CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
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Project Number
J0118

Project Title
The Effect of Geometry and Surface Roughness on Aerodynamic Resistance

Abstract

Objectives/Goals
The objective of this experiment was to investigate the sensitivities of different geometries and surface textures to the amount of aerodynamic drag produced. It was hypothesized that subtle changes in the geometry and surface roughness would have significant effects on the amount of aerodynamic drag.

Methods/Materials
A wind tunnel was built to make drag measurements in four areas: three-dimensional solids, surface roughness, length effects, and two-dimensional plates (edge effects). A leaf blower was used to generate the air flow in the wind tunnel. The drag forces were evaluated by the amount of deflection produced by the air flow resistance pushing against a very soft spring. For each test condition, the test piece was placed in the wind tunnel section and the deflection measurements (drag) was repeated three times. The displacements were measured and recorded in a data table and evaluated.

Results
A total of 15 different test specimens were evaluated. In three-dimensional solid experiments, drag variations differed by almost two orders of magnitude. In the length effect experiments, the amount of drag increase changed significantly less once the cylinder reached a certain length. In the edge effect experiments, it was found that rounding the square edges produced drag forces that were reduced by a factor of 2.5. In the surface roughness evaluation, drag forces were found to increase significantly for irregular surfaces (sponge, bubble-wrap) as compared to relatively smooth Styrofoam surfaces, used as the base line material.

Conclusions/Discussion
From these experiments, it was concluded that minor changes in edge shape, geometry, surface conditions, and length all had significant effects on the amount of aerodynamic drag. This highlights the importance of detail aerodynamic design in many products used today to reduce drag such as airplanes, cars, and bicycle helmets.

Summary Statement
Subtle changes in geometry, surface roughness, and edge shape had significant effect on the amount of aerodynamic drag produced.

Help Received
Father helped cut out wood pieces used to build my wind tunnel apparatus.