IMPLEMENTING LANIER'S PATENTS FOR STABLE, SAFE AND ECONOMICAL ULTRA-SHORT WING VACU- AND PARA-PLANES

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Backyard Technology are interested in aspects of aircraft design described by Edward H Lanier in a series of six patents obtained from 1930 to 1933. Lanier's overall aim was to provide an exceptionally stable aeroplane that would both fly normally and recover from undesirable attitudes without pilot aid. Backyard Technology were specifically interested in Lanier's idea of creating a vacuum cavity in the wing by replacing a section of the upper skin of the wing with a series of angled slats, believing that this wing design would give superior lift and stability compared to typical wing designs.

The MISG group approached this problem with a background reading of Lanier's patents, calculations and study based on the basic theory of aerodynamics, and numerical simulations using the package Fastflo. The complexity of the situation and lack of experimental data made mathematical modelling rather difficult. To the limited extent to which modelling was possible there was no indication that modern aeroplane design had overlooked a major feature which would improve flight characteristics. Lanier's designs from the 1930s are now over seventy years old and are perhaps more readily related to the pioneering aircraft of the early 1900's than those of the present day.

Details obtained of aircraft studies based on Lanier's patents from the 1930's were very limited. A few non-technical articles appeared in contemporary popular science magazines. We were unable to find any reference or citation of the designs in the scientific literature. The main sources of information which we had available were Lanier's six US patents themselves.

Lanier's six patents are each for an entire aircraft design and include commentary on matters such as the windows and landing gear. The aspect of the design of interest is the presence of cavities or slats on the upper surface of the wing and fuselage. In the early patents these were claimed to improve stability; later patents claimed enhanced lift as well. Lanier in part attempted to explain added lift by claiming that a partial vacuum is set up in the aeroplane's wings and body which could lead to increased buoyancy. He also appears to anticipate an additional lift effect by exposing the inside top surface of the lower shell of the wing. Being patents the descriptions are on the whole general without detailed measurements.

During our study, buoyancy calculations indicated that the effect of reducing air density within the wings would have an almost negligible effect, perhaps lightening the aeroplane by a few hundred grams. The other arguments provided by Lanier for additional lift similarly appear unconvincing.

The numerical simulations using Fistful were performed at different angles of attack for a two-dimensional fluid flow over an aerofoil shape that superficially resembled the "Clarke Y wing" profile. To complement flow over the basic shape, the flow was also considered around a similar shape with a cut away cavity and slats to resemble the Lanier design. There was very little apparent difference in lift between the experiments although the Lanier design had a noticeably increased drag in particular for low angles of attack. (For higher angles separation at the blunt nose of the wing meant that the presence of a cavity had less effect on the drag.)

To illustrate the general features of a flow across a slot cavity further numerical simulations were conducted. As a result of the flow a vortex is created in the slot. The vortex flow and pressure in the slot varied with the angle, width and depth of the slot. In general the pressure was higher in the slot than in the flow immediately above it but the geometry could be adjusted to give regions of lower pressure.

In general, wing profile designs must balance lift with drag. Fatter wings tend to have higher lifts for a given speed, however, they also tend to have increased drag making it more difficult to attain speed. In addition, fatter wings at higher speed are more likely to induce separation of the flow and hence stall (loss of lift). At the time of Lanier's patents wings tended to be narrow in profile. However, one of his patents includes an illustration of a conventional wing together with the slatted wing of the patent design. The slatted wing is much fatter in profile than the conventional wing in the picture and if in practice this were the case then that could provide an explanation of increased lift for the Lanier aeroplane.

The investigation of Lanier's designs could be extended. Probably the most natural approach would be to experimentally compare aerofoils using wind tunnel experiments. Improved numerical experiments might also help illuminate the problem. Further historical research might find out more from the 1930's to add to the largely anecdotal information available. The possible stability features at low speed appear the most promising aspect. It could be interesting to see how the Lanier design compared with contemporary aircraft of the 1930's. However, it appears unlikely that any such study would have an impact on modern aircraft design.