

DOCTORAL DISSERTATION ABSTRACT

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Title: "Evaluation of the influence of Leading-Edge Root Extensions and Leading-Edge Vortex Controllers on the aerodynamics of a conceptual delta-wing fighter aircraft"

Field of science: Engineering and Technology

Discipline of science: Environmental, Engineering, Mining and Energy

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The dissertation presents a comprehensive investigation of the aerodynamic influence of Leading-Edge Vortex Controllers (LEVCONs) on a custom delta wing fighter aircraft configuration. Using a combination of computational fluid dynamics (CFD) and low-Reynolds water tunnel experiments, the study systematically examines how forebody-to-wing configurations, including LEVCON geometry and deflection angles, affect vortex formation, trajectory, and breakdown, as well as their ultimate impact on aerodynamic performance.

Multiple static geometries with varying LEVCON deflections were modeled and fabricated to characterize the resulting leading-edge vortices. The CFD results demonstrated clear trends, such as increasing LEVCON deflection angles modifies the apex vortex, alters vortex breakdown behavior, and affects interactions with strake vortices, leading to measurable increases in lift or normal force, as well as pitching moment.

Complementary water tunnel experiments confirmed that even at low Reynolds numbers, LEVCONs effectively manipulate the aerodynamic envelope, confirming their effectiveness in enhancing post-stall performance. Quantitative comparisons with conventional LERX and strake configurations highlighted the improved performance of LEVCONs, particularly in terms of vortex breakdown control, increased maximum lift coefficients and pitching moment augmentation. The study also includes post-processed visualizations of vortex structures, pressure and skin-friction coefficient distributions, and aerodynamic coefficients for multiple configurations, providing a comprehensive dataset characterizing the performance of the proposed LEVCON shape across a broad range of operating angle of attack conditions.

The results conclusively demonstrate that LEVCONs are a highly effective means of enhancing aerodynamic forces and moments on delta-wing fighters. By controlling the strength, trajectory, intensity, and breakdown location of leading-edge vortices, LEVCONs prove to be a versatile tool for optimizing high angle of attack aerodynamics. The combination of CFD analysis and water tunnel testing confirms both the robustness of the results and the practical applicability of LEVCONs for advanced fighter aircraft design.

In summary, this dissertation provides a thorough and positive assessment of LEVCON technology, showing that it significantly augments aerodynamic performance and offers a comprehensive dataset to guide future design, optimization, and implementation of active vortex control devices.

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Date and PhD candidate's signature