Investigation of Wing Design on Small Aircrafts

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USC Viterbi School of Engineering

SHINE Summer High School Intensive in Next-Generation Engineering

Introduction

There are four main components that govern flight: lift, drag, thrust, and weight. However, the two most important components of our lab's research are **lift** and **drag**.

Notions of flight began with the Wright brothers. Since then, aerodynamics has blossomed. We have developed conventional methods with the belief that they are optimal for flight.

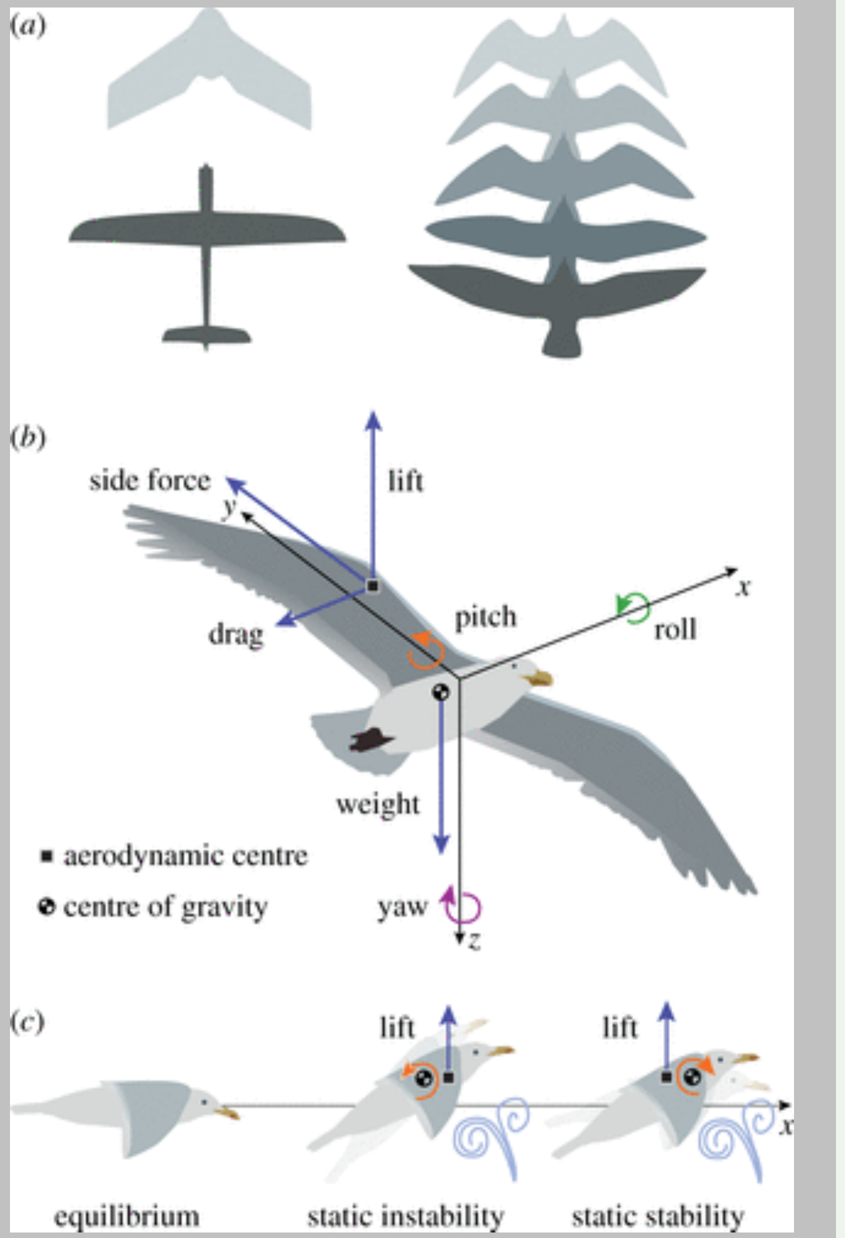
The past 80 years of knowledge and experience has surely guided the flight community to many important improvements in regards to aerodynamics. In the perspective of continuity, we recognize that stiff wing flight came before controlled flight. However, Dr. Spedding senses that our approach to engineering the efficient aircraft could be much better. His research thus focuses on the study of small aircraft, like UAVS.

Objectives & Impact of Professor's Research

Evolution is known as the survival of the fittest.

Organisms that have lived to fly have adapted over time to become optimum vessels for air travel. If natural selection has spent billions of years to pinpoint the best body for flight, why not take its work and apply that to similar-sized small aircrafts?

By integrating our current knowledge of flight with many aspects of how birds fly, Dr. Spedding has the potential to create wings that increases current flight efficiency dramatically.



Seeing how seagulls' wings affect their flight mechanisms could revolutionize the next generation of mechanical flight. PC: The Engineer

Methods

We crafted 6 different aircrafts with different wing designs and flew them to see their effects on flight distance.

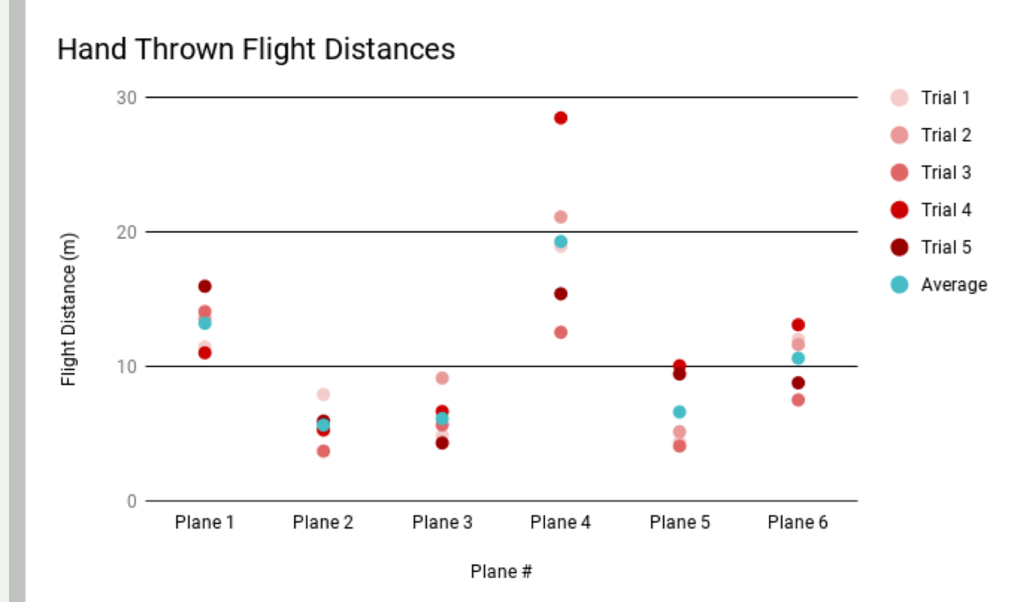
1. Control
2. Blended Type Winglet
3. Split Scimitar Winglet
4. Seagull Wing
5. X-Wing
6. Box Wing

The launcher that we built for our planes. PC: Tianhao Wei

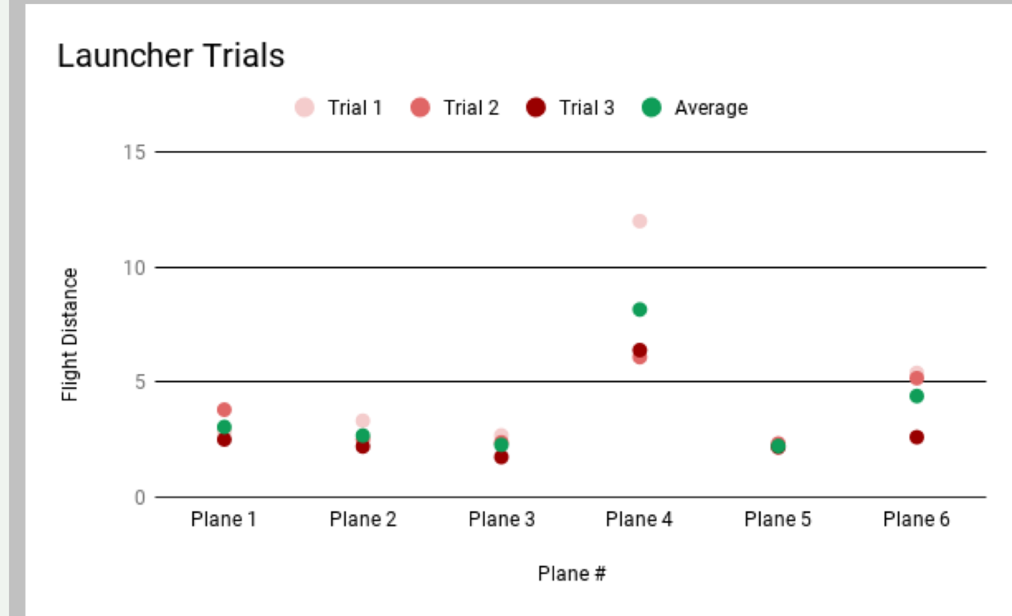
Results/Conclusion

We have clear results that the seagull wing design flew the furthest under the same launch conditions.

Unfortunately, many of our planes were stalling. We identified that a slow and gradual launch velocity produced by throwing was better than the instantaneous launch speed produced by the launcher.



5 trials of flight distances for the hand thrown flight test. PC: Tianhao Wei

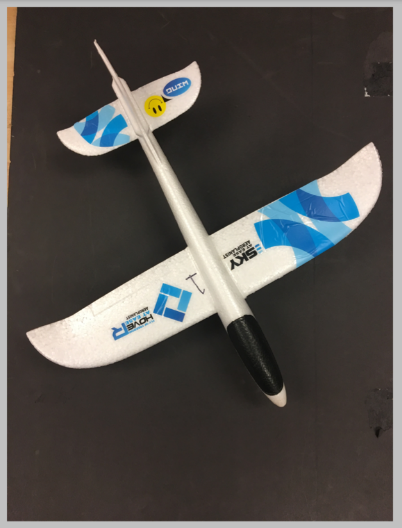


3 trials of flight distances for the launch flight test. PC: Tianhao Wei

Planes 2 and 3 (winglet versions) had a similar stall pattern from both launches. The inconsistency in flight can be attributed to the handcrafted designs of the winglets where size and angles make a difference in aerodynamics.

This preliminary data supports biomimicry as a viable option for flight, at least for small aircrafts.

More testing will be needed to solidify findings and design the optimum wing structure. More calculations would be necessary to quantify the aerodynamics of the different wings.



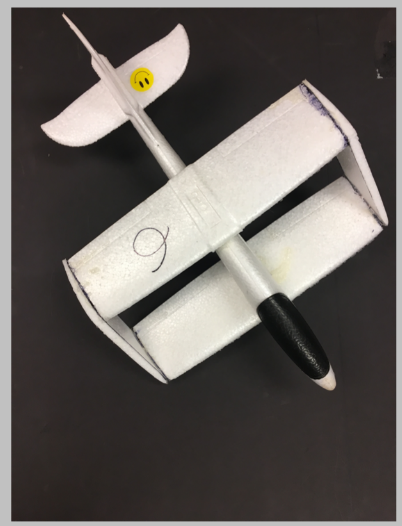
1st wing design: control. PC: Tianhao Wei

2nd wing design: blended winglet. PC: Tianhao Wei

3rd wing design: split scimitar. PC: Tianhao Wei

4th wing design: seagull wing. PC: Tianhao Wei

5th wing design: x-wing. PC: Tianhao Wei

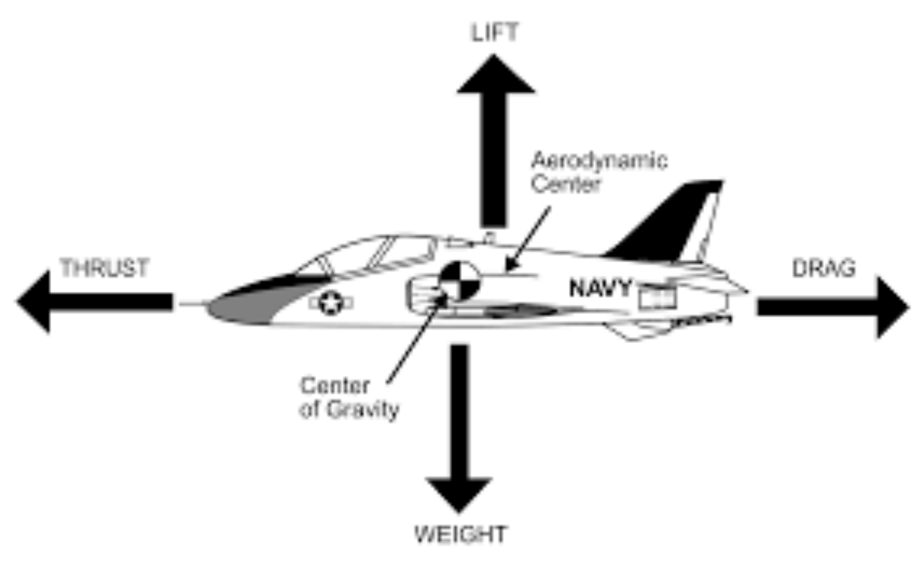


6th wing design: box wing. PC: Tianhao Wei

What I Learned

Stable Flight:

When the aerodynamic center is behind the center of gravity, the plane can stabilize itself in times of low/high angles of attack. The further ahead the center of gravity, the more stable a plane is.



Four forces of flight plus a visual of where the CG and AC should be in respect to each other. PC: Naval Air Training Command

Reynold's Number:

Aerodynamics depends on the viscosity of the gases a body travels through. Reynold's number compares the inertial forces and the viscous forces acting on the body.

* the coefficients of lift and drag do not have a linear relationship

Acknowledgements

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