

## Executive Summary

Aero Nova proposes the design and production of a fixed-wing aircraft utilizing Fused Filament Fabrication (FFF) to compete in the 10th annual 3D Printed Aircraft Competition. This project highlights the rapid development of additive manufacturing by applying a structured design approach that begins with a literature review of high-performing gliders, progressing through aerodynamic simulations to optimize airfoil shape, wing size, and mounting configuration, and integrates in material testing for structural simulations to culminate to the fabrication of a functional aircraft. The primary delivery will be a competition ready FFF aircraft that maximizes flight performance and endurance to yield a full flight time of at least 20 seconds. The broader benefits of our approach include a streamlined effort to maximize technical expertise in additive manufacturing and maximize upon in-flight testing to ensure adequate vehicle performance.

## Background

Additive manufacturing is reshaping modern industry by expanding the design space and enabling the creation of lightweight and highly customizable components across a wide range of applications [1]. In the aerospace industry, it is being used to produce optimized airframe structures, reduce overall system weight, and integrate complex geometries that improve performance while meeting strict material and fabrication constraints.



Figure 1. A350 aircraft 3D printed bracket [2]

Aero Nova is participating in the 10<sup>th</sup> annual 3DPAC. This competition will utilize exclusively additive manufacturing methods to explore new advances and opportunities in the field of remote-control flight. In this competition, we are subject to the following rules:

- 8 seconds of power
- All structural elements 3d printed

In which the longest flight time wins. For this competition, we wish to achieve a minimum flight time of 20 seconds.

## Preliminary Research

Preliminary research began with a literature review of previous team design guides and the selection of airfoils for the main wing and horizontal stabilizer. Airfoil performance data was obtained from public databases and analyzed to identify candidates that met the desired design specifications. Based on this analysis, the GEO-535 airfoil was selected for the main wing and the NACA-0012 airfoil for the horizontal stabilizer.

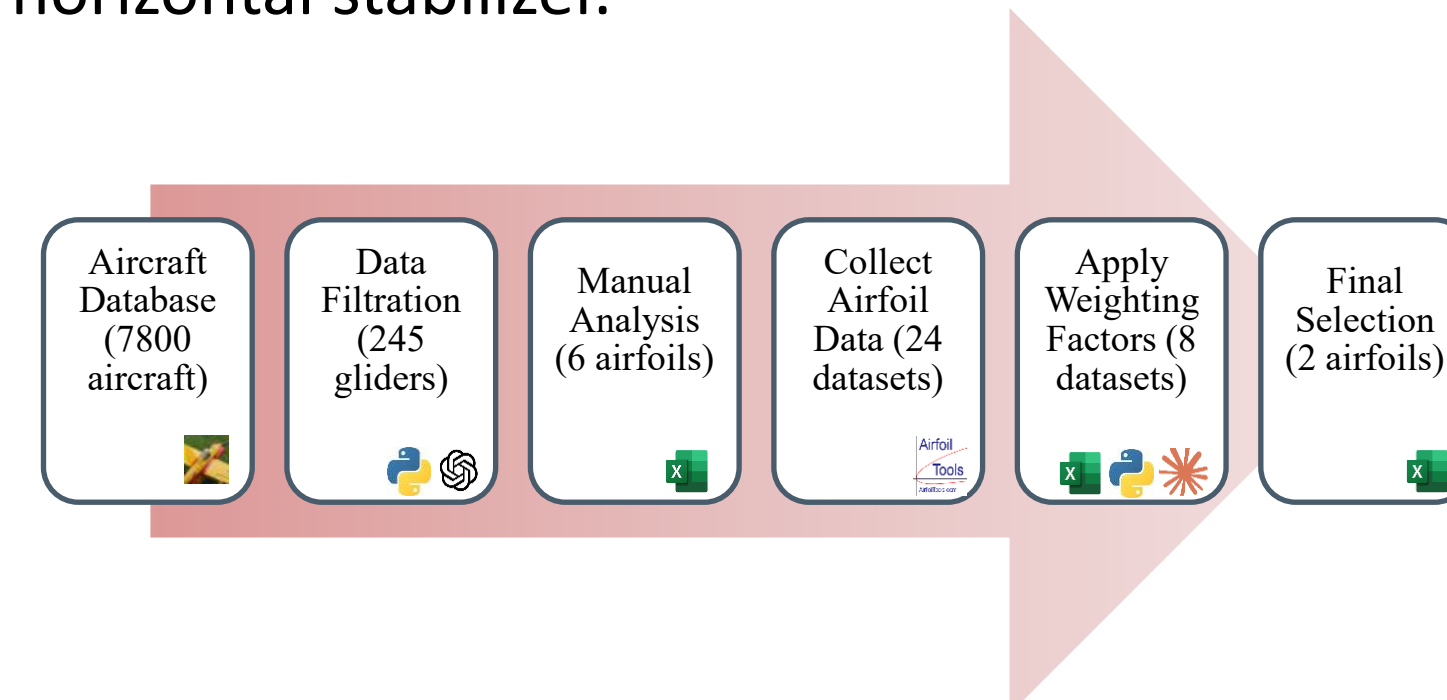


Figure 2. Airfoil analysis flowchart



Figure 3. Eclipson Fox aircraft

The Eclipson Fox, a commercially available RC aircraft, was selected as a reference platform, electronics test bed, and pilot training vehicle. For our structural materials, a weighted decision matrix was used to evaluate commonly used filaments in RC aircraft across key material properties, resulting in the selection of ASA Aero as the surface material and PLA CF as the primary structural material.

## Aircraft Design

Our aircraft features a modular fuselage designed to provide structural support and simplified assembly. The fuselage incorporates integrated fittings for the wings and internal routing channels for control cables. It also houses a removable electronics sled located in the forward section of the aircraft.

The electronics sled is designed to contain the battery, receiver, motor controller, and servos in a compact and easily accessible module. This configuration allows the electronics to be installed or removed as a single unit while maintaining organized cable management within the fuselage.

At the rear of the aircraft, rudder and elevator control surfaces provide aerodynamic control. These surfaces are actuated through a cable-driven mechanism connected to servos mounted in the electronics sled. The control cables are routed internally through the fuselage, enabling efficient transmission of motion from the forward-mounted servos to the rear control surfaces.

Additionally, the wings feature a lightweight crosshatched internal structure to reduce overall mass, utilizing integrated spars for structural rigidity and a 5° dihedral angle for improved aerodynamic stability.

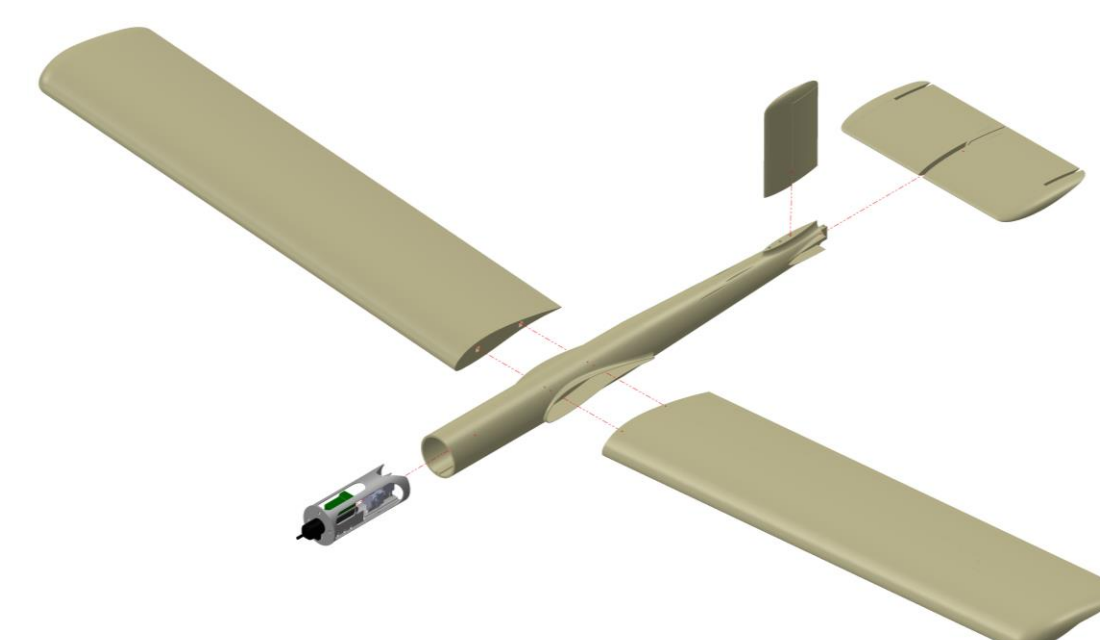


Figure 4. Full assembly design

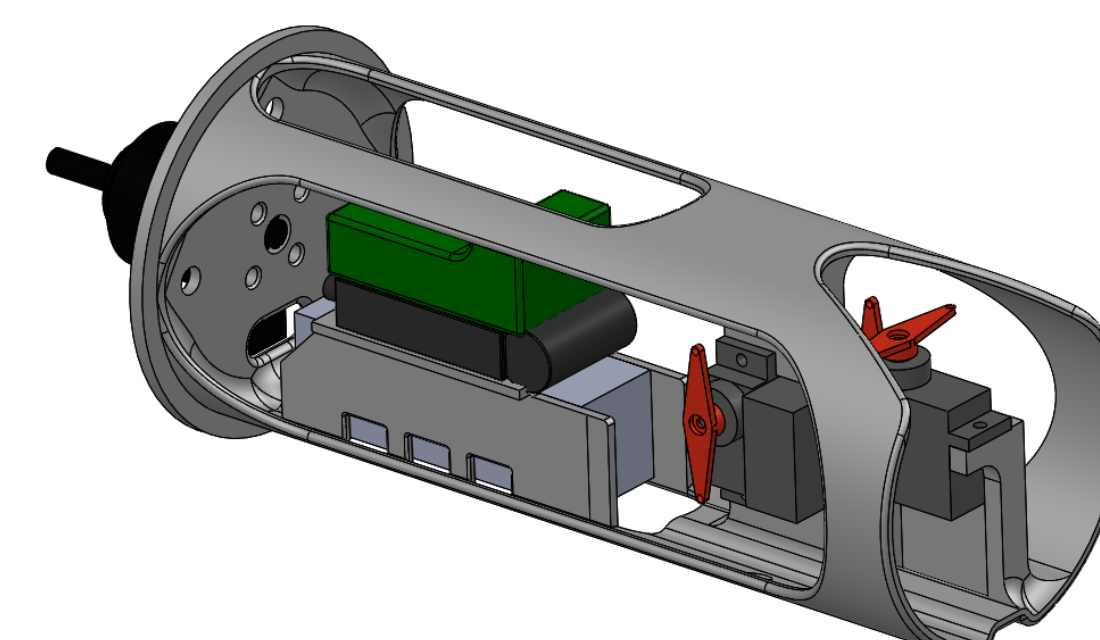


Figure 5. Electronics sled

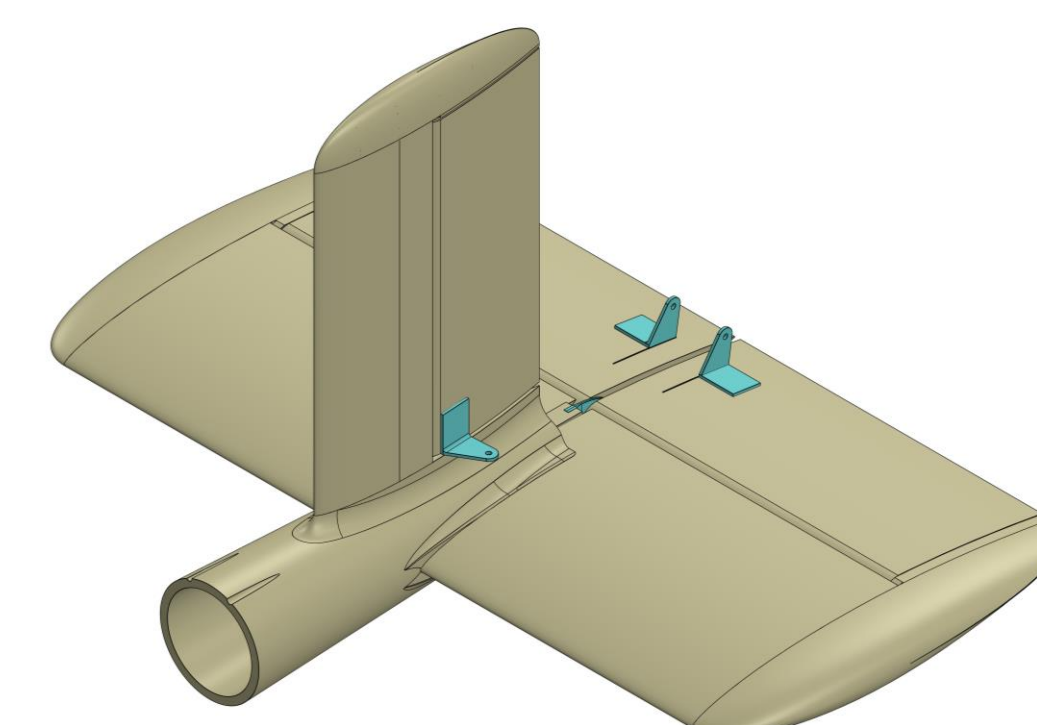


Figure 6. Rear control surfaces

## Aircraft Assembly and Flight

Prior to printing components, optimal print parameters were established through rigorous mechanical testing. Tensile testing of both the surface and structural materials was conducted to evaluate print quality across varying parameters. Through iterative refinement, the resulting mechanical properties exceeded those reported in the manufacturer's official datasheets. These collected properties were then used to perform simple beam calculations and minimize dead weight in the wings of the aircraft.

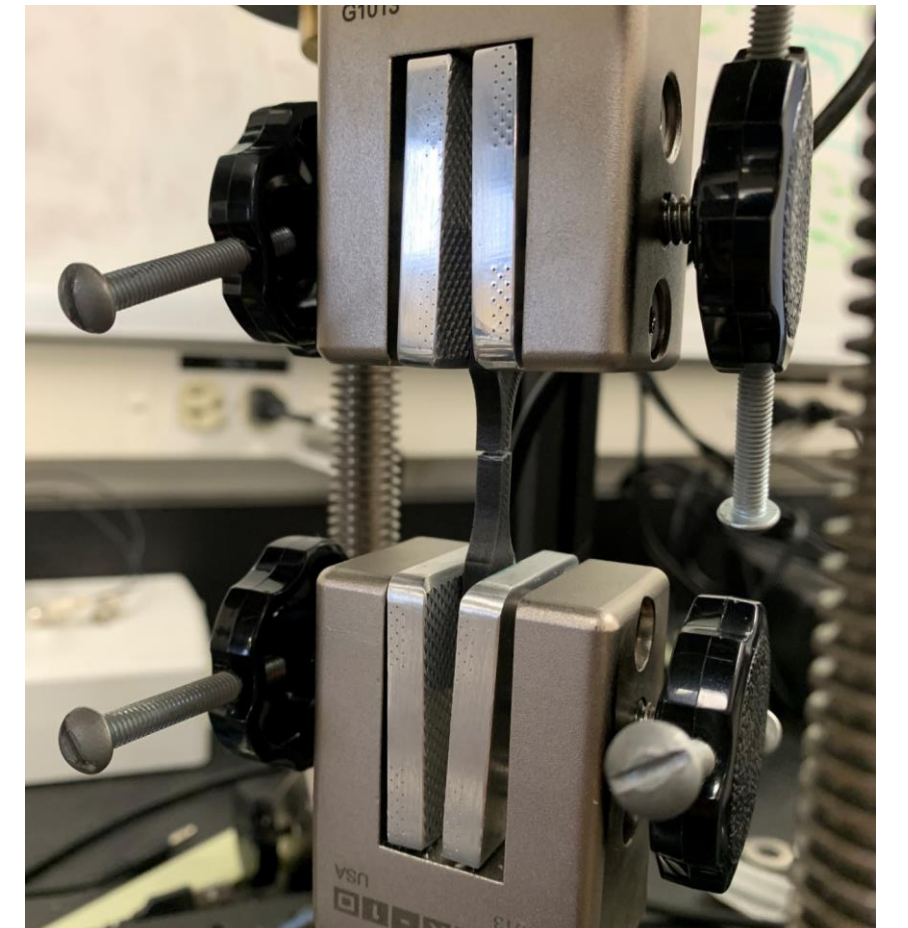


Figure 7. Tensile testing

Our aircraft was designed with modularity and ease of assembly as core principles, allowing each segment to be printed individually and combined into the complete assembly. This streamlined the production process and reduced manufacturing time, while also allowing any faulty or damaged segments to be replaced independently, eliminating the need to reprint the entire airframe and making the design far more practical and cost-effective.



Figure 8. Aircraft full assembly

Our first iteration aircraft was able to deliver a flight time of 8 seconds under full throttle. Due to issues in rear elevator actuation, aircraft control was unreliable, however, the aircraft was able to meet our desired rise time and exhibited relatively stable flight barring control issues. Our second iteration aircraft aims to address these control issues and deliver a flight time well over 20 seconds.

## Conclusions

In conclusion, we successfully designed and built a functional fused filament aircraft capable of controlled flight, achieving approximately 8 seconds of airtime during testing. While this falls short of our 20-second goal, we are actively implementing design improvements to address the challenges encountered, and we are confident in exceeding that target by competition time. Throughout this process, we have gained valuable insight into iterative and modular design, leveraging 3D printing at every stage. Aero Nova would like to acknowledge our faculty advisor, Dr. Taylor, as well as the other two 3DPAC teams for their help throughout this project.

## References

1. Raffaelli, R., Lettori, J., Schmidt, J., Peruzzini, M., and Pellicciari, M., "A Systematic Approach for Evaluating the Adoption of Additive Manufacturing in the Product Design Process," *Applied Sciences*, 2021, Vol. 11, No. 3
2. Kellner, T., "3D-Printed 'Bionic' Parts Could Revolutionize Aerospace Design," *GE Reports*, June 20, 2017.