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Design and aerodynamic analysis of a twin-engine commuter aircraft

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ABSTRACT

The present paper deals with the preliminary design of a new general aviation Commuter 11 seat aircraft. The commuter aircraft market is today characterized by very few new models and the majority of aircraft in operation belonging to this category are older than 35 years. Tecnam Aircraft Industries and the Department of Industrial Engineering (DII) of the University of Naples "Federico II" have been deeply involved in the design of a new commuter aircraft that should be introduced in the market with very good opportunities of success. This paper aims to provide some guidelines on the conceptual design of this new twin-engine commuter aircraft. Aircraft configuration and cabin layout choices are shown and compared to similar solutions adopted by main competitors. The aerodynamic analyses are focused on some particular effects such as the wing–fuselage interference and the nacelle lift contribution and their effect on wing span loading. The aerodynamic analyses have been also essential to validate the preliminary estimation of aircraft stability and control derivatives (both longitudinal and lateral–directional) and to lead to a right sizing of tail surfaces. These analyses have been carried out through the use of a 3-D panel code. Finally some preliminary wind tunnel test results are presented.

0. Introduction

Many in the industry had anticipated 2011 to be the year when the General Aviation manufacturing industry would begin to recover. However, the demand for business airplanes and services, especially in the established markets of Europe and North America, remained soft and customer confidence in making purchase decision in these regions remained weak. This inactivity, nonetheless, was offset in part by demand from the emerging markets of China and Russia. While a full resurgence did not take place in 2011, the year finished with signs of recovery and reason of optimism. GAMA (General Aviation Manufacturer Association) 2011 Statistical Databook & Industry Outlook [9], which is usually a very useful and impressive source of data and statistics for general aviation, reports that the average age of general aviation registered aircraft is 46 year for single-engine piston powered aircraft and 15 years for single-engine turboprop aircraft. The average age for twin-engine 8–12 seats aircraft is 42 years for piston powered models and about 29 years for twin-engine turboprop commuter aircraft. These impressive data dramatically show the need of new aircraft models which will be characterized also by the application of new technologies like composite and light structures, new engines (with lower weight and lower fuel consumption), new and advanced aerodynamics (i.e. optimized airfoil and winglet) and new avionics and flight control systems. Since 1990 Tecnam Aircraft Industries[1] is involved in the design, development and construction of several light and ultra-light aircraft with 2 and 4-seat, characterized by high-wing and low-wing configurations. The company has acquired good and consolidated experience in the design of light aluminum alloy aircraft structures. In the last five years, Tecnam has started also to employ composite materials and some recent model presents an aircraft structure with extensive use of carbon fiber (fuselage and vertical stabilizer). Several research activities have been focused on reducing the empty weight, improving aircraft aerodynamics and flying qualities and reducing aircraft costs. An example of recent innovative design proposed by Tecnam is the P2010 single-engine 4-seat aircraft, see Fig. 1, that combines the carbon fiber fuselage technology employed on previous model (P2008) and efficient aluminum-alloy wing and stabilator derived from recent P2006T twin-engine 4-seat aircraft (that represented a great commercial success for the company). The combined use of carbon fiber and metal structure leads to a global optimization of aircraft aerodynamics, weight, cost and reliability. Carbon fiber ensures smooth surfaces and allows to produce a nice-looking

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[1] Costruzioni Aeronautiche Tecnam website http://www.tecnam.com.

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