Cabin nOise reductioN ground Checked by nEw loudspeakeR exciTatiOn

Reporting

Project Information

CONCERTO

Grant agreement ID: 886836

Project website

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10.3030/886836

Project closed

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31 January 2022

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SOCIETAL CHALLENGES - Smart, Green And Integrated Transport

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€ 736 500,00

EU contribution
€ 549 000,00

Coordinated by
LEAD TECH SRL
Italy

Periodic Reporting for period 1 - CONCERTO (Cabin nOise reductioN ground Checked by nEw loudspeakeR exciTatiOn)

Reporting period: 2020-07-01 to 2022-01-31

Summary of the context and overall objectives of the project

The current race for green mobility is changing the design philosophy in all engineering disciplines; this is tangible especially in aeronautical segment, where optimization and innovation are the key for a sustainable future mobility. In addition, the comfort of passengers is a critical issue for both, manufacturer and airlines, and the noise levels in the passenger cabin of turbopropeller-driven aircraft are typically higher than the levels in comparable turbofan-powered aircraft. The sources of noise in a turboprop aircraft include boundary layer flow noise, structure-borne noise due to engine vibration, and acoustic excitation of the fuselage due to the propeller, with the latter being dominant for most turboprop aircraft. According to Clean Sky program, this proposal has developed an innovative technologies that will be used in the next gen aeronautical transports for the comfort of passengers. The current systems effectiveness is limited by the following aspects:
• fixed fuselage diameter and fixed position;
• absence of a control closed loop for reverberance control;
• manual input for each loudspeaker and third-octave band.
and CONCERTO removes these limits developing a smarter and modular system, making the testing phase simpler and faster and in addion avoiding the typical complex system setup procedures.

The main project outcome are:
- smart testing system
- innovative control loop, because it is a closed control loop to obtain high speed performance with a control strategy and a pre-test analysis to reduce the number of control microphones, time and costs in the test set-up
- modular structure, its mechanical structure and software are designed to accept fuselage of different diameters (from 2.5 m to 4 m) and customizable speakers/microphones configurations
- advanced sw, with a dedicated software implementation developed in order to allow an easy and user-friendly interface.

Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far

The first phase of project was focused on the analysis of requirements and define the documentation. During the first part the work was performed on defining the state of the art of Noise Generation System (NGS), the characteristics, strengths and limitations of existing systems as the previous system in the LNDas well as the ones into the Applied Aviation Research (ZAL). Then, the partners proceeded with the definition of the hardware and software necessary to realize the noise generation system, defining which and how many components to use. This because one major source for aircraft interior noise is the propulsion system. In particular, for propeller aircraft the cabin noise is dominated by harmonic low frequency noise produced by the propellers. After the definition of requirements in terms of mechnics, the activity had been devoted to the realization of a design concept for a supporting structure for loudspeakers to be placed around aircraft fuselages of different diameters, ranging between 2.5 and 4.0 meters (this was an important point as requirement). also because the loudspeakers are intended to work as sound generators in well-defined ranges of frequencies and amplitudes to simulate the noise propagation of turbo-propeller-driven aircraft into the cabin and

supply essential experimental data to improve the comfort of passengers of future airliners. The team produced a design concept that could offer a flexible, adjustable solution, which can be implemented with a minimum work force, considerably reducing the setup time of experimental sessions. The result is a modular structure where its mechanical parts are designed to accept fuselage of different diameters (from 2.5 m to 4 m) and customizable speakers/microphones configurations by few simple elements designed for CONCERTO project. Then there was a phase of development both for cad drawing in order to realize the mechnical structure and software where has been implemented a closed control loop to obtain high speed performance and to reduce the time and costs in the test set-up. Several stricty tests followed both on a test bench first and on the real system then considering that CONCERTO is composed by three ring and 66 loudspeakers in its full configuration. a lot of time was required to perfom all tests and set all settings.
Closed the realization and the assembling of all structures, 3 rings, loudspeakers and subsystems, the consortium completed a great and challenge project as reported in the posts by social media and present on the official project's website.

Progress beyond the state of the art and expected potential impact (including the socio-economic impact and the wider societal implications of the project so far)

The CONCERTO project stands as an effective and valid possibility of being able to increase the company's ability to explore innovative products, thanks to the development of the integrations between the various items involved (passenger seats, lining panels inside the cargo compartments and compartments), thanks to the know-how acquired during the development of the project integrating the iNGS so to simulate the real noise spectrum distributions and levels for all the flight conditions as requested by the Topic Leader, LND. The development of manufacturing and design methodologies allowed the reduction costs and increased the profitability of the initiative also in relation to industrialization investments. The interest of having such a facility arised from a need for investment by Topic Leader to increase the expertise offering new technologies for Regional Cabin Interiors and consequently pointing on the noise reduction.
The CONCERTO project had an important economic repercussions on the partners involved, which have a common denominator: the new 90-seat turbroprop (Next Generation TurboProp). The results of the project, in fact, will represent the state of the art that will see Leonardo Aircraft Division as the main actor in the production of the new regional aircraft and the interest about the noise reduction is an important focus to investigate and improve.
The innovative noise generation system consists of three modular frames that hold evenly distributed loudspeakers at a given distance around the fuselage circumference. The frames can be adjusted to accommodate fuselages of differing diameters. The sound pressure is measured by a number of microphones placed around the fuselage surface. The number and location of the microphones used in the control loop are selected using a pre-test optimisation analysis, which aims to reduce the time and cost of the test set-up. An iterative learning approach is then used to minimise the error between the target and the measured pressure fields.
Finally, CONCERTO project allowed to LND to have a facility to study and investigate the acoustic noise focusing the attention on different contributions related to the engines, fans, transformers and

compressors radiate noise in order to noise increase the interior noise comfort levels, considering that the primary concern with noise in the low frequency range is not only the potential risk of damage to the hearing bacuase low frequency noise is annoying and during periods of long exposure it causes fatigue, discomfort and loss of concentration.
Some main numbers of CONCERTO:
- total mass (single array) 2.2 ton
- cable meters 700m
- peak power 26kW
- ring dimensions about 6.2m x 5.5m

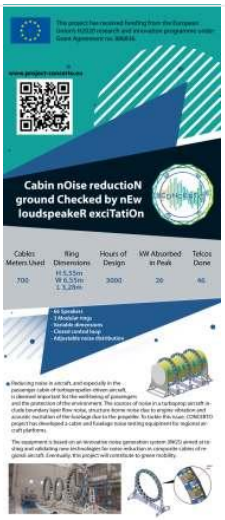
3 rings

Control station

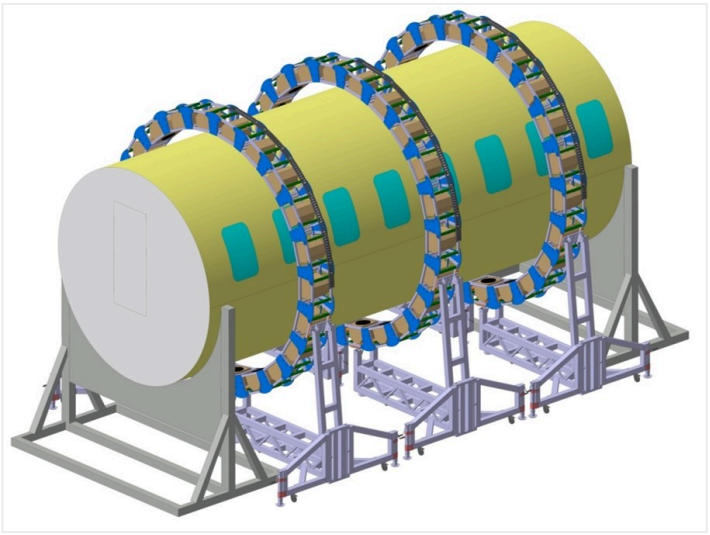
Cable production

Complete system

Project Logo



Rollup



Example of configuration

Testing phase

Assembling phase

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