CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Allison Aoun

Project Number
J0104

Project Title
On the Wings of Mission Piggyback Ride: Winglet and Canard Analysis for Transported Craft Aerodynamics, Phase 2

Abstract

Objectives/Goals
Phase 1 determined the best configuration for transporting space aircraft by using larger planes. Attaching the small ship on the bottom of the large ship, facing forward, right side up, was best, followed very closely by bottom and forward, but upside down. Winglets are being added to increase aerodynamics and reduce fuel usage. I wanted to find out if the addition of winglets to the space shuttle would improve the aerodynamics of transporting it. My hypothesis was that the triangle winglet would do the best. After my winglet tests, I decided to experiment further and retested with the addition of canards to see if they would improve the performance of the winglet additions.

Methods/Materials
I built a wind tunnel and flew a small plane attached to a larger one in 8 different configurations. To confirm, I retested my original experiment and also tested 4 different winglet designs: wedge, cylinder, triangle, and rectangle. Tested configurations included combinations of top, bottom, forward, backward, upside down, and right-side-up positions for each wing configuration. I tested each configuration and wing type 5 times for a total of 200 tests. I then tested each configuration and wing type with the same canard 5 times, 200 tests, for a total of 400 tests altogether.

Results
The addition of a wedge-shaped winglet improved performance in all positions, and the wedge shaped winglet improved the top scoring position from Phase 1. However, all of the other winglets (cylinder, triangle, and rectangle) performed worse than if there was no addition. The addition of a canard improved aerodynamic performance overall.

Conclusions/Discussion
My hypothesis was completely incorrect with regards to the triangle winglet, as the position I thought would be the best ranked near the bottom of test scores. The best winglet was the wedge. Commercial planes are adding winglets; my project indicates that this is a good idea since the addition of one of the winglets was an improvement over no winglet. However, most of the winglets resulted in less aerodynamic performance, which would translate into higher fuel costs. It would be better to add no winglet if the design is not a good one. Since space travel will soon be commonplace, the fuel economy resulting from using aerodynamic science is important. The addition of a canard generally improved performance and could be added for relatively little cost.

Summary Statement
My study uses a homemade wind tunnel to determine the best, most aerodynamic winglet, or wing addition and whether a canard improves the aerodynamic performance of that winglet.

Help Received
None.