

Aerodynamic guidelines in the design and optimization of new regional turboprop aircraft

Fabrizio Nicolosi and Pierluigi Della Vecchia

Department of Aerospace Engineering (DIAS) – University of Naples “Federico II”

Via Claudio 21, 80125 Naples, Italy

E-mail: fabrnico@unina.it, pierluigi.dellavecchia@unina.it

Ph: +39 0817683583 Fax : +39 081 624609

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Abstract

This paper aims to provide some guidelines in the aerodynamic design and optimization of future regional turboprop aircraft with about 90 passengers. Currently there are no configurations on the market of this type, thus a typical 70 passengers turboprop aircraft is taken as reference starting point. The most critical areas in terms of aerodynamic behaviour are highlighted and an automatic procedure manageable through MATLAB® is described: this interface allows to import and modify geometries using interpolating curves and surfaces via NURBS. Within the optimization loop, each new geometry is analyzed through a panel code solver until optimized shapes are found.

Wing-fuselage junction, undercarriage pod, cockpit and wing-tip device are investigated. Design of the winglet is presented highlighting performance improvements during the entire mission profile.

Finally two different fuselage configurations are shown: the first with a 4-abreast fuselage arrangement and the second with 5-abreast, highlighting pros and cons of each configuration.

1 Introduction

Nowadays the increase in oil price, the huge growth of air transport traffic and the increasing attention to the aircraft environmental footprint led to considerable interest of specialists in new configurations of regional transport aircraft. As highlighted by the ATR Senior Vice President of Operations, Luigi Lombardi, during EWAD 2011 conference, the airlines will need about 3000 new turboprops in the next 20 years[1]. The 42% of the new turboprop deliveries expected to be 70 seats. The new 90+ seat segment is a strong percentage of the total, i.e. the 39% as shown in Fig. 1. Also Bombardier Commercial Aircraft Vice President Marketing, Philippe Poutissou, has expressed optimism about the future and he sees strong demand for this size aircraft in the market in the next two decades[2]. In particular, in its latest forecast of new aircraft deliveries in the 20-149 seat market segment over the next 20 years, Bombardier forecasts that 5800 aircraft will be delivered in the 60-99 seat segment and 6300 (only 500 more) in the 100-149 seat category.

For these reasons this work aims to provide some guidelines in the aerodynamic design of future regional turboprop aircraft with about 90 or more passengers.