3D Printed Aircraft Competition

Overview

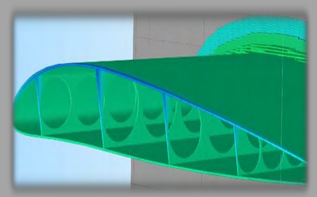
The University of Texas in Arlington (UTA) sponsors an annual 3D-printed aircraft (3DPAC) competition. The Mechanical Engineering Department at San Diego State University is to have at least one, but up to three entries in the 3DPAC competition. Design entries must conform to the rules and regulations of the competition. The teams need to conceptualize, design and analyze, and build a small aircraft for entry into the University of Texas Arlington's 3D Printed Aircraft competition using only 3D print materials and commercially available hardware. Other necessities will include (radio-controlled aircraft) pilot training, safety equipment in the event of an RC aircraft mishap, and enough extra material to manufacture at least two additional airframes of the same design. FAA registration will be required. For entry into the UTA 3DPAC, lodging and transportation will also be required.

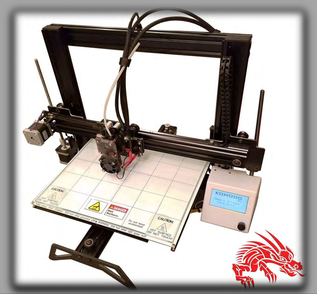
Competition Rules

- All airframe components, including all aerodynamic surfaces and control surfaces, must be printed using a purely (not hybrid) 3D printing technology
- Aircraft may be unpowered, or they may be powered using a safe propulsion method for a maximum continuous duration of 5 seconds
- Aircraft may be controlled or uncontrolled and follow any course, but flights must operate safely within a 300 x 160-foot area and remain under 30 feet
- All design, analysis, and fabrication of the competition entry is the sole responsibility of the student team members

Fabrication and Assembly

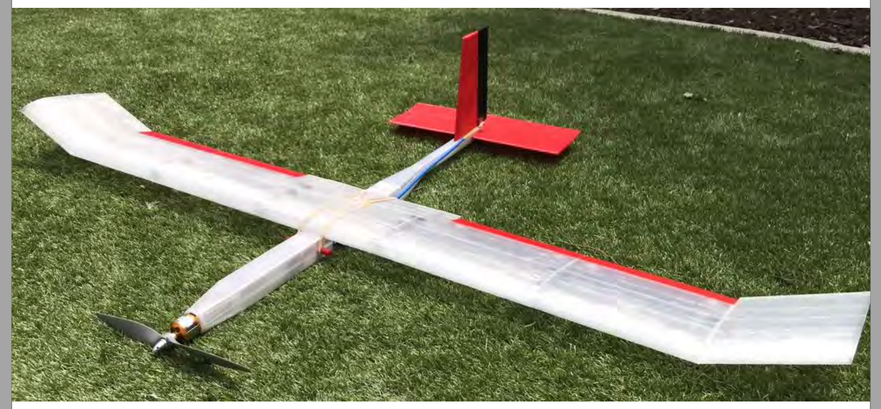
- Using modeling programs such as SolidWorks and slicer software such as Cura and Simplify3D, large parts of the aircraft are sectioned off into smaller parts to create 3D printable sections. All components were printed on a Komodo Filament Deposition Manufacturing (FDM) 3D printer.
- Assembly was done using, glue, tape, rubber bands, surface processing such as sanding with sandpaper, soldering for the electrical connections, and hardware like such as screws and connecting rods. The wing is attached to the fuselage with the use of rubber bands
- The prototype models were printed with PolyLactic Acid (PLA) and the final aircraft was printed with PolyEthylene Terephthalate Glucose (PETG)





Design Characteristics

- Wingspan of 1.5 m, chord length of 0.203m , aspect ratio of 7.5
- 25 different designed components
- 54 total printed components
- Total print time of one full model: 108 hours
- Total aircraft weight: 1.7kg (3.74lbs) + components
- Wing Loading: 5.6 kg/m^2



Lessons Learned

Plan for failure
- Have a backup plan for if (when!) something goes wrong
- Allow extra time for manufacture of parts – there will be print failures

Practice:
- Do trial runs of prints before printing the final version (like a rough draft)
- Pilot training is of paramount importance

Design for Manufacture
- For FDM 3D printing especially, design parts with printable angles and reinforcement at thin feature joins

COVID-19
- How to continuously and effectively work as a team without in-person interactions

Team Bandicoot

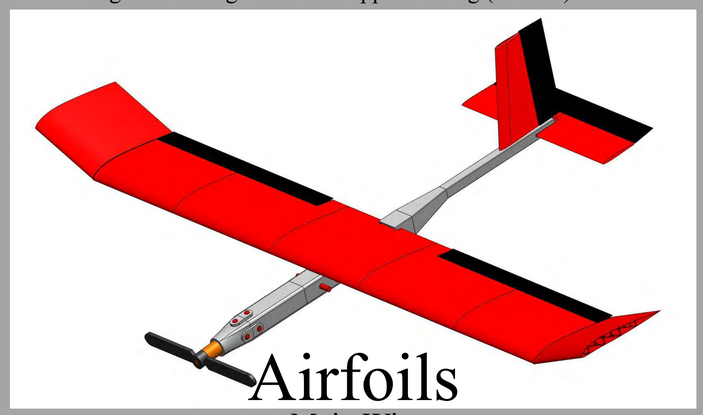
From left to right: Mitch Mahowald, Steven Malley, Jonathan Navarrete, Brian Sperry

Tests

San Diego State University: November 6th, 2019
- Tested 3 prototype aircraft: 4" chord, short wing, 5" chord

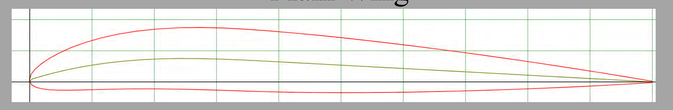
Black Mountain Park:
- Successful flight test of foam model, hybrid model, and V4 model

Wing load testing: max load applied 10 kg (20.2lbs)



Airfoils

Main Wing



NACA35010, $C_L = 0.5$ at angle of attack $\alpha = 2°$

Horizontal Stabilizer and Elevator

HT-12, $C_L = 0.0$ at angle of attack $\alpha = 0°$

Acknowledgements

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