CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Max Bhatti

Project Number
J0105

Project Title
An Evaluation of the Flight Characteristics of Ornithopter-Type Aircraft Systems

Abstract

Objectives/Goals
The objective of my project is to observe the flight characteristics of thrust, mass & speed of 2-Wing & 4-Wing Penaud ornithopters & to measure the effect of wing battens on these parameters. This project will use a propeller-driven model as a control.
My hypothesis is that since the membrane wings of the ornithopters are very efficient at thrust generation, the 4-Wing ornithopter should generate the most thrust and the control model the least thrust. While the 4-Wing ornithopter would have the most mass & the control model the smallest. Thrust production is predicted to climb linearly with the symetric addition of wing battens. All models are predicted to have very similar thrust curves. Peak thrust-to-mass ratio is predicted to be highest in the control while being the same in the ornithopters.

Methods/Materials
The control model tested was constructed from a kit, while I construct my own ornithopter models for testing. To take thrust measurements, the models were attached upside down to a long ¼" thick square dowel which was in turn attached to a scale. The rubber band was wound 50 times before being released. A stopwatch started at the activation of the model was placed next to the scale while the two screens were filmed. To take mass measurements, the models were weighed several times & their masses were averaged. More trials of the 4-Wing model, models with battens, & speed will be performed very soon.

Results
The peak thrust of the control was 74.53 mN, while the 2-Wing ornithopter gave 25.5 mN. The control produced a sharp 3.06 second burst of thrust while the ornithopter produced a decreasing amount of thrust over a period lasting between 10.88 & 11.67 seconds. The mass of the control model was 17.55 grams. The mass of the 2-Wing ornithopter was 8.85 grams. The peak thrust to mass ratio of the control was 4.25, while the ornithopter had a ratio of 2.88.

Conclusions/Discussion
My results depart completely from my hypothesis except in the area of thrust to mass ratios. The current results show that 2-Wing ornithopter type aircraft provide a small amount of thrust over a large period of time, as an endurance plane or surveillance drone would require. This information is very useful, as ornithopter systems are being considered more & more for things like military surveillance systems, so it is important to learn about how they fly.

Summary Statement
I tested a 2-Wing ornithopter & a propeller driven control model in the criteria of thrust, mass, & thrust-to-mass ratio; currently I am making a 4-Wing model, measuring speed & measuring how wing baffles affect the models' performance.

Help Received
My science teacher Ms. Copeland lent me the digital scale used. Many thanks to my parents, who bought most of the materials & helped me stay on schedule.