

# Numerical Aerodynamic Analysis of a New Twin Engine Commuter Aircraft

## Longitudinal and Lateral-Directional Derivatives

[Nicolosi Fabrizio, Corcione Salvatore, Della Vecchia Pierluigi, Agostino De Marco]

**Abstract** — This paper deals with numerical investigation about both longitudinal and lateral-directional static aerodynamic characteristics of a new twin-engine commuter aircraft with eleven seats, Tecnam P2012. Numerical analyses have been performed on complete and many partial aircraft configurations in order to evaluate the contribution of each aircraft component and to estimate their mutual interferences. The analyses have been conducted at wind tunnel Reynolds number in order to provide a validation of the numerical investigation. Finally numerical analyses have been also performed at free flight conditions, in order to have an estimation of the Reynolds number effect in especially on the aircraft base drag coefficient and on the wing span loads in both flap up and flap down conditions.

**Keywords**—CFD, Longitudinal and Lateral-Directional Stability, Commuter Aircraft

## I. Introduction

Since 2011 Tecnam Aircraft Industries (<http://www.tecnam.com/Default.aspx>) and researchers at DII (Department of the Industrial Engineering of the University of Naples) are deeply involved in the design of a new 11 seats commuter aircraft, the P2012 Traveller. Design guidelines, specific market opportunities, numerical aerodynamic analysis and wind-tunnel tests have been outlined by the authors in previous works [1-3]. The authors at DII have matured experience in aerodynamic design [4] and flight tests of light aircraft [5, 6] and many research activities have been performed in collaboration with Tecnam.

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## II. The P2012 Traveller

The Tecnam P2012 Traveller is a twin engine, 11 seats, high-wing and body mounted horizontal tail aircraft. Design specifications have led to a fixed landing gear, high cabin volume and short take-off and landing distances. The aircraft is powered by two Lycoming piston TEO-540-A1A engines. The aircraft will be used both as a passenger airplane but it has been designed to be a very versatile and flexible aerial platform, offering multi-role opportunities. More details about

preliminary design phase and aerodynamic analysis have been shown by authors in previous scientific articles [1-3]. Fig. 1 shows the aircraft three views. P2012 has a straight tapered wing with surface of about 25 square meters and a wing span of about 14 meters. Two quasi symmetrical nacelles are installed on wing and two winglets are mounted at wing tip. Slender fuselage geometry of about 12 meters can accommodate up to 11 occupants (2 pilots plus 9 passengers) with an higher fineness ratio for the aircraft category equal to  $l_F/d_F = 7.24$ . P2012 main geometrical dimensions are summarized in Table I. Conventional horizontal body mounted tail plane has been adopted with a horn balanced elevator movable surface and 30 degrees sweep vertical tail plane with dorsal fin has been designed with a high control power rudder surface. The research group has performed in the past extensive activities on light and general aviation aircraft, acquiring experience in the analysis, aerodynamic design and flight testing of this particular aircraft category.

TABLE I. P2012 MAIN GEOMETRICAL CHARACTERISTICS

Symbol	Value
$S_w$	25.40 m <sup>2</sup> (268.2 ft <sup>2</sup> )
$b_w$	14.00 m (45.9 ft)
$AR_w$	7.72
$\bar{c}$	1.87 m (6.14 ft)
$\lambda_w$	0.73
$l_F$	11.59 m (38.0 ft)
$h_F$	1.60 m (5.3 ft)
$d_F$	1.60 m (5.3 ft)

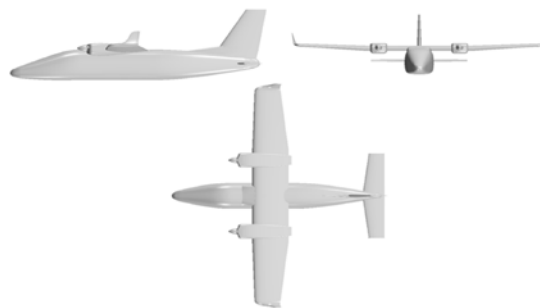


Figure 1. P2012 Traveller, three views (CAD)

## III. Mesh and physics setup

Aerodynamic analyses have been fulfilled through the software STAR-CCM+ [7]. The software includes all the required features from the pre-processing, to the post-processing and data analyses tools. The whole simulation