CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

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Project Number

J0101

Project Title

Over the Wing: Effect of Wind Speed, Temperature, and Wing Angle on an Electrically Propelled Blown Wing's Performance

Abstract

Objectives

My experiment's goal was to model a blown wing concept, which increases wind velocity around the wing by having propellers lined along its leading edge, with varied wind speed, propeller speed, wing angle of attack, and wind temperature.

Methods

A virtual plane on X-Plane 11 (software from Laminar Research) was flown with different intensity thermals to model the blown wing effect, at different angles of attack, in different temperatures, for two minutes; the difference in elevation was recorded. As for the model, a box fan was set on the ground, and a styrofoam wing on a weighing scale was placed in front of it. A tower fan was horizontally placed between the box fan and wing setup to model the blown wing effect. An anemometer measured average wind speed across the wing. The difference between the initial scale reading (no fans running) and reading after the variable changes was recorded.

Results

The higher the difference in elevation, the less efficient the experimental group was. The most efficient conditions of the simulation was the stronger thermal, with the wing at 0 degrees at 55 degrees C. The least efficient was no thermals with the wing at -1.8 degrees at 55 degrees C. Higher differences in scale readings indicated increased efficiency. The most efficient condition of the physical model was the high-speed tower fan with a high-speed general airflow from the box fan, and the least efficient condition was no tower fan with a medium speed general airflow from the box fan.

Conclusions

In the simulation, the hypothesis was partially supported, with data indicating an increase in efficiency with more intense thermals and higher angles of attack, but a lack of trend in temperature (perhaps due to a minor effect or the software s possible incapability to model changes). As for the physical model, my hypothesis was fully supported, with data indicating increased lift with increased "propeller" and wind speed. Both experiments support the concept that blown wings provide more lift than standard wings, increasing efficiency.

Summary Statement

This project served to determine factors contributing to flight efficiency by flying a virtual plane and creating a physical model, varying wind speed, the blown wing affect, wind temperature, and wing angle of attack.

Help Received

My father assisted me in operating the controls to fly the plane with X-Plane. After reading papers published by Joby Aviation and NASA (the companies whose study on the blown wing inspired my project), I created my physical model.