Name(s)

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Project Number

J0137

Project Title

Explaining Lift and Drag Using Newton's Laws

Abstract

Objectives/Goals

The objective was to explain what causes lift and drag on an airplane wing. I have designed and built a low speed wind tunnel to show that a simple mathematical model based on Newton's 2nd and 3rd Laws of Motion gives reasonable predictions of lift and drag forces for small angles of attack and wind speeds.

Methods/Materials

I built my wind tunnel in our garage using materials found around the house, plus a few inexpensive items purchased from the hardware store. I measured the angle of attack using a plastic protractor. The measurements of the lift forces were made with a common kitchen scale. Wind velocity was measured with a homemade anemometer.

Results

I demonstrated that lift and drag on an airplane wing do, in fact, follow Newton's Laws for small angles of attack. I showed that lift increases as the sine of the angle between the wind direction and the wing cord, and that drag increased as one minus the cosine. I also showed that both lift and drag increase as the velocity of the wind squared.

Conclusions/Discussion

My project taught me many math and science basics. First, I learned how to calculate the mass of a certain volume of air. I learned that air moves smoothly over the wing contour for small angles of attack. I learned that force, velocity, and acceleration are vector quantities, i.e., they have both magnitude and direction. I learned how to calculate the horizontal and vertical components of these vectors with simple trigonometry. Lastly, I learned how to apply Newton's Laws to these components.

Summary Statement

My project uses a wind tunnel that I designed and constructed to show how Newton's 2nd and 3rd laws of motion explain the forces of lift and drag on an airplane wing.

Help Received

Father introduced me to Newton's Laws of Motion, and helped to cut materials for wind tunnel.