PhD in MECHANICAL ENGINEERING

Research Title: Model Based System Engineering approach applied to Aircraft Digital Twin

MBSE Aircraft Digital Twin

Funded by	LEONARDO COMPANY SpA

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Context of the research activity	This research activity is based on the cooperation with Leonardo Company (https://www.leonardocompany.com/it/home) and aims at developing the new tools for the design, development and maintenance of innovative products, as the hybrid aircraft with electric propulsion included. Particularly, the concept of "digital twin", currently describing the capability of creating a virtual model of the operative system completely suitable to investigate all the issues related to its behaviour in service belonging RAMS (reliability, availability, safety and maintainability), will be developed in terms of methodology, tools and design of suitable platforms for the industrial product lifecycle development. A real test case will be exploited and investigated, to assess the most suitable modelling activities and to interoperate the multiscale and multiphysics approaches implemented. This activity aims at improving the current industrial tools for a straight production of the aeronautic systems, as well as to enrich all the technologies related to the systems engineering and enabling the design of the innovative aircraft. The activity will be developed in tight cooperation with the Company as well as together with other research groups, as the integration of models and tools will be gradually required to set up the overall design tool chain.

Objectives	The main activity of this study consists in setting up a set of suitable parametric and numerical models, based on the multi-physics and multi-scale approaches currently under development, of some safety critical aircraft systems. A specific target is the hybrid electric aircraft, but a generalization of proposed approaches will

allow implementing the technical solutions set up even to other strategic aircraft layouts.

This study intrinsically includes a deeper education of the PhD candidate within the technical methodologies and tools of the Model Based Systems Engineering (https://www.springer.com/gp/book/9783319718361#:~:text=Decision%20and%20Control,Systems%20Engineering%20and%20Its%20Application%20to%20Industrial%20Product%20Development,Material%20and%20Industrial%20Product%20Development)

Particularly, after a preliminary development of specific numerical models of the aircraft systems, performed by resorting to the most known methods (FEM, BEM, MBD, analytical modelling etc), a key issue consists in the integration of those models at aircraft system level, through some software connectors, based on known protocols and tools, even in regime of co-simulation.

Another level of integration to be investigated and then performed consists in connecting the functional modelling tools, managing system requirements, behaviours and architectures, to the so-called physical modelling, which includes the above mentioned numerical models.

According to the MBSE approach, a specific verification & validation step will be developed, by resorting to some experimental tests on component, system, and aircraft levels, as far as the working conditions will allow.

A dedicated session of the whole activity will face the problem of reducing the order of models to allow exporting and co-simulating several ones of those together. Moreover, the possibility to resort to big data to enhance the capabilities of that tool chain will be explored.

This project will be developed in tight cooperation with Leonardo Company, through several industrial supervisors and by resorting to several infrastructures of the Corporate.

Skills and competencies for the development of the activity	The candidate must be educated within mechanical, aerospace, automotive engineering degrees or similar; being able to set up a numerical modelling activity to investigate the static and dynamic behaviours of structures, by resorting to some typical methods as the FEM and/or multibody dynamics, and/or to general purpose mathematical tools (as the Matlab/Simulink®, Modelica® and similar). Basic knowledge of typical tools for drawing and writing is required. A basic experience in experimental testing, as for instance that coming from BSc and MSc in Mechanical / Automotive / Aerospace Engineering is required. A good knowledge of programming is welcome. Moreover, the candidate must be able to fluently speak English, and to work in a motivated team.