CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)

Ashwat Chidambaram

Project Number

S0306

Project Title

Maximizing Aerodynamic Efficiency through Dynamically Changing Airfoil Cambers

Abstract

Objectives/Goals

Airplanes are known for their constant innovations in efficiency. Scientists and engineers in the industry today are always pushing to discover new ways to produce the same output with reduced energy and fuel consumption. I sought out to find a way to make planes fly more efficiently through innovations in wing design that can change wing camber midflight. By seeking a way to increase the coefficient of lift vs. the coefficient of drag ratio along with a higher lift force and lower drag force, higher efficiency would be achieved as planes can fly in the optimal state for given conditions based on various factors.

Methods/Materials

Due to the limited facilities available as a high schooler doing this project (no access to a wind tunnel or aerospace-grade materials), the design of four different airfoils was instead done on Autodesk Inventor Professional. All tests were subsequently run on Autodesk Computational Fluid Dynamics and VisualFoil 5.0, in order to determine the coefficients of lift and drag. While maintaining parameters such as air density, velocity, and wing surface area constant, the angle of attack was varied at four different positions among all airfoil designs. The force of lift and drag were calculated at each of these angles as well, and all data was subsequently compared to that of a Boeing 787's statistics.

Results

After collecting all data and analyzing the values of the four airfoils in comparison to that of a Boeing 787, the final results showed that utilizing this new airfoil design provided the same lift capacity at 5.6% less velocity and with a drag reduction of around 72%. As a result, this would require approximately 70% less engine power, leading to a substantial decrease in the amount of fuel and energy required to power the plane through its flight.

Conclusions/Discussion

I found that highly cambered airfoils were more efficient at lower angles of attack, and less cambered airfoils were better at higher angles of attack. The continuous-bodied airfoil that bends in shape is able to produce the same amount of lift coupled with a reduction in drag, showing its significant advantages over traditional aircraft with drag-inducing flap mechanisms. With less fuel and less power required to maintain the same flight conditions, it is in the best interest of the industry (lower operating costs), consumer (cheaper ticket prices), and environment (reduced emissions).

Summary Statement

I designed and tested an airfoil design that changes shape, and measured the effects that it has on lift and drag compared to traditional aircraft in the industry today.

Help Received

I taught myself how to use CAD software and run CFD simulations through various tutorials and forums on the internet. I spoke briefly with my flight instructor about my ideas and the concept I was trying to develop and test.