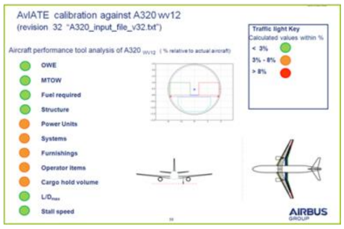




*Figure 8: Concept architecture – electric compressors local to the TED.*

Hazards arising from system failures were assessed for each architecture, including hazards arising from environmental threats. This included preliminary Functional Failure Modes and Effects Analysis and the challenges associated with safety assessment and certification. The suitability of the concepts for integration into the representative future reference aircraft were assessed in detail, including compatibility with the flight control systems, system power weight and volume.

The final subtask of work package 5 was the analysis and multi-disciplinary assessment of the most promising architectures, with the aim of identifying the "real world" benefit to the aircraft of such a Trailing Edge Device (TED) system. The scope of this assessment was to use a rapid low order methodology developed by Airbus to estimate buffet margin. The wing design space was investigated using and Airbus developed Aircraft technology evaluation tool, based on the single aisle use case (Mach=0.78, ToC=35,000ft, 3000nm, Payload=17,250kg). The parameters used for investigating the wing design space were as follows: planform constants $\Lambda 0.5$, t/c, ηcrank ; planform variables, span, taper, area. The study was limited to aerodynamic buffet onset (i.e. no account was made of structural excitation). Wing span loadings were calculated assuming that the Centre of Lift remains constant for CL range of interest. It was assumed that buffet is initiated when local sectional Cl exceeds a specified value (function of Mach, sweep, thickness & design philosophy).




AviATE Tool Adapted for Buffet Study

*Figure 9: Screenshot of AviATE tool adapted for Buffet study.*

The assessment of FTED for Buffet control was successfully carried out utilising data from across the WP5 partnership. The study examined a range of wing planforms for a typical Single Aisle aircraft mission, with buffet delay and mass flow requirements derived from 2D experimental and validated CFD data provided by WP5.1 and 5.2. System weights utilised trades developed in WP5.3. High span small area wings with flow control are identified as giving fuel burn benefits, with the benefit of the control reducing with increased wing area. Space allocation issues have been identified as challenging and will require significantly higher nominal pressure ratios. A possible weakness of the analysis is that the mass flow calculation is based on 2D data. Recent studies (e.g. CS "Bucolic") have indicated a strong span-wise buffet development for swept wings. This span-wise effect could be exploited to potentially reduce the mass flow required for buffet control. However this is not thought to be sufficient to invalidate the conclusions of the WP5.4 study.

The WP5 partners have engaged in various dissemination activities such as 3AF AERO2017, 52nd International Conference on Applied Aerodynamics. An article was prepared and presented, entitled "Flow Control at the Trailing Edge of Wings and Profiles: an overview of the AFLoNext project". Additional foreseen publications include the MSc thesis of Ben Shitrit of Tel Aviv University, various journal papers and contributions to CEAS 2017 (WP5 special session) and ISR Aero 2018.

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# INTERVIEW

AFLoNext newsletters offer you the possibility of getting to know some of the project partners a little better… Thus, the Interviews section will let you discover the day-to-day life of the people involved in achieving the AFLoNext goals.

In this edition of the AFLoNext Newsletter # 6, we propose you three tags which will lead the interview: stakes – applications – challenges – achievement – impact - trends in industry.

## EMMANUEL DETAILLE
## CHIEF TECHNOLOGY OFFICER
## COEXPAIR

**Q1**: You are the leader of the task 3.2.1 "Feasibility study and design for manufacturing" within AFLoNext. Can you please remind us the objectives and stakes of this work package?

**E. Detaille**: Coexpair and Safran System Aerostructures (SSA) have designed and manufactured a A320 Nose Landing Gear Door (NLGD) using Same Qualified Resin Transfer Molding (SQRTM) composite process.


*Figure 10: Airbus A320 frontward door.*

One of the objectives of the project is to validate an innovative architecture for the Main Landing Gear Door. This approach is demonstrated on a smaller part, the NLGD, by replacing the current sandwich part (i.e. frontward door as shown on figure 10) by a monolithic structure for stiffness optimization analysis (see figure 11). A flight test on A320 aircraft is planned at DLR in October/November 2017.

*Figure 11: A320 NLGD manufactured by Coexpair (one-shot injection).*

Compared to the original manufacturing process, the SQRTM process presents some obvious and real advantages. The primary advantage is that the injection and cure of the full structure is done in only one operation, instead of several operations (such as honeycomb machining and stabilization, sandwich lamination and cure, intermediate controls, curing of the final sandwich structure etc.).

**Q2**: What is innovative about these activities? Was the use of SQRTM new for this kind of **applications**?

**E. Detaille**: An advanced qualified aerospace manufacturing process is the core of the project: the SQRTM is an Out-of-Autoclave (OOA) process used to produce a one-shot complex structure having very stringent requirements in terms of structural performance, weight optimization, aerodynamic quality and cost. This integration eliminates several metallic parts and reduces weigh. SQRTM is a robust alternative to autoclave, combining advantages of RTM (closed mold process) with advantages of prepeg material (high toughness resins):

a) Possibility of highly integrated level of functionalities and net edge,
b) The customer's (or Airbus') standard autoclave material database is valid. Material allowables generated by SQRTM are equal or slightly better than ones obtained by autoclave,
d) SQRTM is a closed mold process (see figure 12), which leads to a strong control on the geometry (radii, plies conformity) and the thicknesses (i.e. volume of fiber) and so of the mechanical properties,
e) High surface quality on both sides allows easy ultrasonic in-situ inspection,
f) Robust process generating less scraps and non-conformities,
g) Potential for automation with the use of UD reinforcements (AFP or ATL),
h) Ability to manufacture large scale volumes with limited tooling costs.

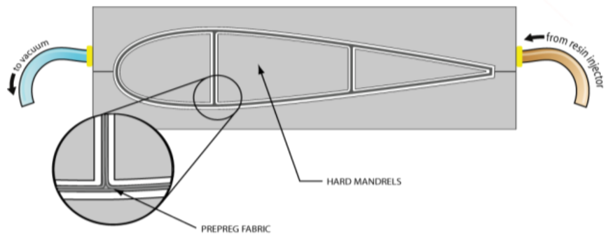


*Figure 12: SQRTM = Net-Shape process (by courtesy of Radius Engineering).*

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Moreover this process has been combined with a "design for manufacturing" approach towards:

- Optimizing the stiffness of the NLGD structure. The stiffness of the existing sandwich NLGD is uniform in all directions. In a monolithic structure, such as the AFLoNext, the stiffness of the structure is defined by designing the stiffeners (i.e. direction, location, shape etc.) based on the load cases;
- Lowering the cost / performance ratio in comparison to existing metallic solutions.

***Figure 13: "I" stiffener panel doors manufactured by Coexpair & SSA in European IMS&CPS FP7 project (experience gained & manufacturing risks mitigated).***

The design selected is based on the load cases, the Interface Control Drawings (ICD) provided by Airbus Spain and the background from previous IMS&CPS FP7 project (see figure 13).

Considering a high production rate (serial production), a preliminary Reduced Order Model (ROM) cost analysis showed a possible reduction on the overall manufacturing time in the range of 10-15% with the design shown here under (i.e. monolithic approach vs. multi-steps infusion of honeycomb material). Thanks to SQRTM, this reduction could be increased by integrating the fittings in the design as done for the A350 door demonstrator (not done on the A320 door due to constraints for the flight test).

**Q3**: What have been the **challenges**?

**E. Detaille:** There were several challenges during the project:

a) Functionality – Verify similar global stiffness of the new NLGD (to be able to close both the doors during the test);
b) Assembly (see figure 14) – Reuse existing fittings (hinges, stops, seals etc.). The design of the monolithic NLGD has been modified to fit to the original fittings;
c) Qualification – Acceptance of the technical dossier by Airbus;
d) Safety – Verify that no failure of the door will occur (e.g. in case of door actuation failure) under ultimate loads (1.5 times the maximum load ever seen during all the life of the aircraft).
Note: this method is similar to certification for parts for serial production. The difference is that in this case, the budget allocated was very limited and effort performed was a lot larger than expected.

***Figure 14: NLGD during fittings assembly at SSA.***

**Q4**: What do you think have been / will be the most significant **achievement**?

**E. Detaille:** Coexpair & Safran System Aerostructures (SSA) have designed and manufactured a Nose Landing Gear Door (NLGD) using SQRTM composite process.

One major achievement lies mainly in the flight test vibration monitoring of a highly integrated structure featuring some new design approach like an "I" profile stiffener that turns smoothly to two "C" profile stiffeners (see figure 11). This leads the way to further structure topological optimisation and maybe a more bio-mimetic Main Landing Gear Door. This is an innovative answer to vibration issues, mass optimisation and cost reduction.


***Figure 15: Fruitful collaboration between Coexpair and SSA teams for NLGD installation test on the aircraft performed at DLR July 13, 2017.***

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Another significant achievement for us, but also for the Airbus community, will undeniably be the flight test of a SQRTM part on A320 aircraft planned at DLR in October/November 2017 (see figures 15 & 16).


***Figure 16: Successful functional test of the 2nd NLGD (flying part) performed at DLR August 1, 2017.***

**Q5**: What has been / will be the **impact** of the results on the AFLoNext consortium? How will the results be beneficial to the AFLoNext partners and aerospace players?

**E. Detaille**: Improving innovation capacity and integration of new knowledge: the maturity of (SQ)RTM technologies in USA was higher than in Europe. The strategy of Coexpair was to grow in Europe, at Coexpair, an engineering team and a supply chain equivalent to the one available in USA, at our partner Radius Engineering. Today it is the case. Thanks to AFLoNext project and the continuous growth of Coexpair innovation capacity, a unique place for design, fabrication and qualification of advanced composite components has emerged in Europe, at Coexpair. This clearly enforces European competitiveness.


***Figure 17: Coexpair innovative equipment systems.***

The NLGD development will have a remarkable impact on the sustainable development of the European Aeronautic Industry and especially AFLoNext consortium because the research developments will contribute to:

- Increase the TRL of our landing gear door concept but especially demonstrate SQRTM process is increasing added value of composite part manufactured using a technology – accepted by Airbus & Safran – that can be extended to other aircraft components as fuselage frames, wing components etc.
- Deliver matured technologies in the area of highly integrated structure based on innovative design approach for novel aircraft configurations showing a potential for advanced eco-efficient design: reduced aircraft weight, structure topological optimisation, vibration mitigation and cost reduction.

This approach will consist in generalizing RTM and SQRTM processes to produce composite structures – in Europe – by developing new production lines especially fitted with European equipment while preventing outsourcing of these high added-value activities towards low-cost countries. Adoption of SQRTM by Boeing and Embraer for serial production is a clear signal that European OEMs, such as Airbus and Safran, and Tier-1 suppliers like Sonaca and Spirit have to speed-up their adoption of the process. This project will contribute to it.

**Q6:** In broader terms, how does the work that you perform within AFLoNext align with contemporary **trends in industry**?

**E. Detaille:** The NLGD development will contribute to sustainable transportation by allowing reduced energy usage by lightweight approaches for transport. This will allow transport in the future to consume less energy than is currently the case. Through increasing capacity using new lightweight materials, transport systems will be more efficient carrying more passengers or freight.

The impact on environment is straight forward thanks to the fuel economy. The RTM and SQRTM processes have also a positive impact on environment. It was published at Airbus Material Dialogue, Bremen 2009, that energy consumption for the manufacturing of a monolithic flap made in RTM is on 25% of the energy consumption to make all flap elements in an autoclave. Also, the (SQ)RTM processes drastically reduce the consumables such as nitrogen used to fill autoclaves and plastic vacuum bagging films used to seal tools.

The very low scrap rate achieved with production using SQRTM process (maximum 0.5% for serial production, 2/2 perfect doors and 0% porosity for AFLoNext project) is reducing the wasted material with positive impact on environment. Moreover the policy at Coexpair is to use solvent free release agents and injection equipment which is self-cleaning to minimize the consumption of solvent for cleaning.

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## GET-TOGETHER

The list of scientific and technological events related to the AFLoNext research areas can be found on our website. The file is regularly updated. Don't hesitate to inform us of any other event likely to interest the members of the AFLoNext community.

### EASN CONFERENCE 26-29 SEPTEMBER 2017, WARSAW, POLAND

The 7th EASN International Conference on "Innovation in European Aeronautics Research will include talks and presentations by key-figures from the academia, industry, research community and policy makers. It will also include thematic sessions on a series of domains and disciplines of A&AT along with technical workshops where evolving ideas, technologies, products, services and processes will be discussed. Research projects can exploit the opportunity and disseminate their results and achievements in dedicated sessions. Source: https://easnconference.eu/.

### CEAS 2017 16-20 OCTOBER 2017, BUCHAREST, ROMANIA

The Aerospace Europe CEAS 2017 Conference brings together academic, research, industry and operator representatives for a fruitful date exchange of the latest ideas and developments in European aeronautics and aerospace. Source: http://ceas2017.org/.

### STAB SYMPOSIUM 07-08 NOVEMBER 2017, GÖTTINGEN, GERMANY

The STAB Symposium aims to encourage networking between researchers and industrials involved in the German aerospace sector. Symposium website: http://www.dlr.de/as/desktopdefault.aspx/tabid-652/1104_read-1678/

### AIAA SCITECH FORUM 2018 08-12 JANUARY 2018, KISSIMMEE, FLORIDA, USA

In 2018, you can expect scores of opportunities for collaboration and discussion on the following topics: Aeroacoustics, Aircraft Design, Applied Aerodynamics, Fluid Dynamics, Meshing, Visualization, and Computational Environments • Modeling and Simulation and many more. Source:: https://scitech.aiaa.org/Program/

### 58TH IACAS 14-15 MARCH 2018, TEL AVIV & HAIFA, ISRAEL

The Israel Annual Conference on Aerospace Sciences is an important annual event on the calendar of the aerospace community in Israel and arouses a great deal of interest abroad. Taking part in this yearly event are engineers, scientists and experts in the field of aeronautics and astronautics, representing well-known local aerospace agencies and industries, as well as participants from major research centers worldwide.
Source: http://iacas.technion.ac.il/program/

### AIAA AVIATION 2018, 25-29 JUNE 2018, ATLANTA, GEORGIA, USA

The AIAA Aviation and Aeronautics Forum and Exposition will combine the best aspects of technical conferences with insights from respected aviation leaders. Source: http://aviation.aiaa.org/

### ICAS 2018, 09-14 SEPTEMBER 2018, BELO HORIZONTE, BRAZIL

The 31st Congress of the International Council of the Aeronautical Sciences will cover all aspects of aeronautical science and technology including military and civil aviation applications. Engineers, scientists, technologists, managers and leaders in aeronautics from around the world will be there to present their work, develop collaborative relationships and networks. Source: https://eventos.abcm.org.br/icas2018/

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