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Conceptual design of a light sport aircraft

Boer, Michael Frederick

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Abstract

The design of a conceptual aircraft was required to fulfil the recreational and commercial flight training roles as part of a rural development initiative. The regulations regarding the airworthiness of aircraft and the South African microlight and ultralight aircraft market were investigated to determine the niche performance requirements. The large sales enjoyed by the new Light Sport Aircraft (LSA) category created an opportunity to design an aircraft conforming to both the non-prescriptive ultralight and prescriptive LSA consensus standards. This would allow the aircraft be used in several countries. The best practices regarding design for manufacture used in industry were investigated to create a framework of consideration for the detailed design of the aircraft. The performance of the market leading ultralight and LSA was analysed. The Cessna C-162 Skycatcher and Tecnam P-92 were investigated as the main competitors. Flight speed, payload, structural efficiency and aerodynamic efficiency were analysed to set target performance requirements. The aircraft was required to have a minimum power utilisation of 1.05kt/hp, minimum useful load of 250kg and a minimum cruise speed of 110kts. The aircraft was constrained to a 100hp engine. These performance user requirements were used with cost, environmental and operational requirements to design a high-level concept. The concept was developed so that each major system on the aircraft had been designed to create a complete concept. The method used to develop several concepts for several systems and assess them against the user requirements was developed from the dialectic engine principle of destruction and creation. This process was performed simultaneously. The systems were broken into basic principles and components before being creatively integrated into improved systems. Three design features were generated and patented. The designs included a propeller spinner that assisted with air induction for better cooling, a winglet to assist with breakdown of wake vortices and an excrescence free flap system for a light aircraft. The only design used on this aircraft was the flap system. The aircraft concept was further refined using the same destruction and creation synthesis technique. The concept aircraft was the subject of a detailed business plan and launch strategy that would use the aircraft to leverage funding to start a new industry in the Eastern Cape province. The performance of the aircraft concept was calculated using standard performance techniques that were modified for use, based on experience with other light aircraft. The major emphasis was on the energy available to accelerate, climb and turn. The method developed to analyse a descending turn without power was used to demonstrate that the aircraft could manoeuvre better than the competitors at low power settings. The energy levels needed to surpass the competition were used to design an aircraft with a significant energy margin at speeds of 65-85KCAS, making the aircraft ideal for flight training. The aircraft was designed with a higher aspect ratio and lower wing loading than the competitors to achieve better energy levels and better performance in hot and high conditions. The reduction in maximum speed was not significant when compared to the turn and manoeuvre performance. The structure of the aircraft was then designed to withstand the loads prescribed by the consensus standards. The aircraft was shown to comply with the standards. The completion of the structural design of the major components allowed for the design to be costed. The business plan was revised to include the cost of the manufacturing facility and total investment cost required to realise the project. The proposer of the project funded a full-size mock-up of the aircraft that was launched at a major airshow. The regulatory framework of regulations and technical standards was extensively revised, making the process of obtaining production-built type approval for a design less onerous. Recommendations for structural testing and transient energy analysis were made.