AFLoNext

2ND GENERATION ACTIVE WING

NEWSLETTER °4

December 2015

Welcome to the fourth newsletter from the AFLoNext project!

AFLoNext gathers forty European partners from fifteen countries for a period of four years, until May 2017. 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 will regularly keep you up-to-date on progress made within AFLoNext. What's more, you will be given a possibility to discover how the consortium partners cooperate to achieve the project objectives. You will also find out how and when we disseminate the AFLoNext results. This is in case you feel like meeting with us!

We take this opportunity to wish you all a great Holiday Season and a Happy New Year!

A WORD FROM THE COORDINATOR

We have now well taken off into the third year of AFLoNext. The oncoming months have a lot of challenges in store for us: we will have to secure the large scale testing activities such as the flight tests, wind tunnel tests and ground based demonstrators.

The second half of 2015 was intense in terms of meetings and face-to-face discussions with the members of the AFLoNext community. Indeed, we organised our first workshop in September and participated in AERODAYS 2015 in October. In this newsletter, we will look back at these events and tell you all about them. Do not forget that our website is regularly updated with the news on our past and upcoming dissemination activities.

In this fourth issue of our newsletter, you will also find out the latest results achieved by the project partners. 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

AFLoNext will be present at the AIAA 2016 and 6th EASN International Conference on Innovation in European Aeronautics Research. Further details will follow soon on our website.

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AFLONEXT FIRST WORKSHOP

Our first workshop was organised in collaboration with the 5th CEAS Air & Space Conference. It took place on 10 September 2015 at the premises of the Delft University of Technology, the Netherlands.

Fig. 1: Premises of the TU Delft.

The objectives of the workshop were for the AFLoNext community to share the results achieved by the industrial and academic experts developing novel aircrfat configurations and to network, exchange and discuss challenges all along the event. The workshop sessions were well attended and gathered almost 100 participants. 27 entities involved in AFLoNext were represented by the project partners. Nearly 50 external participants had registered to the workshop, they came from various European countries but also from more distant places such as Brasil, China and Iran.

Fig. 2: Presentation during the workshop.

The workshop started early in the morning with the presentation given by the AFLoNext coordinator illustrated with the project video. It was followed by the presentations from two key note speakers: Markus Fischer (Airbus Operations GmbH) and Clyde Warsop (BAE Systems). The key notes speeches provided a wider view on and beyond AFLoNext, allowed to promote a constructive debate and to inspire reflections. Moreover, they situated the AFLoNext technology streams in their technolgy trajectories until Clean Sky 2.

Fig. 3: Key note speaker Clyde Warsop (BAE Systems).

Furthermore, 17 presentations were given within 5 sessions organised around the AFLoNext technology streams:

- Hybrid Laminar Flow Control on wing and fin
- Active Flow Control on outer wing and Active Flow Control on wing / pylon
- Active Flow Control on wing trailing edge
- Vibrations mitigation / control in undercarriage area
- Noise reduction on flap and undercarriage

You can download all workshop presentations from our website. Do not hesitate to contact us (contact@aflonext.eu) in case you have any questions related to our first workshop.

SUCCESS OF AFLONEXT AT AERODAYS 2015

Aerodays 2015 took place on 20-23 October 2015 in London. The AFLoNext consortium was represented at the event via several channels:

- 4 presenters of the AFLoNext team: Martin Wahlich (Airbus Operations GmbH), Jochen Wild (DLR), Michael Bauer (Airbus Defence and Space GmbH), Zdobyslaw Goraj (Politechnika Warszawska), in different sessions.
- A specific stand co-animated by Peggy Favier (L-UP), Martin Wahlich (Airbus Operations GmbH), Martin Schüller and Perez Weigel (Fraunhofer ENAS), Emmanuel Detaille (Coexpair) and by our colleagues Jochen Wild (DLR) and Ardeshir Hanifi (KTH) who shared the stand for their respective coordination of DESIREH and RECEPT but are also active members of the AFLoNext consortium.

Fig. 4: FRAUNHOFER ENAS Synthetic Jet Actuators presented at the AFLoNext stand during Aerodays 2015.

The AFLoNext stand confirmed its attractiveness thanks to the presentation of the FHG Pulsed Jet Actuator and IM-CPS Landing Gear door prototype. We would like to thank again all our visitors for the fruitful exchanges held during the informal market places / discussion corners that captured external interest to the different technologies investigated in AFLoNext.

Fig. 5: COEXPAIR NLG door presented at the AFLoNext stand during Aerodays 2015.

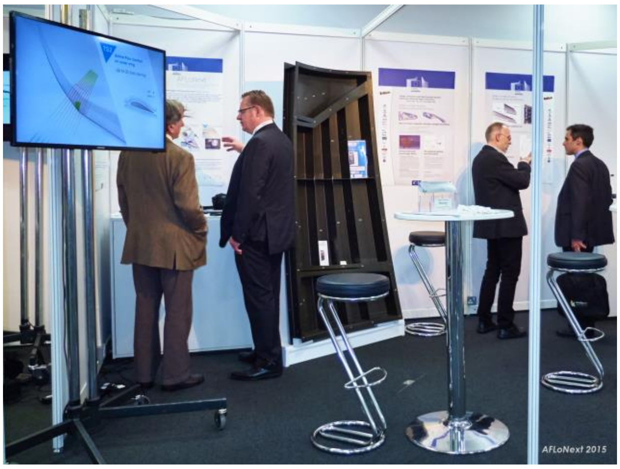

Fig. 6: Discussions at the AFLoNext stand.

Aerodays 2015 has been described as “a resounding success and has acted as a positive enabler for industry, governments, the European Commission, research institutions, academia and many others to come together to present strategic perspectives and achievements in aviation research and innovation“ (www.aerodays2015.com).

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Aerodays 2015 highlights:

- 1,090 delegates attended the event on one or more days
- 650 delegates attended the reception at Lancaster House
- 450 delegates attended the networking dinner at the Science Museum
- 280 speakers presented (253 parallel, 27 plenary)
- 90 exhibitors participated

Fig. 7: Martin Schüller (FRAUNHOFER ENAS) answering a visitor's questions at the AFLoNext stand.

WORK PROGRESS WITHIN THE PROJECT

HYBRID LAMINAR FLOW CONTROL

Following the Design Review in February of 2015, the HLFC Wing Leading Edge ground demonstrator has undergone extensive redesign and refinement addressing key problems. A 150mm front spar aft shift was agreed, providing greater space for the complex systems. The single duct solution was replaced with a resized dual duct solution where the HLFC suction and hot air anti-ice systems are largely separate. The Kruger and its interfaces have further matured, improving the sealing when stowed. The super-plastic-deformation diffusion-bonded suction skin has undergone a redesign optimising the suction chambers to mitigate manufacturing risks while meeting aerodynamic and anti-ice requirements. Significant effort has gone into the identification of a suitable 3D laser drilling facility (Fraunhofer ILT), a key objective in WP1.2. Finally the DMU has been developed to a more mature standard to the point where the manufacture of long lead items can be launched. This was decided in a Critical Design Review held at CIRA, Italy, in October. Further issues highlighted at this review included structural and operability challenges to the design, which underscore the challenge applying HLFC to the wing of a real world commercial airliner. Questions such as the upper cover joint concept will remain part of continued research which is being planned based on the lessons learnt thus far in AFLoNext. Work continues to finalise the DMU, define the assembly sequence, launch the manufacture, and plan the tests. Work on alternative skin concepts continues, providing a more mature basis for future research.

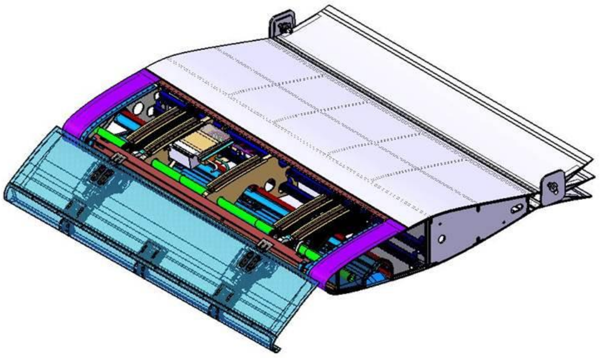

Fig. 8: AFLoNext WP1.2 HLFC Wing Leading Edge Ground Based Demonstrator DMU (skin panel removed for view of internal systems).

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ACTIVE FLOW CONTROL ON AIRFRAME

Active flow control technologies are being developed by a consortium of 18 partners targeting to recover performance issues of novel aircraft configurations in aerodynamically sensitive regions. Two challenges are addressed: i) large nacelles of Ultra High Bypass Ratio turbofans come with the risk of flow separation, thus performance deficit at wing/pylon junction ii) large span wings with aggressively designed wing tip could contain flow separation at the wing tip thus increased drag.

Recently, a Preliminary Design Review took place with support from an industrial expert panel judging the flow control concept for the wing pylon area, focusing on two axes: flow control with and without air net mass flux. Current ground testing aiming to verify the performance and functionalities of flow control hardware supported by numerical simulations will prepare the next Critical Design Review (2016). In parallel the design of interfaces between flow control hardware and the wind tunnel model is on-going, key players being the hardware designers and the tunnel operator.

For the second technical challenge of performance deficits at outer wing, numerical simulations (CFD) were carried out following the requirements from aerodynamic and hardware designs.These requirements include jet actuation velocities, actuation width, length and spacing. It turns out that current hardware concepts face problems to deliver the required peak velocities. In parallel flow control robustness and environmental ground testing is being prepared by INCAS, aiming to execute them in the last project year. The partner TAU will do an aerodynamic validation of flow control technology applied to a generic configuration via dedicated wind tunnel testing.

Fig. 9: View on the flow control actuator stage during the performance ground tests conducted at Airbus Group Innovations in Munich.

Fig. 10: Outer wing configuration to be tested at Tel Aviv University.

CONTROL MEANS FOR VIBRATION AND AEROELASTIC COUPLING

Within the scope of defining devices to reduce the vibration levels of the main landing gear door, important steps towards flight test have been achieved.

All Computational Fluid Dynamics (CFD) calculations have been completed for the baseline configurations covering different parts of the flight (take-off and approach) as well as fully and partly deployed landing gear. Comparisons to flight test data from previous tests show a good agreement to the numerical results. Further insight will be possible, once the flights within AFLoNext have been performed. The CFD and flight test data has been used to develop mitigation devices in the landing gear area. Three sources for the main landing gear door vibrations have been identified: the wake of the nose landing gear, the interaction between the flow and the main landing gear door cavity and the separation on the main landing gear door itself. Based on this knowledge, several devices have been developed and are currently being assessed in terms of practical feasibility and effectiveness.

The ground vibration test (GVT) on the main landing gear door has been performed and the data is currently being used to update the FEM. The updated FEM will allow a more accurate prediction of the door behavior during flight test as well as the assessment of structural mitigation devices.

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The new monolithic nose landing gear door concept has been frozen. The new door consists of a stiffener panel concept made from monolithic carbonfibre prepreg.

Fig. 11: Instrumented main landing gear door on the DLR ATRA A320 during the GVT.

NOISE CONTROL ON AIRFRAME

The data from wind tunnel test, which was conducted in late 2014, were analysed by DLR. Based on this test data, the proof of noise reduction potential of different treatments on a/c level could be given. The preliminary design of low noise devices for the main landing gear of the A320 test aircraft has been already done by Messier-Bugatti-Dowty (see Issue #3) and prioritised during a specialists meeting at Airbus in Filton in summer 2015. Beside this, gear-wake flap interaction noise has been isolated from array measurements in the wind tunnel test data and could be identified in the far field, which is important for the assessment of the community noise near airports. Flight Test (FT) qualification for Landing Gear is ongoing.

The activities on the flap side edge (FSE) modification are proceeding very promising. After the principle design of the FSE modification has been done in the first half of 2015, final tests on material and the attachment of the porous flap side edge treatment have been carried out. In the meantime a pair of A320 flaps has been manufactured and delivered at the begin of October. These flaps will be modified in early 2016, after the Critical Design Review has been held end of 2015. As for the landing gear the preparation of the FT qualification documents is going on, to enable the flight test of the porous flap side edge in 2016 as planned.

MULTIFUNCTIONAL TRAILING EDGE CONCEPTS

Multifunctional Trailing Edge Device (TED) studies continues to draw interesting results from numerical assessments of the TED concepts of the partners. Cross-comparison between all partners' results against AVERT 2D benchmark was completed and delivered during summer 2015. This data is now available for use in the downstream assessment activities, to be performed later in the project. In addition to the 2D assessment activities, a code validation exercise against the 3D benchmark is ongoing, expected to deliver in November 2015.

Fig. 12: Atmospheric Intermittent Wind Tunnel (VZLU).

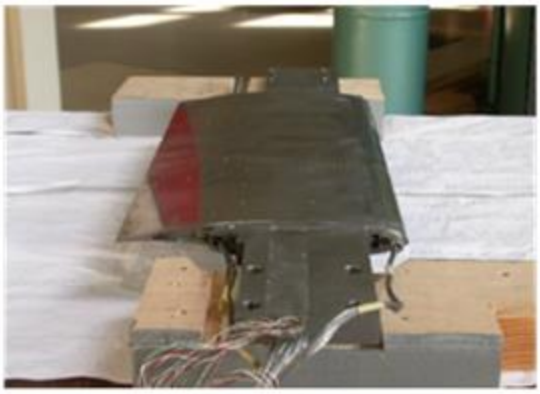

Fig. 13: 2D ONERA OAT15A aerofoil.

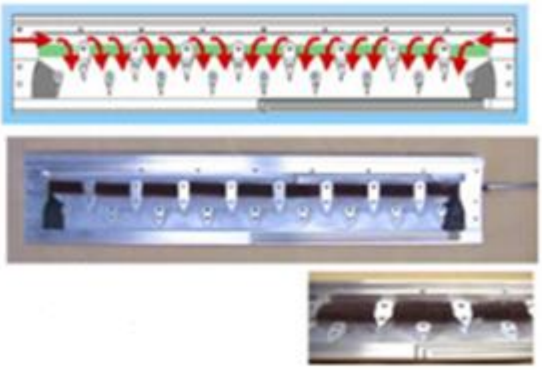

Fig. 14: Pneumatic TED.

In addition to the benchmarking exercises, transient tests of the Suction and Oscillatory Blowing (SaOB) system have been performed using a bench-top setup at the Tel Aviv University. This experiment was aimed at calibration of the transient response of the SaOB actuation system. It is essential to test the transient response of all components, separately, before starting to test the entire system. This is a preparatory stage for the transient response tests of the unsteady fluidic Gurney flap system as installed in the AR2 airfoil.

Preparation of the Transonic Wind Tunnel (TWT) for testing continues at the University of Manchester, using their quiescent bench test facility.

Quiescent tests were performed at Nozzle Pressure Ratios (NPR) of between 2 and 5. Of particular interest is the successful continued attachment of the jet at NPR 5, as shown in the figure below.

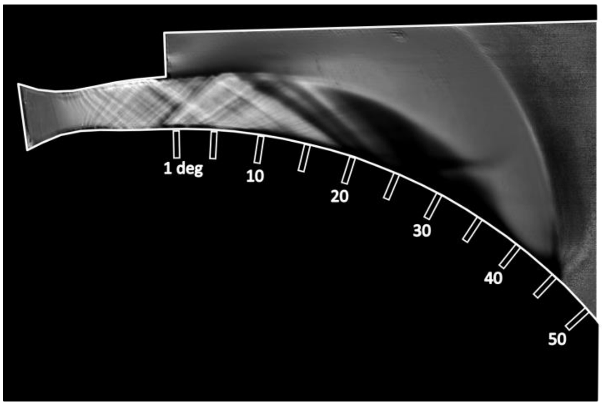

Fig. 15: Schlieren of NPR 5 run, with pressure taps indicated.

A high speed camera was installed into the Schlieren imagery rig. The resulting images collected confirmed that the flow remained steadily attached to the Coanda surface. The blurred area seen in the 250µs exposure below is a result of effectively averaging the turbulence in this area. The second image taken with a 1µs exposure captures this turbulence with greater clarity.

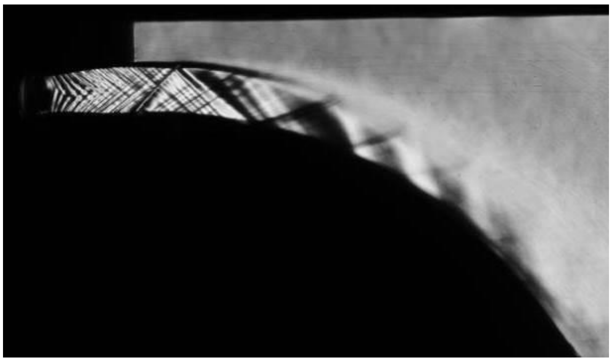

Fig. 16: Schlieren image taken with 250us exposure.

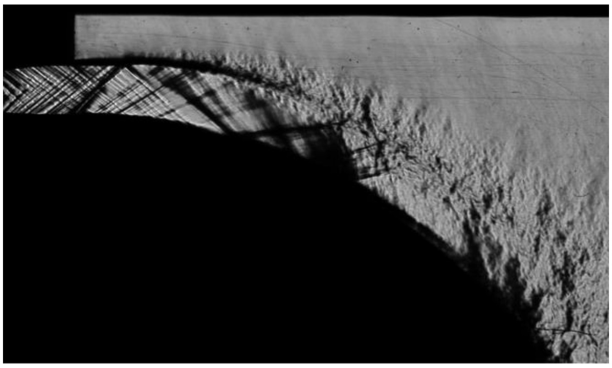

Fig. 17: Schlieren image taken with 1us exposure.

Preparations for the planned transonic test regime are ongoing, with work focussed on preparing the data acquisition system and refining the model design.

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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.

56TH IACAS

The 56th Israel Annual Conference on Aerospace Sciences will take place on 9 March in Tel Aviv and on 10 March 2016 in Haifa, Israel. Source: http://www.iacas.technion.ac.il/

22ND AIAA/CEAS AEROACOUSTICS CONFERENCE

The Association Aéronautique et Astronautique de France (3AF) and the American Institute of Aeronautics and Astronautics (AIAA) organise the 22nd AIAA/CEAS Aeroacoustics Conference on 30 May – 1st June 2016 in Lyon, France. Source: http://www.aeroacoustics2016.com/

ECCOMAS CONGRESS 2016

The VII European Congress on Computational Methods in Applied Sciences and Engineering will be held on 5-10 June 2016 in Crete, Greece. Source: http://www.eccomas2016.org/

DLRK 2016

The German Society for Aeronautics and Astronautics (DGLR) organises the German Aerospace Congress on 13-15 September 2016 in Braunschweig, Germany. Source: http://www.dglr.de/nc/meldungen/dglr_news_meldung/article/dlrk-2016-findet-in-braunschweig-statt/index.html

6TH EASN INTERNATIONAL CONFERENCE

The European Aeronautics Science Network (EASN) and the Institute of Science and Innovation in Mechanical and Industrial Engineering (INEGI) organise the 6th EASN International Conference on Innovation in European Aeronautics Research on 18-21 October 2016 in Porto, Portugal. Source: http://www.easn.net/

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 # 4, we propose you three tags which will lead the interview:

Nose Landing Gear Door (NLGD) - final NLGD concept - Finite Element Model (FEM) - Same Qualified Resin Transfer Moulding (SQRTM)

EMMANUEL DETAILLE
CHIEF TECHNOLOGY OFFICER
COEXPAIR

Q1: You are involved in the activities aiming to check the feasibility and to manufacture new structural concepts of the landing gear doors to reduce vibration levels. Could you please explain us the work performed to develop the new design of the **Nose Landing Gear Door (NLGD)**?

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Fig. 18: Airbus A320 frontward door.

A1: Coexpair & SLCA are currently working on the design of the NLGD (i.e. frontward door as shown on figure 18). The objective is to replace the current sandwich NLGD by a monolithic structure for flight test.

Some major development steps have been identified to meet the objectives defined at the beginning of AFLoNext project :

- Door concept selection
- Detailed design of the door
- Design of the mold
- Manufacturing of the door

Fig. 19 : "I" stiffener panel doors manufactured by Coexpair & SLCA in European IMS&CPS FP7 project (= experience gained & manufacturing risks mitigated).

The current design proposals are based on both the load cases and Interface Control Drawings (ICD) provided by Airbus Spain and the background from previous IMS&CPS project (see figure 19):

Step 1 – Concept generation

- review of preliminary requirements between SLCA & Coexpair (compliance matrix)
- analysis on how to meet main requirements (e.g. same shape envelope, same connections as current ones etc.)
- ranking of all generated concepts in three main families on the basis of a trade-off conducted with several criteria : technical (inspectability, withstand load cases…), production (suitability for potential serial production), Aflonext requirements (time schedule with respect to flight test)
- current auxiliary parts kept identical to ease door installation on the aircraft

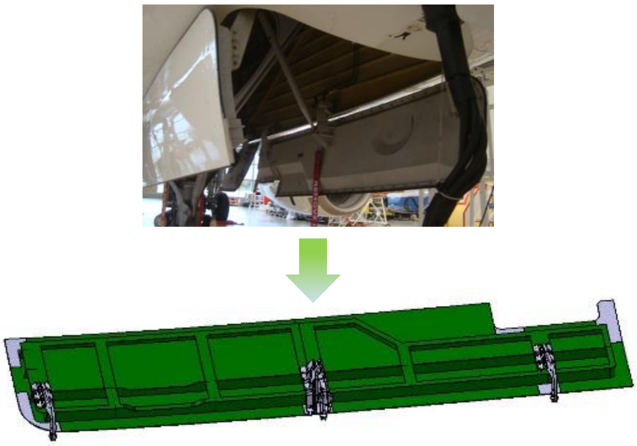

Fig. 20: "I" stiffener panel door designed by Coexpair & SLCA in AFLoNext.

Step 2 – Final design based on selected NLGD concept (see figure 20).

- FEM analysis to freeze the lay-up in each section
- Definition of ply groups for preforming in each area
- Definition of the final geometry (3-D CAD model)
- Definition of adaptations of some existing connections if needed

Q2: What were the criteria for selection of the **final NLGD concept**?

A2: As described previously, the ranking of all generated concepts has been operated in three main families on the basis of a trade-off conducted with several criteria : technical (inspectability, withstand load cases…), production (suitability for potential serial production), Aflonext requirements (time schedule with respect to flight test).

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Q3: What are the stakes of the **Finite Element Model (FEM)** analysis?

A3: There are several stakes (see figure 21) :

1. Functionality – Check similar global stiffness of the new NLGD to be able to close both the doors during the test.

2. Safety – Check no delamination propagation under ultimate loads (1.5 times the maximum load ever seen during all the life of the aircraft) & check no failure of the door (in case of door actuation failure). This method is similar to certification for parts for serial production, the difference is that in this case, as the door will fly only a few dozens of minutes (and not for several years), the qualification process near the authorities for the flight test will not require, for example, fatigue tests (tests used to show that a part can withstand a load several dozens of thousands of time over several years).

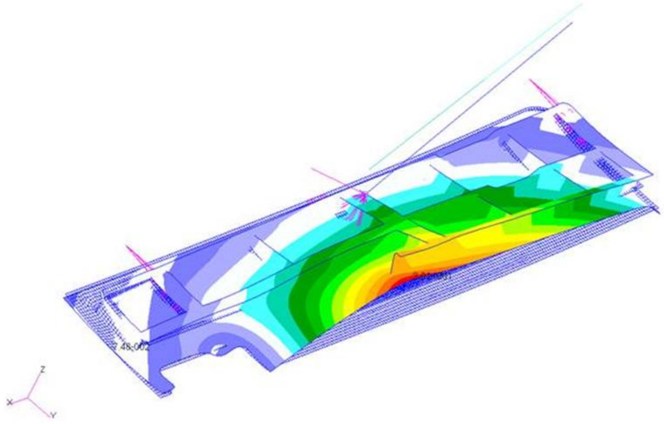

Fig. 21: FEM models performed with Nastran for design load cases (ultimate & failure) provided by Airbus.

Q4: What can you tell us about the manufacturing process that will be used i.e. the **Same Qualified Resin Transfer Moulding (SQRTM)**?

A4: SQRTM is a robust alternative to Autoclave combining advantages of RTM (closed mold process) with advantages of autoclave (high toughness resins)

- SQRTM is an Out-of-Autoclave (OOA) process
- material allowables generated by SQRTM are equal or slightly better than ones obtained by autoclave
- closed model process (see figure 5) as RTM (in comparison to autoclave : very good control of thickness so of the volume of fiber, and so of the mechanical properties + possibility of high level of integration of functionalities)
- SQRTM allows use of program-specific prepreg ("same qualified"), including toughened systems such as Hexply 8552, Hexply M21, Cycom 977, Cycom 5250-4 BMI, and Toray 3900-2 (BMS 8-276)[1]
- tape-laid, drape-formed or hand-laid then debulked under vacuum
- tooling is Al, steel or Invar
- possibility of net edge
- as tool is heated, small quantity of prepreg resin is injected into tool to fill tool cavity around edges of part, resin hydrostatic pressure maintained at 8-9 Bar during cure

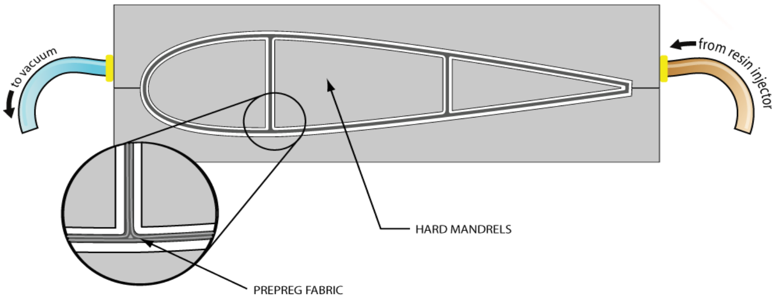

Fig. 22: SQRTM = Net-Shape process.

[1] Cycom 977-2 and Cycom 5250-4 are registered trademarks of Cytec. Hexply 8552 and Hexply M21E are registered trademarks of Hexcel. Toray 3900-2 is a registered trademark of Toray.