



# AERODYNAMIC DESIGN AND ANALYSIS OF AN INNOVATIVE REGIONAL TURBOPROP CONFIGURATION

Fabrizio Nicolosi\*, Salvatore Corcione\*, Pierluigi Della Vecchia\*, Vittorio Trifari\*,  
Manuela Ruocco\*,

\*University of Naples Federico II, Department of Industrial Engineering, Aerospace  
Division

**Keywords:** Aircraft Design, Aerodynamic analysis, Winglet, High Lift Devices, CFD analysis

## Abstract

The Innovative turbopROP configuration (IRON) project complies with the European Union topic JTI-CS2-2015-CPW02-REG-01-03 (Green and cost efficient Conceptual Aircraft Design including Innovative Turbo-Propeller Power-plant) as part of the Clean Sky 2 program for Horizon 2020. The topic leader is Leonardo, CIRA (Italian Aerospace Research Center) is the coordinator and several core-partners are involved into the project. The research work is focused on the feasibility study of an innovative turboprop aircraft configuration with rear engines installed on the horizontal tailplane.

This paper deals with the aerodynamic design and analyses carried out during the first loop of design concerning the baseline configuration provided by Leonardo Company.

Major activities have been addressed to the design of the wing airfoil and to an efficient high lift system (including the possibility of a morphable drooped nose). Winglets have been specifically designed to improve the climb performance concurrently reducing the induced drag in cruise condition.

The complete aerodynamic database assessment has been performed also by means of high fidelity analyses, such as CFD-RANS simulations, to estimate the isolated wing high lift capabilities (flap up and flap down) and the fuselage aerodynamic characteristics. To assess the complete aircraft trimmed drag polar database, a detailed weight and balance analysis has been performed. This analysis has shown that for this innovative configuration, the center of gravity excursion is very large, highlighting the inadequate sizing of the horizontal tailplane to

trim the aircraft in the whole center of gravity excursion range.

To overcome this issue, different aircraft configurations have been considered. Among them also three lifting surfaces has been considered. This latter has been identified as the most promising solution to best comply with the provided aerodynamic requirements.

## 1 Introduction

The IRON project is focused on the feasibility study of an innovative turboprop regional configuration. The research addressed to the analysis and design of this innovative regional platform will be developed through three different loops with increasing level of complexity and fidelity (see Fig. 1). The aircraft configuration will be assessed through numerical simulations during the first and second design phase, and experimental validations will be performed during the third loop, so that at the end of the project a Technology Readiness Level (TRL) 4 will be reached.

The loop 1 started in July 2016 from the baseline configuration provided by Leonardo Company and ended in January 2017. The aircraft under investigation is an innovative layout with low wing. Engines are rear installed on the horizontal tail tips as shown in Fig. 2.

Top Level Aircraft Requirements (TLAR) have been issued by Leonardo company, which also provided the aircraft maximum takeoff weight and wing area.

TLAR are very challenging: a cruise Mach number of 0.62 at 30000 feet, with a moderately maximum lift coefficient and low drag to achieve