CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

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Project Number

J0109

Project Title

How Flaps on the Underside of a Wing Affect Its Aerodynamic Efficiency

Abstract

Objectives/Goals

The objective was to determine how the arrangement of flaps on the underside of an wing affects its lift:drag ratio (aerodynamic efficiency). Since I expected that multiple flaps would have more lift than a single flap, but that multiple flaps would not have more drag than a single flap, I hypothesized that wings with more flaps would be more efficient than wings with fewer flaps.

Methods/Materials

A wing with removable flaps and a wind tunnel with air straightener were constructed out of foamboard and cardboard. To measure lift, the weight of the wing was measured in the absence and presence of a fan-generated wind of 12 m.p.h. To measure drag, the backwards force of the wind on the wing was measured using a scale mounted vertically. The lift and drag of 8 wing configurations were measured, including a control wing with no flaps, and 7 wings with 1, 2, or 3 flaps in all possible arrangments. Two measurements of lift and drag were taken for each wing type, and mean lift, mean drag, and lift:drag ratios were calculated.

Results

All wings with flaps had greater lift, drag, and aerodynamic efficiency than the control wing with no flaps. As hypothesized, wings with more flaps generally had more lift than wings with fewer flaps, whereas adding two or three flaps did not increase drag more than adding a single flap. Therefore, a general trend of increasing efficiency in wings with greater flap number was found, although two outliers to this trend were observed.

Conclusions/Discussion

Control surfaces on wings, such as ailerons, flaps, and spoilers, which exploit the Bernoulli effect by manipulating wind speeds above and below the wing, are generally found on the leading and trailing edges of the wing, as well as the upper surface. My experiments suggest that control surfaces on the underside of the wing can also be useful in increasing wing efficiency. Generally, higher flaps numbers are more aerodynamically efficent than fewer, most likely because they increase lift without proportionally increasing drag. The existence of two outliers, however, suggested that the arrangement of flaps is as important as the number for lift generation, and that symmetry may be an important factor.

Summary Statement

I designed and built a wing to test how flaps on the underside of a wing affect lift, drag, and aerodynamic efficiency, and found that more flaps maximize lift without increasing drag proportionally, and so are more efficient.

Help Received

Father helped cut pieces for wind tunnel. Mother helped cut, glue and fit on posterboard.