

426 Laboratory Project Proposal

As air travel becomes an increasingly used mode of transportation for both goods and humans, the inefficiency of widely used wing configurations is becoming an increasing environmental and economical concern. It is suggested in quantitative studies by Gagnon et al. (1) and Lyu et al. (2) that alternative wing styles may be more efficient. Specifically it is suggested that both a box wing (BW) or blended wing body (BWB) design could be markedly more efficient than current standard jet configurations, however both of these analysis are done entirely through computer simulation.

The goal of this project will be to qualitatively show or contradict the hypothesis that either of these wing types may be more efficient in terms of lift to drag ratios than traditional aircraft design in a wind tunnel. Analysis of these wing styles will be kept strictly at sub-sonic levels as the investigation is comparing primarily to commercial airlines.

In order to conduct this experiment a 3d model of a standard wing 100 passenger capacity jet will be 3d printed as a control along with 3d models of both an equal capacity BWB and BW style plane. For simplicity these models will only include a basic body and wing; engines will be excluded from this analysis as in the hypothetical BWB and BW models one does not know what type of propulsion would be chosen and this consideration is outside the scope of this project. A note that the given capacity is arbitrary and is simply a requirement on size of fuselage so as not to compare drastically differently sized models since the optimal length and wingspan of each wing style is inherently different. Hence why keeping wingspan (or some other metric) constant would be a naïve comparison.

Each of these models will be tested in a subsonic wind tunnel at varying speed (say 5m/s increments) to determine which has the highest lift to drag ratio and at which speed this occurs as efficiency of travel is an important consideration in this context.

As it is understood by the student that the research required to determine and model an optimized (or at least somewhat optimized) form of each of these wing shapes may prove quite difficult and potentially kill this project idea prior to takeoff as a fall back project the student will study only the problem of optimization on the traditional wing shape used in most aviation. This will involve similar experimental testing on many models with slight variation on the wings parameters in order to attempt to determine the most efficient wing model.

Works Cited

- 1) Gagnon H, Zingg DW (2016a) Aerodynamic optimization trade study of a box-wing aircraft configuration. J Aircr 53(4):971–981. doi: 10.2514/1.C033592
- 2) Zhoujie Lyu and J. R. R. A. Martins. Aerodynamic design optimization studies of a blended wing-body aircraft. Journal of Aircraft (accepted, Dec 2013) doi:10.2514/1.C032491
- 3) P.O. Jemitola, J.P. Fielding, Box wing aircraft conceptual design, in: ICAS 2012, Brisbane.
- 4) Harijono Djojodihardjo and Kim Ern Foong, Conceptual Design and Aerodynamic Study of Joined-Wing Business Jet Aircraft, Journal of Mechanics Engineering Automation (accepted, February 2013)
- 5) T. Ikeda, C. Bil, 2006, “Aerodynamic Performance of a Blended Wing Body Configuration Aircraft,” 25th International Congress of the Aeronautical Sciences, 06.