NEWSLETTER N°3

June 2019

Welcome to the ACASIAS project newsletter

ACASIAS' goal is to reduce the environmental impact of aircraft by improving aerodynamics and reduction of the weight of the aircraft. ACASIAS will embed sensors and antennas into typical aircraft structures (for instance fuselage panels, winglets and tails). The aerodynamic performance is improved by the conformal and structural integration of antennas. The noise reduction of CROR engines inside the cabin is facilitated by installation of an Active Structural Acoustic Control (ASAC) system in the lining.

Word from the Coordinator

The second year of the project will come to an end soon but all ACASIAS partners continue their interesting research activities with great involvement to achieve the project objectives and to deliver outstanding technical results!

The Intermediate Review Meeting was held in January 2019 in Brussels this year. The EC Project Officer concluded that the highly motivated ACASIAS consortium had achieved a significant progress.

For the assessment of structural and electromagnetic properties of the ACASIAS innovative structures airworthiness requirements need to be considered which are necessary for future certification. To this end we had a very informative and efficient meeting with EASA in February 2019.

We are now preparing activities for the manufacturing of the ACASIAS innovative structures. Special moulds are being prepared for the efficient manufacturing of the orthogrid structure in WP2 and for the manufacturing of the smart winglet in WP4. Furthermore technology is developed for the active cooling of electronic hardware components which need to be integrated in the Ku-band antenna tiles to achieve satellite communication.

In strong cooperation with CIMNE we are organizing the European Conference on Multifunctional Structures, which will take place in Barcelona. You will find more information about this conference in this newsletter. We are very proud of the large number of papers that were submitted by the ACASIAS team.

In this third issue of our newsletter, you will find the latest results achieved by our project partners. And the interview with Stephan Algermissen will show some aspects of his day-to-day life in achieving the ACASIAS objectives. I wish you all a good reading,

Harmen Schippers

NEWS & EVENTS

The ACASIAS conference, EMuS2019 "European Conference on Multifunctionnal Structures", will take place, the 11th and 12th of June 2019, in Barcelona. This event will bring together scientific and the industrial community to present the recent advances made on mechanical structutures.

>> Read more

ACASIAS presentation leaflet is now downloadable :

>> Download the pdf

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This project has received funding from European Union's Horizon 2020 research and innovation programme under grant agreement No 723167

Fuselage panel with integrated ASAC (Active Structural Acoustic Control) system for reduction of CROR cabin noise with minimal impact on weight: WP3 results

"Bring active systems for noise reduction closer to the market!" These words summarize our main challenge in WP3 very well. In contrast to previous research, we address topics like industrial manufacturing, maintenance and cost effective components for active systems. Together with our partners and the support of the industrial advisory board we are well positioned to find good solutions for raising the technology readiness level of these systems to make them attractive for airliners.

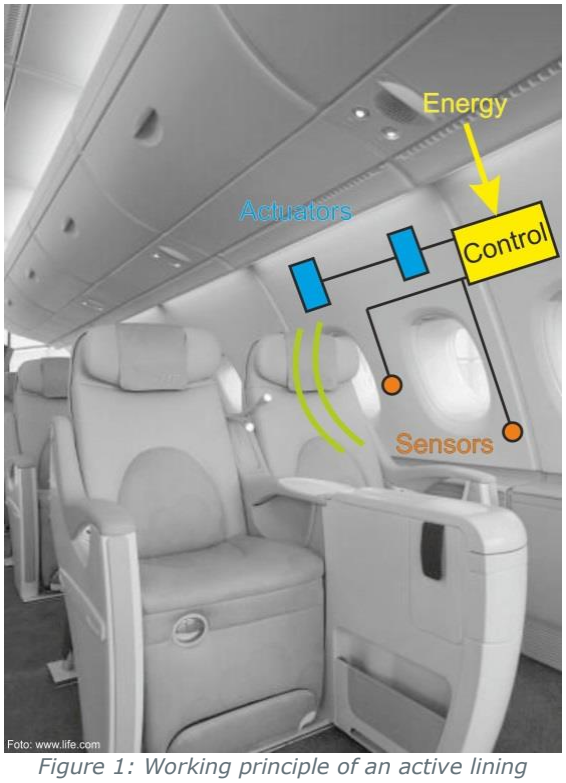

Figure 1: Working principle of an active lining

First of all, we address our target application the noise reduction using active linings for an aircraft with contra-rotating open rotor (CROR).

First experiments with ASAC systems for CROR noise were conducted with a loudspeaker array. This array is able to reproduce an acoustic wavefield coming from a CROR engine with up to 112 dB sound pressure level. This level is equivalent to the one at a rock concert. Real sound pressure levels on the outside of a fuselage due to a CROR engine may reach up to 148 dB at specific frequencies. Promising results with ASAC systems allow to expect an acceptable sound pressure level for passengers in an aircraft equipped with this new engine type.

The main achievements reached today are the detailed design step, which are the results of the collaborative work between all WP3 partners. The ACASIAS partners share a common understanding of the project goals. The periodical meetings are fruitful and constructive since engineers from many disciplines are participating and share their knowledge.

With the rise of new propulsion technologies, such as the CROR engine, the airliners and suppliers are willing to install active systems for noise reduction. Nonetheless, the scope of applications of active systems is much wider. They can also be used as retrofit solutions in aircraft with turboprop engines to reduce the noise level inside the cabin. Additionally, the passenger announcement systems can be replaced by the active linings. This saves weight and gives the opportunity to increase the speech intelligibility.

A smart Fibre Metal Laminate (FML) GLARE (Glass Laminate Aluminium Reinforced Epoxy) panel with integrated VHF communication slot antenna and GPS patch antennas

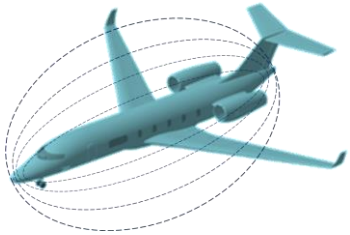

Figure 2: Integrating electrcomagnetic functions into Fiber Metal Laminates

The work on integration of antennas in a Smart Fiber Metal Laminate aircraft skin panel continued in the ACASIAS project to develop the main concepts into workable design solutions that are viable from a structural strength and antenna performance perspective.

To recapitulate, similarities between fiber metal laminate and antenna constructions (i.e.: metallic elements separated by a dielectric material) make a strong case for integrating antenna functions into aircraft (fuselage) skins, when targeting aerodynamically 'cleaner' future aircraft.

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The real challenge in developing this technology lies in integrating different, and normally separated, functions of load transfer and transceiving RF energy; to integrate and embed non-structural elements into aircraft skins without adversely affecting aircraft weight, operating cost and maintainability.

Development has so far resulted in two baseline designs that are going to be build shortly, and that will undergo testing in the second half of this year.

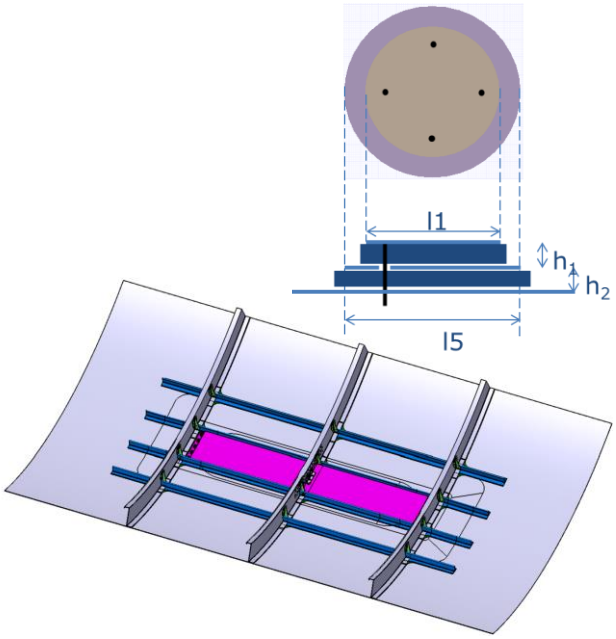

Figure 3: Preliminary designs of the 2 firsts concepts

This work is particulary complicate since the fact to integrate an antenna directly in the plane fuselage could result in weakening the resistance of the plane enveloppe, wich aims to ensure the pressurisation inside the plane. Despite numerous difficulties encountered during the development work, in the end, a satisfactory design has been made for each of the two integrated antennas. Difficult topics still lie in front of us, mainly in the area of manufacture and industrialisation, but confidence exists in delivering functional prototypes that could eventually have real life applications.

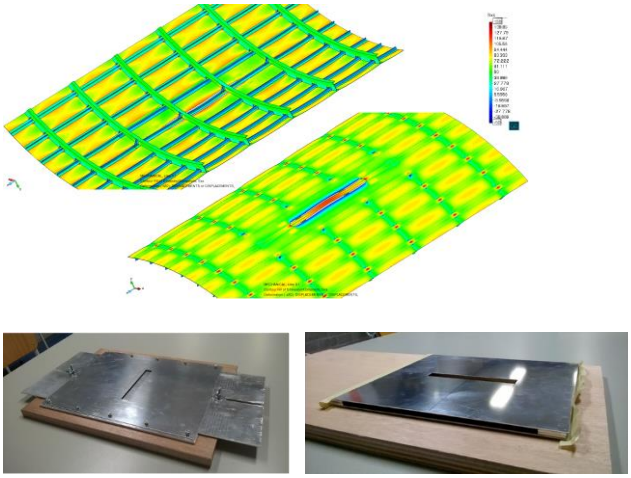

Figure 4: , Simulations, actual and virtual testing have shown promising results

So far, simulations, actual and virtual testing have shown promising results as well as deeper insight into the mechanics and failure modes of these integrated structures.

Other main achievements have been that **a viable solution has been found for the integration of the large VHF antenna**, especially in being able to reflect the inward RF wave outwards, within acceptable spatial constraints that minimize the impact on structural strength and usable cabin space.

A great achievement also lays in the **smaller GNSS antenna, which is a truly integrated antenna.**

The outlook for the remainder of the development is to validate the designed solutions, by testing and analysis. Furthermore, identifying and selecting notional applications for this technology will form part of the next development phase also.

Further details will be shared during the EMuS conference, in Barcelona, coming June 11 and 12, where two topics related to this work package will be discussed:

- "Radiating Aerostructures", and
- "Integrating electrcomagnetic functions into Fiber Metal Laminates – the structural challenge"

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THE CERTIFICATION ROAD

The ACASIAS project aims to bring to the market four innovative structures:

- Innovative structure 1: Stiffened skin for integration of Ku-band antenna tiles. The objective is to manufacture an orthogrid stiffened panel with a glass/quartz to embed the tiles in the grid structure.
- Innovative structure No. 2: Stiffened composite structure with integrated sensors, actuators and wiring. DLR has already initiated work for this technology in previous projects. The objective is to integrate sensors, actuators and wiring in the fuselage structure.
- Innovative structure No. 3: Integration of blade antenna in composite winglet. The main innovations are the manufacturing of blade antenna on flexible substrate, the integration of flexible substrate into Winglet of Aramid foam and the Quartz skin that covers partly the winglet.
- Innovative structure No. 4: Integration of VHF-slot and GPS antennas in GLARE-like fuselage panel. The main innovations are the integration of flexible substrates in FML, the miniaturization of antenna; the manufacturing of radiating slots in upper skins of FML and the decrease of antenna height.

In order to guaranty the adequation of these higly innovative structure to the market and to the end user needs, the ACASIAS consortium takes councel from an Industrial Board composed by members from aeronautic industry experts, such as Airbus Defence and Space, Lufthansa Technik, Dassault Aviation, Aerodata AG, Diehl Aircabin GmbH and the certification organisation: the European Union Aviation Safety Agency.

The certification from the responsible aviation regulatory authority of all the proposed innovation is mandatory before a newly developed aircraft model may enter in operation. The certification insures that the innovation meets the safety requirements set by the European Union.

The four steps of the certification process are:

- The technical familiarisation and Certification basis. This step consist into the forst presentation of the project to the EASA in order to set of rules that will apply for the certification.
- The establishment of the Certification Programme.
- The Compliance demonstration. This compliance demonstration is done by analysis during ground testing (such as tests on the structure to withstand bird strikes, fatigue tests and tests in simulators) but also by means of tests during flight.
- The Technical closure and issue of approval. If technically satisfied with the compliance demonstration by the manufacturer, EASA closes the investigation and issues the certificate.

All ACASIAS' innovations will have to go through these steps before being brought to the market. To ease this process, ACASIAS and the Industrial board members work already together on these aspects.

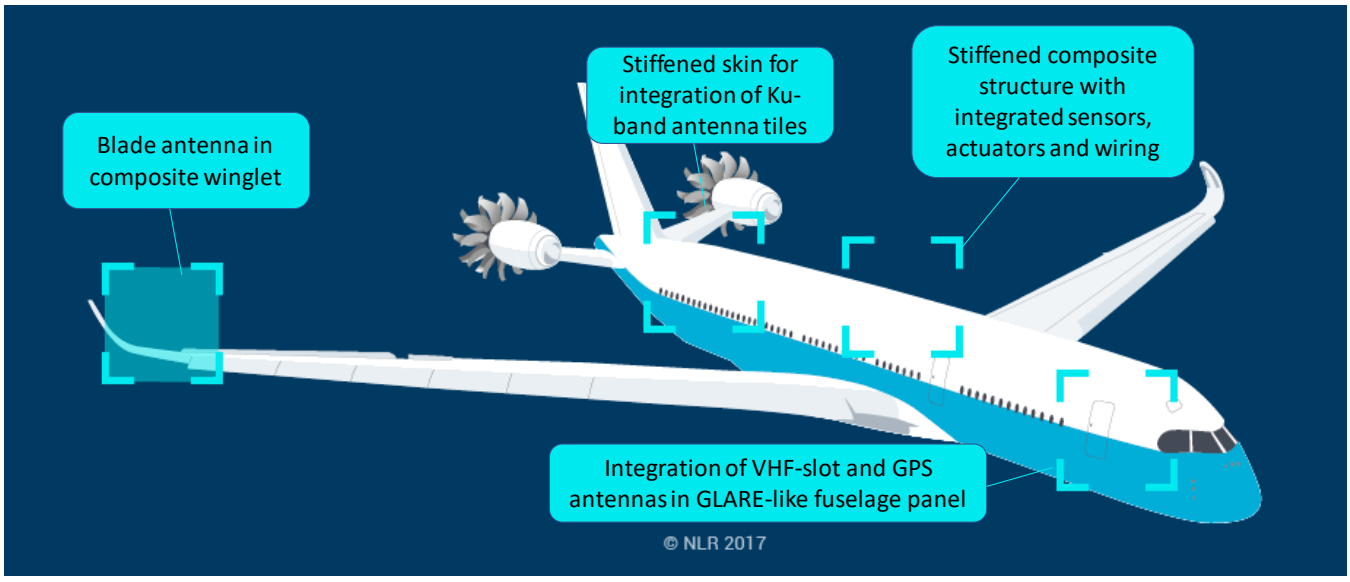

Figure 5: ACASIAS four innovative structures

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GET-TOGETHER

EMUS CONFERENCE 11TH-12TH JUNE 2019

The ACASIAS project organise the EMUS conference wich is the European Conference on Multifunctionnal Structures. The main aim of the Multifunctional Structures conference is to share among the scientific and the industrial community the recent advances made on mechanical structures with multiple functions. Recent advances in material technology have improved the additional capacities of such structures in a way in which now, their added functionalities can be as important as their mechanical performance.

Multifunctional Structures conference will look into a wide range of structural systems, serving different purposes: structures with embedded sensors that give them the capacity to react to an external stimulus, structures with embedded antennas, self-healing and self-monitoring structures, structures with improved fire performance, acoustic performance, or electromagnetic performance, and so on. The large amount of possibilities offered by multifunctional structures make them very valuable in all engineering fields, being of special relevance to the transport sector, in all its forms: automobiles, ships and yachts, aero-structures, etc.

The conference on Multifunctional Structures will take place in in Barcelona, on June 11th and 12th, 2019. This conference is as part of the EU H2020 ACASIAS project. EMuS 2019 will is also supported by ECO-COMPASS Multifunctional Structures experts

Source: http://congress.cimne.com/emus2019/frontal/default.asp

INTERNATIONAL PARIS AIR SHOW 17TH-23TH JUNE 2019

The International Paris Air Show is organised by the SIAE, a subsidiary of GIFAS, the French Aerospace Industries Association.

The 53rd Show will take place at the Le Bourget Parc des Expositions from 17 to 23 June 2019, and once again will bring together all the players in this global industry around the latest technological innovations. The first four days of the Show will be reserved for trade visitors, followed by three days open to the general public.

Source: https://www.siae.fr/en/the_show/presentation.htm

9TH EASN INTERNATIONAL CONFERENCE 3RD-6TH SEPTEMBER 2019

This event, organised by the EASN Association, the University of Patras and the National Technical University of Athens is about "Innovation in Aviation & Space" which will take place in Athens, Greece from the 3rd until the 6th of September, 2019.

The aim of this gathering is dual. To act as a forum where innovative ideas, breakthrough concepts and disruptive technologies are presented, while in parallel be the place for disseminating the knowledge and results achieved in the frame of research projects of the aviation and space field. The previous EASN International Conference, held in Warsaw, Poland in September 2017 has been attended by more than 300 participants from various disciplines and a similar attendance is expected also for the 2019's event.

Source: https://easnconference.eu/home

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INTERVIEW

ACASIAS 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 ACASIAS goals.

In this edition of the ACASIAS Newsletter n°3, we propose you the interview of the Dr. Stephan Algermissen, working at Institute of Composite Structures and Adaptive Systems within the DLR. He received his doctor's degree in Mechanical Engineering from the Technical University Braunschweig in 2010. In his dissertation he investigated "Self-Tuning, Robust Control of Structural Vibrations for Parallel Robots" and since then, his research interests include system identification, vibration/acoustic control, robust and self-tuning control, and controller implementation.

The tags leading the interview are: **Active Structural Acoustic Control – Innovation market oriented – Smart integrated structures – private and work life balance**.

DR. STEPHAN ALGERMISSEN
WP3 LEADER
DLR– GERMANY

Q1: As the WP3 leader, you are involved in a smart layer of sensors and actuators into a fibre reinforced plastic structure to set up a smart active acoustic lining panel. Could you please remind us the objectives and challenges of these activities?

The sensors and actuators you talk about are components of so-called active systems. They allow a controller to sense vibrations and to react to it. You can compare it with balancing a stick on your hand. Your eyes see the movement of the stick, the controller that is called your brain calculates the best moves to keep the stick upright and your muscles execute them. This is the same principle that we have in active structures. In the case of WP3, the sensors are accelerometers on a lining that measure its vibrations. Exciters induce forces to change the vibrations of the lining. The objective is now to synthesize a controller that is able to use the sensors and the actuators to reduce the noise that is transmitted through the lining to the passengers' ears. In ACASIAS we are applying this technique to noise coming from a new type of engine called a contra-rotating open rotor (CROR). This engine type promises far less fuel consumption and CO_2 production than common jet engines. The major drawback is that they emit a high level of noise. Current insulation materials are unable to protect passengers against this unhealthy noise exposure whilst active linings are an attractive option to overcome this challenge. In ACASIAS we treat the active system as an enabler for bringing CROR engines into service.

Q2: What is innovative about these research activities?

In ACASIAS we want to go one step further than work done in other projects in that we are considering industrial manufacturing, series production, maintenance and health monitoring issues in addition to finding out only how to reduce noise. With this approach we are addressing the needs of aircraft manufacturers and their suppliers. What has been done before is to determine what the optimal positions are for actuators and sensors and apply these devices to these positions, without any consideration of the industrial issues. In previous research this was sufficient for the laboratory experiments, but in ACASIAS we are thinking about the real world.

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Q3: What are the strengths of DLR in the ACASIAS consortium?

Our Institute of Composite Structures and Adaptive Systems within the DLR has extensive experience in the realization of active systems. Through the collaboration with aircraft suppliers we gained insight into their needs. Our technical equipment for vibration and sound measurements and for controller rapid-prototyping combined with our Acoustic Transmission Loss test facility give us the opportunity to implement complex active system and to test them in extensive experiments. Our new 3D-printing branch allows us to shorten our product development cycle by creating new parts very fast and reliable.

In ACASIAS we want to go one step further than other projects that focus on understanding the noise reduction. ACASIAS also focus on industrial manufacturing, series production, maintenance and health monitoring.

By doing so, the project will propose solution adapted to the aircraft suppliers needs.

Q4: The WP3 work on active sensors and actuators when the other WPs focus their activity on the integration of antennas in the fuselage and winglet: is there some benefits that WP3 can gain from the work performed in the other WPs?

At first glance antennas and active noise reduction seem to have little in common. But if you take a closer look, you will find a few parallels. In an electrical sense antennas are as active as sensors and actuators. Both need wiring for their supply with electrical energy. Interfaces allow them to interact with their environment. Apart from that you should not forget that both technologies have to be integrated into structures! You can see it at our partners Trackwise and Invent. Both are involved in several WP where their experience with structures and wiring is needed to support the teams. As for myself I don't have much background knowledge about antennas. But in our periodic meetings all partners come together and I like the inspiring atmosphere there, talking about their disciplines.

Q5: How does the work performed in WP3 correlate to general trends in industry?

One main trend in industry is to integrate a kind of "intelligence" into all kinds of parts. In WP3 we address this issue. Our objective is to combine a lining structure with an active noise reduction to create an autonomous, "intelligent" lining. The idea is to offer a plug-and-play solution to the airliners that is ready for series production. The active linings don't need external sensors or actuators. Just supply electrical energy and mount it to the fuselage.

Q6: In addition to your position as an engineer for DLR you also have another professional activity, as a farmer. Can you tell us more about this activity?

Almost 16 years ago, my wife decided to take over her father's farm. We had an employee who retired already. As he began to reduce his working time, I joined my wife in 2010. DLR gave me the opportunity to share my working hours between the farm and the research in the institute. Now, I start my week in DLR and come home for running the farm at the end of it. I like the challenges of both jobs especially the technical aspects. Experiences I gain in one job give me ideas and input for the other one. This works in both directions. On the farm you have to face the weather which influences nearly everything. In DLR my work is influenced by various impacts except the weather. That keeps it exciting!.

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