

3D Printed Aircraft Competition – Team 3D1

ME Senior Design

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Executive Summary

Senior Design Project Team 3D1 “Battlehawks Engineering” is designing and building an aircraft for UTA’s 10th Annual 3D Printed Aircraft Competition. All components of the airframe must be 3D printed, the aircraft must only fly within the 300 x 160 x 60 foot area of the UTA Maverick Stadium football field, and the aircraft may use only up to 8 seconds of continuous propulsion.

The aircraft has been designed and improved upon over the course of a year and is still in progress. Work will continue until competition day on July 11th, 2026.

Background

Since its inception in the early 1980s, 3D printing has promised to revolutionize the engineering design process.

The aerospace industry quickly adopted this technology for rapid prototyping, design testing, and the ability to create lightweight, geometrically complex components. Over the decades, aerospace companies and research have allowed 3D printing to step out of design and make its mark as a viable option for fabrication.

The 3D Printed Aircraft Competition (3DPAC) challenges competing student teams from any accredited university to utilize the evolving landscape of 3D printing technology and apply it to the design of an aircraft while grappling with the benefits and constraints of this process.

The 3DPAC rules state:

- All airframe components must be 3D printed
- No size or weight restrictions
- Powered thrust available for a maximum continuous duration of 8 seconds
- Must operate safely within a 300 x 160 x 60 foot area
- The team with the longest flight time wins!



Figure 1. Previous 3DPAC competitions

Experimental Setup

Based on the rules outlined by the 3DPAC, the constraints and goals for our aircraft determined for our project were:

1. All components of our airframe must be able to be 3D printed and must consider the size and compatibility of the printer that will be used.
2. The design of the plane should be optimized for reducing weight and maximizing lift wherever possible, especially after the maximum 8 seconds of thrust, to maximize airtime.
3. The airframe pieces and the connections of those pieces need to remain structurally sound to prevent a structural failure during flight.
4. The design of our plane should be modular between all airframe components to allow for easy repair and testing of new part designs without needing a whole new plane.

Initial analysis led our design to be modeled after real-world high-performance gliders. To guide our aircraft development, the Selig 1223 RTL airfoil was chosen as our wing airfoil due to its high lift qualities, ABS as our 3D printing material to avoid complications that could come with alternative, more complicated materials, and a Bambu Lab P1S printer as a reliable 3D printer for continued use.

Experimental Test Plan

Our current design is the result of many revisions and changes since we started last August, changing features like our fuselage cross-section, motor mounting area, wingspan, and our tail’s sizing and distance from the center of our plane.

Current Battlehawks Engineering Aircraft Design Characteristics:

- Aircraft length of 25.5 inches (about 2 feet)
- Wingspan of 62 inches (about 5 feet)
- Weight of about 3 pounds
- Modular design to ease the swapping of airframe pieces
- RC components to enable elevator and rudder control surfaces to adjust pitch and yaw
- Brushless motor to power a propeller for the maximum 8 seconds of thrust
- ABS material that is easy to print and join with superglue

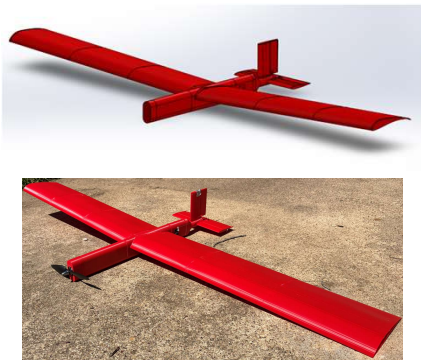


Figure 2. CAD Model and Full Assembly



Figure 3. Flight Test #4

The wingspan of our aircraft is supported with continuous carbon fiber reinforced spars to increase overall stiffness to prevent premature failure during flight due to bending. The use of these spars was supported by structural analysis calculations that showcased high bending stresses of up to 800 psi at the root of the wings under a 3g load case to account for variability in flight conditions and fabrication.

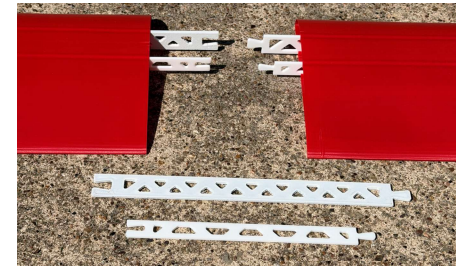


Figure 4. Carbon Fiber Spars within the Wings

Experimental Results

Test Flights 1-3 – Failure, 0-2 s flight time: Unsuccessful due to integration issues at component interfaces, suboptimal launch conditions, and oversized control surfaces that led to instability.

Test Flight 4 – Success, 5-6 s flight time: Our first real fight, the aircraft was able to achieve flight and respond to pitch inputs. However, the limited range of motion in the control surfaces at the time of assembly reduced maneuverability, making it difficult to correct its trajectory and leading to an early crash.

Conclusions

Our current fully assembled design abides by all the competition rules and holds up structurally during flight. Our aircraft is also able to generate enough lift to gain altitude.

However, a fully controllable aircraft has not yet been achieved. Further work will focus on correcting the effective range of motion for our control surfaces as well as adjusting the sizing and distancing for our tail to achieve an ideal moment balance.

Our current fabrication procedure only takes 3 days to print and build a new aircraft, which has allowed us to test multiple different iterations of our aircraft, demonstrating the worth additive manufacturing has on being able to physically test out concepts and ideas quickly and without great financial risk.

Battlehawks Engineering would like to thank Dr. Raul Fernandez, Dr. Robert Taylor, Timothy Stevens, Mikaela Leevy, Mr. and Mrs. Stephens, and our fellow UTA 3DPAC teams for their support on this project.

References

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