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# NITROS An Innovative Training Program to Enhance Rotorcraft Safety

**Giuseppe Quaranta**  
[giuseppe.quaranta@polimi.it](mailto:giuseppe.quaranta@polimi.it)  
Associate Professor  
Politecnico di Milano  
Milano, Italy

**George Barakos**  
[George.Barakos@glasgow.ac.uk](mailto:George.Barakos@glasgow.ac.uk)  
Professor  
University of Glasgow  
Glasgow, UK

**Max Mulder**  
[M.Mulder@tudelft.nl](mailto:M.Mulder@tudelft.nl)  
Professor  
TU Delft  
Delft, The Netherlands

**Marilena Pavel**  
[M.D.Pavel@tudelft.nl](mailto:M.D.Pavel@tudelft.nl)  
Assistant Professor  
TU Delft  
Delft, The Netherlands

**Mark White**  
[mdw@liverpool.ac.uk](mailto:mdw@liverpool.ac.uk)  
Senior Lecturer  
University of Liverpool  
Liverpool, UK

## INTRODUCTION

Helicopter accident and fatal helicopter accident rates have fallen for three consecutive years since 2014 [1]. However, the current rate is still excessive. Per flight hour, it is still ten times more likely to be involved in an accident in a helicopter than in turbojet fixed-wing aircraft [2]. As the future of rotorcraft is linked with new designs and personal VTOL air vehicles with extended operations it follows that rotorcraft safety will be under even more scrutiny by regulatory authorities and rotorcraft operators. At present, several key research programs financed by the European Union (EU) are exploring innovative vertical take-off vehicle configurations that may start the transport revolution long-sought by the pioneers of vertical flight and foreseen by ACARE's vision 2050 [3].

A recent research activity launched in 2016 under the umbrella of the Marie Skłodowska Curie Joint Doctorates Programme in European Union – Network for Innovative Training on Rotorcraft Safety (NITROS) project <https://www.nitros-ejd.org/> - aims to train (up to doctoral level) a new generation of talented young engineers to become future specialists in developing innovative approaches to address rotorcraft safety issues. NITROS researchers will learn that rotorcraft safety requires, at the engineering stage, the highest level of interdisciplinary cooperation. Exploiting the analysis done by the European branch of the IHST [4], three main threats to rotorcraft safety have been identified. This analysis led to the following three NITROS specific research objectives:

1. Develop a detailed framework for rotorcraft modelling integrating rigid-body and aero-servo-elastic modelling features capable of dealing with structural or propulsion / mechanical system failure in rotorcraft;
2. Understand how humans can safely and efficiently use and be interfaced with rotorcraft technology.
3. Enhance the understanding of the unique and complex aerodynamic environment in which rotorcraft are working, often in hostile conditions of wake encounter threats, undesirable interactions with obstacles, icing and, brownout conditions

In fact, borrowing Padfield’s [5] description of the key factor that influence a mission, it is possible to state that the safety of a mission performed by a helicopter derives from the analysis of the interactions among three key pillars - the vehicle, the pilot and the operational environment.

In NITROS, a unique cross-disciplinary research and training program was set up encompassing Control Engineering, Computational Fluid Dynamics (CFD), Modelling and Simulation, Structural Dynamics and Human perception cognition and action. The project is aligned with the European Union endeavor to reduce the rate of aviation accidents by tackling all critical aspects of rotorcraft technology. Twelve young researches will take part in a dynamic network composed by engineering schools (Politecnico di Milano, Liverpool University, Glasgow University and Delft University), research centers and industrial partners that include Leonardo, a rotorcraft manufacturer, Bristow, an important operator, CAA Civil Aviation Authority in UK, a certification body, EUROCONTROL, a regulatory bodies, and two important research centers: NLR The Netherlands Aerospace Centre, specialized in aviation research and Max Plank Institute for Biological Cybernetics specialize in all aspects related to human machine interface. The paper will introduce the organization of the NITROS network and will focus on the 12 research projects that are currently running. The twelve projects will focus on three main pillars and their interconnections: aircraft design, human machine interface and interaction with the environment. The objective is to inform the community about the project and stimulate fruitful collaborations on rotorcraft safety.

### CURRENT STATUS OF THE WORK



**Figure 1: The 12 research projects that will be pursued by NITROS researchers.**

Each research program is focused on a problem that affects the safety of the current or innovative rotorcraft configurations. The possible implications of the problem in terms of manufacturing, operations and certification procedures will be thoroughly discussed with the industrial partners.

The 12 Early Stage Researchers that will participate to NITROS Programs have been selected. The research subject that will be performed are presented in the Figure 1.

The projects will pursue the objectives stated in the introduction. Projects number 1, 5, 6 and 8 will be mainly focused on the analysis of the interaction of the helicopter with the environment. Projects number 2, 4, 9 and 12 will investigate aspects that are more related to aircraft design. Projects 3, 6, 10, and 11 will focus more on aspects related to the human vehicle interaction (see

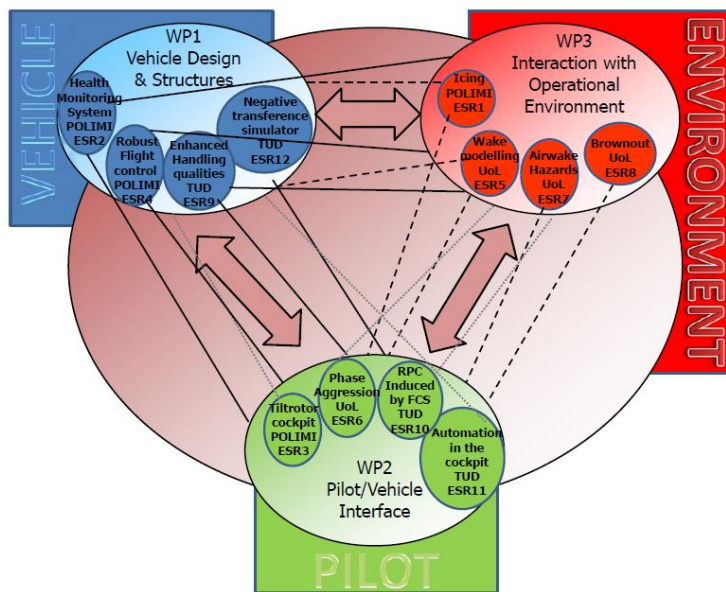


Figure 2).

NITROS is expected to develop a new approach in the rotorcraft engineering community by training a highly skilled group of young engineers capable of 1) understanding the fundamental complex phenomena characterizing rotorcraft and 2) taking considerable measures for improving actual standards of rotorcraft safety.

Figure 2: NITROS Research WP and their intercorrelations.

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