POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

PNRR_352 Research Field: DITCHING LOADS SIMULATION AND VALIDATION

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	Funded by PNRR M4C2 (dalla ricerca all¿impresa) Contributes to M1C2 (digitalizzazione, innovazione e competitività nel sistema produttivo) The objective of the research is to develop the capability to simulate a water ditching event of an aircraft, to feed the design, verification, and certification phases of the airframe. To date, the phenomenon has been studied through extremely expensive experimental tests, carried out at an advanced stage of the project. This means that the characteristics of the machine are already established and the level of certification obtainable for ditching may not be satisfactory. For this reason, the possibility of numerically simulating the phenomenon, through the development of new methodologies, becomes of crucial importance for determining the distribution of loads on the keel of the fuselage already in the preliminary design phase. In particular, this research aims to develop software that allows obtaining the distribution of loads in a specific ditching condition for airframe structures, requiring as input simply the geometric and structural characteristics of the panels that make up the helicopter fuselage and the condition of impact. The software queries a database of cases built through a series of numerical simulations

	representing different impact situations in the water. Part of these simulations will be validated through an experimental tank drop test campaign in order to ensure greater reliability of the method and re-use of existing data from previous research projects. Once the project is completed, the end-user will be able to obtain the distribution of loads on the new structure in a few seconds. The objectives can be described as: ¿ Develop an innovative method for fluid-structure interaction simulations aimed at reducing the cost without affecting the accuracy. ¿ Create a database of cases that encompass the range of typical impact conditions (based on different speeds, different impact angles, and different structural properties of the panels). ¿ Develop software capable of receiving as input a CAD file and a file for the structural properties that queries the database and provides the desired solution in a short time. ¿ Develop a model to simulate ditching conditions to support the design The proposed method can also be considered as a candidate for certification by simulation in ditching conditions
Methods and techniques that will be developed and used to carry out the research	The series of case studies is established regarding the typical impact conditions, while the structural formulation of the panel is based on the different panels that make up the fuselage of the helicopters. Once the case studies have been identified, the numerical approach is developed, which is based both on a fluid dynamic analysis and on a purely structural analysis using HPC capabilities. The fluid dynamics analysis relies on the commercial solver ANSYS Fluent. The impacting body is modeled as an internal boundary of the fixed domain, and a mesh is

constructed on it. The fluid dynamics analysis is certainly very accurate, but it is able to model only rigid bodies.

The structural analysis, on the other hand, relies on the LSTC LS-Dyna software and models the falling body as an object that moves within the domain due to the force of gravity and impacts on the free surface of the water.

The two-fluid phases making up the domain are modeled through an Arbitrary Lagrangian-Eulerian Multi-Material (MM-ALE) formulation. By doing so, it is possible to include in the model the structural response of the panel following the impact.

The fluid dynamics analysis will be used as a reference solution for the rigid case for the correct modeling of the problem in the structural field. Once the problem is modeled correctly, the deformability of the body is introduced and the results of these analyzes will be compared with the experimental campaign to be carried out, aimed at evaluating the reliability of the analyzes in the deformable case.

Subsequently, the database of cases is populated, generating a map of cases, and the final software is written.

The general needs for the above-described activities are:
¿ The possibility of using HPC to create a reliable database of possible scenarios.
¿ The possibility of performing tests to validate initial simulations and the method to be developed
¿ Develop a simplified simulation to be used for rough estimation during the conceptual phase/early design stages

The Ph.D. candidate will need to interact with the industrial partner (Leonardo Helicopters) to identify the initial need for the research and the database to be investigated. The candidate will spend a minimum period of 6 months in Leonardo Helicopter, to identify the initial database and to verify the results of the research, and a minimum period of 6 at the ¿Center Collision Safety and

	Analysis¿ George Mason University, Virginia, USA, working on similar activities.
Educational objectives	The specific objective of this Ph.D. is to develop skills in ditching impacts modelling, fluid-structure interaction, advanced material characterization methodologies, development of new numerical tools for the design of helicopters. The candidate will learn how to use the up-to-date simulation tools for the study of ditching phenomena. He will conduct a series of real tests for the validation of the developed numerical models and, more generally, will acquire an in-depth knowledge of fluid-structure interaction modelling. The education will be complemented by a broad variety of soft skills, including presentation of the research, report writing, outreach, dissemination, and preparation of industrial progress meetings. The candidate will also obtain personal enrichment by practicing different working methodologies (industrial, spin-off, and academic).
Job opportunities	The job opportunities that this project opens up are in the field of: ¿ Helicopters and aircraft design. ¿ General fluid-structure interactions during impacts for the design of off-shore platforms or vessels
Composition of the research group	0 Full Professors 2 Associated Professors 1 Assistant Professors 3 PhD Students
Name of the research directors	Prof. Marco Anghileri

Contacts
Dipartimento di Scienze e Tecnologie Aerospaziali - Politecnico di Milano Via La Masa 34, 20156, Milano - Italy +390223997162 - email: marco.anghileri@polimi.it - web site: www.aero.polimi.it

Additional support - Financial aid per PhD student per year (gross amount)

Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	Leonardo Helicopters
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	Center Collision Safety and Analysis, George Mason University, Virginia, USA
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

The PhD candidate will receive a desk and a personal computer. Apart from the compulsory ones, the PhD candidate will have the opportunity to follow additional courses, to receive economic support to attend summer schools and participate in conferences. There will be the possibility of paid teaching assistantship.The candidate will spend 6 months at the ¿Center Collision Safety and Analysis¿ George Mason University, Virginia, USA