Mackenzie Carter: STOL 'n Lift

Background

Aircraft, specifically large transport planes, need a lot of room and speed to land and take-off because of their weight and size. A significant amount of time and space is required to obtain the appropriate speed to generate enough lift for takeoff and to slow down after a controlled landing. The efficiency of planes could be greatly increased if this space and time could be reduced.

Purpose

My experiment was to determine if repositioning the engine to in front of the leading edge of the airfoil and redirecting the high velocity air from the engine over the top of the wing would assist in a shorter take-off and landing of an aircraft.

Hypothesis

I predict that as more air is redirected over the top of the wing, while reducing the flow of the air from the engines under the wing, it will increase the amount of lift and decrease the amount of thrust produced.

Materials

Wind tunnel

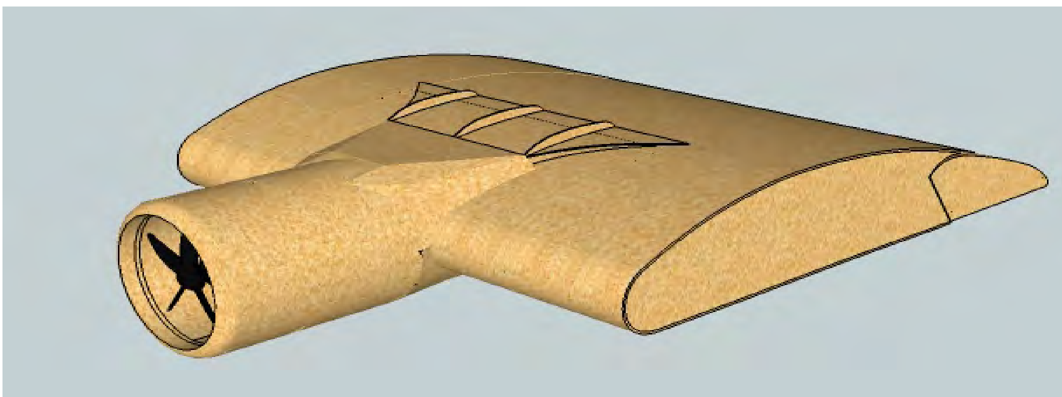
- Clear Lexan
- Coreplast
- Aluminum Bars
- Aluminum Tubes, round and square
- Threaded rod and nuts
- Rivets and washers
- 3 Low-friction Pulleys
- Cable
- 1600cfm drum fan
- Carbon Fibre rods

- Weights
- Foam
- Miscellaneous wire, rods, and bushing

Testing Equipment

- Logger Pro 3 Software
- Vernier LabPro
- Dual-range force sensor
- Computer

Airfoil

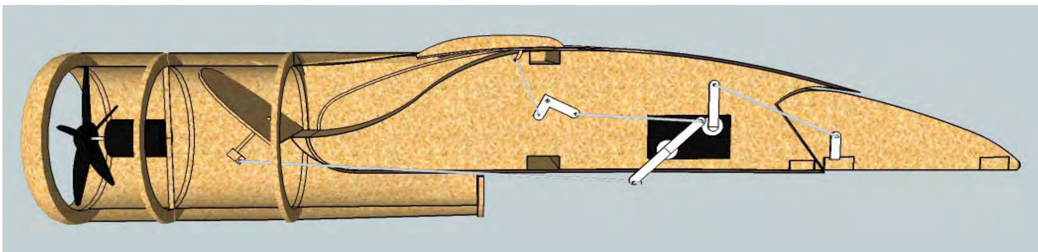


- Balsa Wood
- Light Ply Wood
- Cyanoacrylate Adhesive
- Adhesive Accelerator
- Bell crank
- Rods
- 3 Servos
- Nylon control horns
- Plastic hinges
- Magnets
- 5 bladed electric ducted fan
- Wiring harness
- 5 channel receiver
- Radio
- Lithium Ion 7.2V Battery

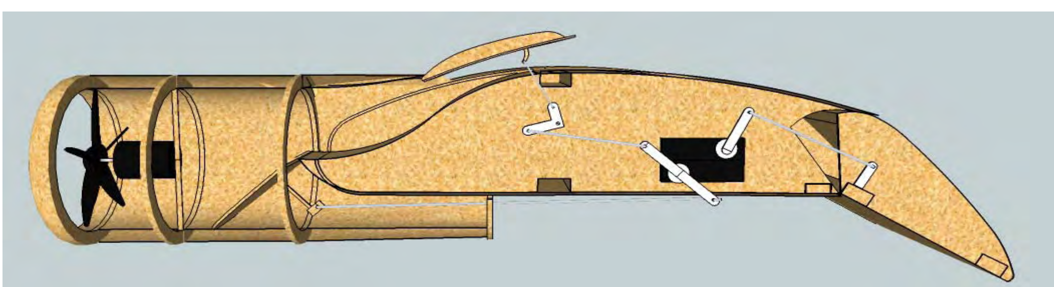
Procedure

A simple box style wind tunnel was constructed with a fan used to draw the air over the airfoil which allows the stream of air to remain linear. The airfoil was suspended within the wind tunnel by a cable passing over two low friction pulleys and attached to a counter balance neutralizing the mass of the airfoil.

1. A cable was attached between the bottom of the airfoil and the force meter to measure lift.
2. The radio transmitter was turned on
3. The battery was connected to the airfoil
4. The setting on the remote was set to flaps up and 0° angle of attack.
5. The airflow was set to 0% redirection so that all of the air was going under the wing.



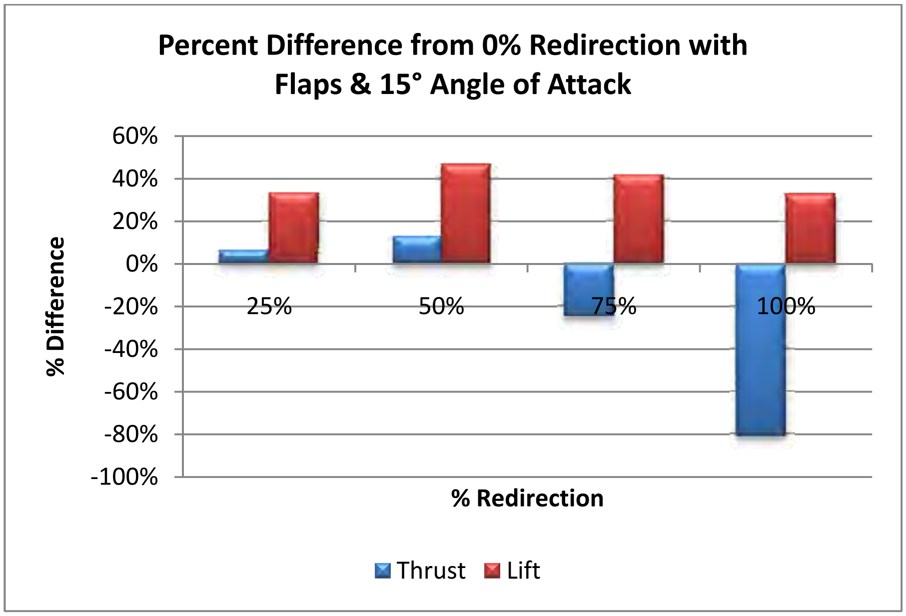
6. The electronic force meter was zeroed
7. The ducted fan and the wind tunnel were turned on
8. 500 samples within ten seconds were recorded
9. Using the diverter flap, the airflow was set to 25% redirection and steps 6 to 8 were repeated for 25%, 50%, 75% and 100%.
10. Steps 6 to 9 were repeated twice so that for each setting there were 3 trials.
11. Steps 6 to 10 were repeated with flaps down.



12. Steps 6 to 10 were repeated for flaps down and 15° angle of attack.

13. The cable attached to the bottom of the airfoil was disconnected then attached to the back of the airfoil through a low friction pulley to the force meter in order to measure thrust.
14. Steps 2 to 12 were repeated.

Results



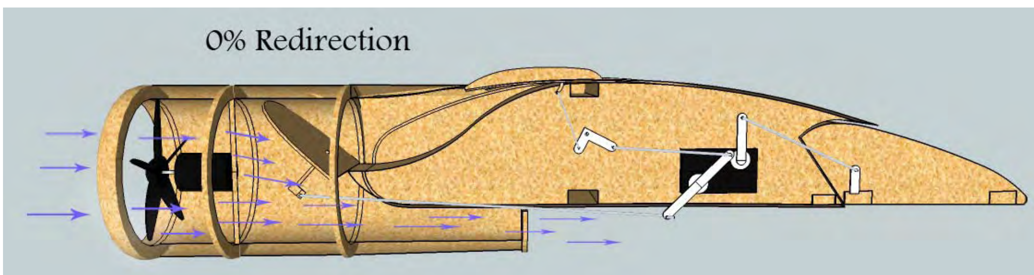
Conclusions and Applications

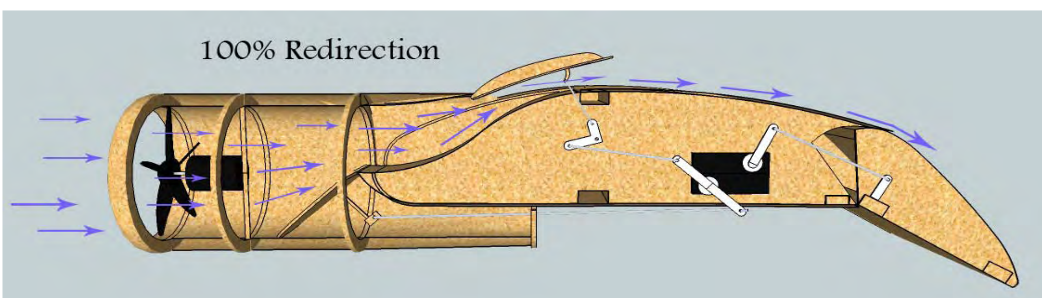
Throughout the three different flight settings, the amount of thrust decreased and the amount of lift increased from 0% to 100% redirection of airflow. Around 25% to 50% redirection, the amount of thrust unexpectedly increased. I conclude that this increase is due to less backpressure on the engine because the diverter valve is half open resulting in the least amount of resistance for the air to exit above and below the airfoil. This allows the engine to run more freely and at higher revelations per minute producing more thrust. Since the upper vent is partially open, the air above the wing can contribute to the production of lift utilizing the Coanda effect. If this is true, redirecting more air through a smaller vent opening may result in a more quantifiable Coanda effect.

The flap, while increasing lift and reducing thrust at 0% redirection, amplified the effects of redirecting the air. This is because the Coanda Effect uses a curved surface that the air adheres to and increases in velocity throughout the curve. The flaps increase the curvature allowing for a greater Coanda Effect. As more air is redirected above the wing the greater the effect.

Increasing the angle of attack increases the effectiveness of the airfoil. With an angle of attack, the amount of thrust can be further decreased while maintaining lift.

Overall, redirecting the air above the wing increased lift and decreased thrust which could allow an aircraft to take-off and land in a shorter distance. With further testing and refinement, I believe that this innovation could be incorporated into a functional wing design.





Acknowledgments

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Appendix

Bibliography

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