Dipartimento Meccanica Matematica Management

MUR
Dipartimento
di Eccellenza
2018-2022
2023-2027

Research project

Name and Surname: Umberto Galietti

Title: Development of innovative SHM procedures for monitoring the structural integrity of aeronautical components

Reference Labs:

- Structural Health Monitoring and Thermal Methods for Experimental Mechanics (Prof. Umberto Galietti)
- Advanced Structural Diagnostic Laboratory (Prof. Davide Palumbo)

Description:

This research concerns the development of innovative techniques and methods of investigation and the design of components with 'embedded' and non-embedded sensors, for the 'monitoring of the state of integrity-SHM' of aircraft parts made with sustainable and circular materials. Structural Health Monitoring (SHM) combines various techniques such as vibration analysis, acoustic emission, strain and temperature sensing, piezoelectric transducers and smart sensors, and thermographic imaging to assess the integrity and safety of structures in real time.

These activities will produce positive economic / environmental effects for the sector thanks to the repair of existing components which would limit their production and disposal. The added value is obtained from research, analysis, simulation and experimentation activities aimed at increasing knowledge on defects and damage mechanisms induced by the load conditions to which they are subjected. Thanks to university-based research, industrial research will cover company 'gaps' in relation to a specific problem, and this will also allow us to propose a standard framework for computational modeling and testing of these materials. The analysis algorithms and test procedures will be exported to industry to create automated investigation systems. The result will be an enrichment in terms of knowledge in the industrial field thanks to the formation of highly specialized professional profiles constantly updated on the new test and analysis procedures in direct line with the University.

The added value is also given by the 'green' choice and the culture of monitoring, the future of the manufacturing industry, which is also pursued through the enhancement of human capital through the definition, communication and pursuit of a long-term purpose or the creation of new highly specialized professionals. This should generate a culture in which people adhere to a system of values and a positive long-term vision and strive to achieve it, contributing to the improvement of the aerospace sector and generating a positive impact on other people and industries.

Finally, the implementation of these inspection techniques will significantly reduce the time and costs associated with repairs. With continuous condition monitoring, even if a defect appears, maintenance will be timely and cost-effective while ensuring the safety of airline passengers. This generally has repercussions on the entire aerospace sector as it indirectly contributes to ecological and safe air transport.

The project aims to achieve the following Work Packages (WP):

WP1: Development of experimental procedures for the study of the damage developed in composite materials stressed with static and dynamic loads.

The goal will be achieved by conducting mechanical characterization tests on laboratory specimens made with sustainable and circular materials. The damage analysis will be conducted using non-destructive techniques capable of guaranteeing reliable results but in much faster times and a lower number of specimens than traditional techniques.

WP2: Development of non-destructive experimental procedures and techniques for the diagnostics of composite materials. The goal will be achieved by conducting non-destructive tests with SHM techniques on specimens and components in composite material. The novelty of the survey is represented by the use of different sensors (embedded and contactless) for the complete characterization of defects in terms of size, depth and type. The aim is to reduce test times compared to traditional NDT techniques.

WP3: Application and verification of procedures developed in the laboratory on components and structures on site. The verification of the objective will take place with the application of the procedures and techniques developed in the previous WPs on real components during normal operating conditions or during the stops provided for maintenance activities.

The research activity will be organized according to the following phases:

Phase 1: Feasibility tests and optimization of the procedures developed with non-destructive techniques (from month 1 to month 12)

- Choice of materials and production of specimens for mechanical characterization tests and production of specimens with known defects for non-destructive testing.
- Test campaign with various non-destructive techniques (NDT) and SHM techniques on the specimens made in order to optimize the set-up and test parameters.
- Drafting of test procedures and software development for data analysis.

Phase 2: Study of embedded sensors for continuous structural monitoring (from month 13 to month 24)

- Choice of the most suitable sensors for application on the material chosen in Phase 1.
- Test campaign on sample specimens in order to optimize set-up and test parameters.
- Drafting of test procedures and software development for data analysis.

Phase 3: Application of the procedures and software developed in Phases 1 and 2 on real components (from month 25 to month 36).

Choice of components to be studied.

- Application of the procedures developed in phases 1 and 2 on the selected components repeated at regular time intervals.
- Application of the procedures and software developed in phases 1 and 2 on prototype components.
- Drafting of a maintenance plan for the continuous control of real components.

Candidates should provide detailed CV

Contacts

Umberto Galietti: umberto.galietti@poliba.it