

Executive Summary

The ASCENDX team is developing a fixed wing 3D printed aircraft to compete in the 10th annual 3DPAC hosted at UTA. This competition challenges students to design and manufacture lightweight 3D printable airframes while leveraging 3D printing technologies with the goal of achieving the longest flight duration at the competition. The team has developed a lightweight three-channel aircraft in accordance with competition rules that will be powered for 8 continuous seconds and then glide within the allowed airspace with the goal of taking first place. The aircraft has undergone multiple iterations to achieve optimal glide time with V3 featuring a 15% weight reduction from the previous V2 model.

Background

With additive manufacturing rapidly becoming common in industry, as well as its increasing cost effectiveness over the last few years, the potential to improve current parts is more apparent than ever. This technology allows us to create geometry that is impractical or almost impossible to make with conventional manufacturing methods and have functioning prototypes in a fraction of the time it would normally take. This project focuses on the use of 3D printing technology in the aerospace industry while staying within design and manufacturing constraints. 3D printing technology continues to advance allowing for low-cost rapid prototyping production of complex and lightweight parts in the aerospace industry.

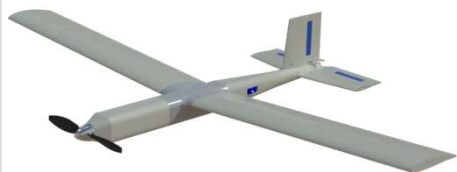


Figure 1. Full Aircraft V3 Assembly

Experimental Setup

Competition Constraints

- All airframe components, aerodynamic surfaces, and control surfaces must be purely 3D Printed.
- Propellers, motors, and electronics may be purchased off the shelf.
- The aircraft may be powered for a maximum of 8 continuous seconds.
- Must safely operate within a 300x160x60 foot area at Maverick Stadium.
- Cannot use tape to repair aircraft.

ASCENDX Design Selection

- 3D Printers: Bambu P1S (256x256x256 mm) & Markforged Mark Two (320x132x154 mm).
- Materials: ASA Aero, Polycarbonate, TPU, Nylon Carbon Fiber.

Table 1. Final Aircraft Configuration

Airfoil	Wingspan	Aspect Ratio	Dihedral Angle	Fuselage Length	Total Weight
Eppler 393	1225 mm	10.5	4°	650 mm	~485 g (1lb)

Aircraft Structure & Analysis

The aircraft structure features a squared fuselage printed using ASA Aero with 2-mm thick walls reinforced with integrated helix-patterned stiffeners. Section 3 of the fuselage supports the spar pass through creating a continuous load path between wings and is printed using polycarbonate. The wing features 1-mm thick walls, ribs angled at 45 degrees and is also printed using ASA Aero.

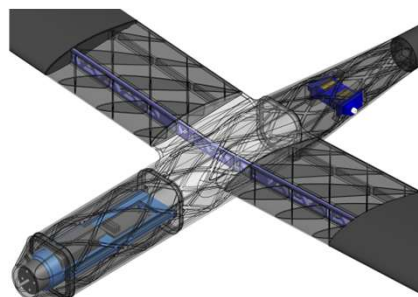


Figure 2. Aircraft Internal structures



Figure 3. Wing Deflection Analysis

Electronics Selection & Manufacturing

The control surfaces are attached to the stabilizers using a thin piece of flexible TPU and are actuated using control rods from two servos. The aircraft is powered by a 2300kV brushless motor and a 25A ESC with a 4S 450 mAh 75C LiPo battery all connected to an 8x5 folding propeller.

The aircraft structure is manufactured using a Bambu Lab P1S, an enclosed FDM printer required for printing ASA Aero due to its sensitivity to temperature fluctuations. The full aircraft structure takes approximately 76 hours to print. Carbon fiber wing spars are fabricated using the Markforged Mark Two printer, which utilizes a dual nozzle system to produce nylon parts reinforced with continuous carbon fiber.



Figure 4. Nylon Carbon Fiber Spar



Figure 5. Electronics Sled

Experimental Results

The aircraft internal structure was optimized on V3 to include a higher wing rib density and increased fuselage stiffener sizing while maintaining a lightweight design. Since tape is not allowed to make repairs, the team was successful in implementing 3D printed TPU strips to make repairs. This along with the addition of the spar allowed for the removal of tight cap and plug connections at the wing and instead opting for super glue to bond parts together. The fuselage still utilizes cap and plug connections and super glue for assembly with the square design providing a stable landing surface. The V3 aircraft was able to achieve controlled flight for over 30 seconds while powered.



Figure 6. Current V3 Aircraft In Flight

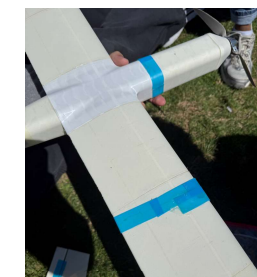


Figure 7. TPU Repairs

Conclusions

The V3 aircraft has been tested and proven to be flight worthy and capable of sustaining controlled flight meeting the client's objectives and constraints while also only weighing about 1lb. Future plans for the aircraft will consist of improving its glide characteristics by reducing aircraft weight and drag. The next iteration is already in development featuring a rounded fuselage and significant weight reduction.

We would like to thank our advisor, Dr. Robert Taylor, for providing insight and guidance throughout this project.