Modular UAV Wing Design Using Standardized Parts and 3D Printing

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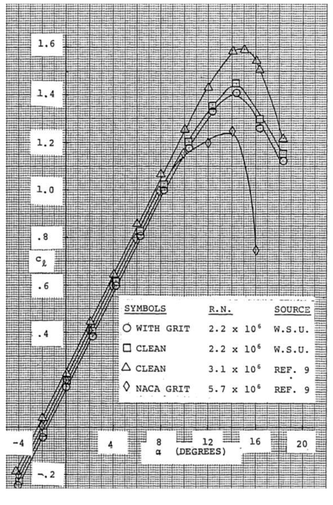
Abstract

Many Universities have research programs that make use of UAVs to aid them in their research depending on their needs. However, getting or creating these UAVs especially if they are big can be expensive. Throughout my time at USC I helped in designing an airfoil for a plane like UAV design. This model of the airfoil builds upon the previous airfoil and UAV design built in the 2025 spring semester by Matthew Burnett, George Coffey, Josiah Worch, Smythe Goforth. I worked with my group to add holes into the wing that use more standardized parts. These parts would reduce the cost of production making it easier for colleges to fund the creation of the UAVs which then later can be used for research purposes. I utilized inventor CAD to 3D model and design the wing and then used a Bambu 3d printer to make test prints looking at tolerances, hole sizes, and hole distance. Throughout this redesign we found it would be cheaper and easier to make use of 20x20 aluminum and m4 screws in the design which is what we based our new design off of.

What is an Airfoil

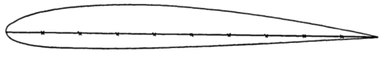
- An Airfoil is a curved structure that creates lift
- The lift is created by manipulating airflow
- The airfoil creates high pressure on the top and low pressure on the bottom
- We used an airfoil as our source of lift in the UAV
- We used the NACA 2412 airfoil
- NACA 2412 is simple and easy to print
- Good stall

Cl vs Alpha



Seetharam et al., 1997

Drawing of NACA 2412 airfoil



Seetharam, Rodgers, & Wentz, 1997

Issues of the Old Design

- Lots of custom parts (ex. Use of pipes)
- More expensive to assemble
- More complicated to assemble as well
- Once put together couldn't be taken apart

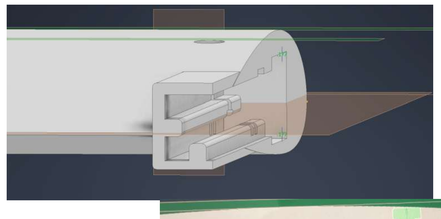
Burnett, Coffey, Worch, & Goforth, 2025

Goals of the New Design

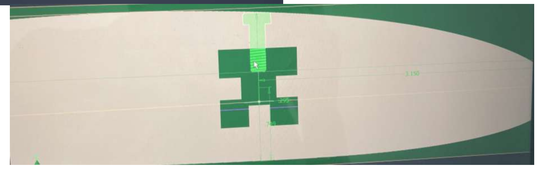
- Use more commonly available standardized parts
- Make changes in the wing to allow the use of these parts
- Make the UAV cheaper and easier to assemble
- Make the UAV easy to put together and take apart

How to Achieve These Goals

- Use more commonly available standardized parts
- Make changes in the wing to allow the use of these parts
- Make the UAV cheaper and easier to assemble
- We will be making use of 20x20 Aluminum and M4 screws for the frame
- These parts are fairly common and versatile

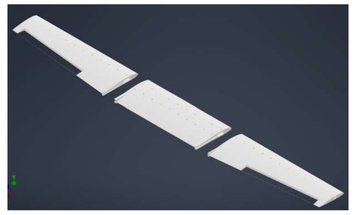


Both of these CAD models have holes for 20x20 and M4 screws in them



Design Process

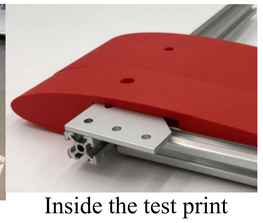
- We Used Inventor CAD to 3d model the wing and frame
- My job was to create holes for 20x20 and the M4 screws
- I put 3d models of 20x20 and M4 screws into CAD
- Using the parts to test if the holes I made worked
- Used assemblies to test how the different wing parts fitted



Exploded view of the Wing assembly in CAD

- I did test prints throughout the various designs I made to test tolerances and different hole sizes
- The goal was for the holes to have a very small amount of extra room so it wouldn't fit too tight

Test print of the Wing



Inside the test print

Conclusion

- The use of 20x20 aluminum and M4 screws make the wing easy to assemble and cheaper to produce
- CAD is great for making constant revisions and prints
- This UAV when completed can be a great asset for colleges looking for a cheap UAV for research purposes

Reference List

Seetharam, H. C., Rodgers, E. J. & Wentz, W. H. Jr. (1977). Experimental Studies of Flow Separation of theNACA 2412 Airfoil at Low Speeds. Wichita, Kansas: Aeronautical Engineering Department Wichita State. ntrs.nasa.gov/api/citations/19950002355/downloads/19950002355.pdf

Burnett, M. J., Coffey, G. R., Worch, J. N., & Goforth, S. C., (2025). Integrated Remote Environmental Monitoring UAV. Columbia, SC: University of South Carolina

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