Designing and Flying a Fully 3D Printed Remote Control Plane

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INTRODUCTION

This project follows the well known process of aircraft design but applies it through the lesser researched and documented application of 3D printing for manufacturing. This application poses many challenges and benefits that my project seeks to address and discover. While 3D printed RC aircraft have been built before, this project documents the feasibility of an inexperienced and unqualified aerospace engineer attempting to design a fully 3D printed aircraft. This is useful for many other hobbyists and professionals alike who want to develop their own idea into a flying creation through the relatively new technology that is 3D printing.

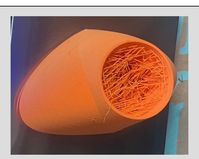
RESEARCH METHODOLOGIES

- Aircraft design is a **well-documented** and **researched** field.
- But, requires **significant education and experience** to understand and implement.
- Project aims to understand and implement enough basics to design a well-controlled, efficient aircraft.
- **Technical papers** from universities on building RC aircraft served as a basic **framework**.
- Further research was necessary to fill major gaps.
- Manufacturing the plane through **3D printing r**equires knowledge and skill of Computer Aided Design **(CAD).**
- This project evaluates whether 3D printing's **benefits outweigh the additional effort** compared to traditional methods.
- Started with **no experience** in CAD, RC vehicle, or aircraft design.
- Represents a beginner's experience designing and building their first plane through additive manufacturing.

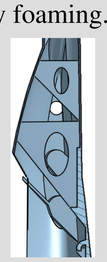
- **Various types of research conducted:**
  - Experiential research to learn processes and steps.
  - Experimental and simulation research during the design process for aerodynamic analysis to make design decisions.
  - Research was both qualitative and quantitative.
    - Qualitative: Different wing structures.
    - Quantitative: Selection of airfoil, wing planform, wing position, tail position, tail size, etc.

DISCUSSION, ANALYSIS, AND EVALUATION

Special Considerations of 3D Printing



Stringing
- LW-PLA creates a mess of “stringing” due to it constantly foaming.
- Certain slicing techniques can prevent or limit this.



Design Considerations
- No overhangs greater than 45 degrees
- Sufficient surface area for bed adhesion

Advantages
- Intricate and complex possibilities
  - The blended wing body, tapered wing, and many other features would be very difficult to do with traditional construction methods.

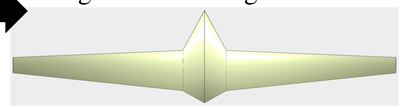
DATA AND PROJECT EXECUTION

The Basic Design Process

Determine Goal
- What speed will the plane fly at?
  - **~25 mph**
- Should it be designed for speed or **endurance**?
- Will it carry a payload? -**No**
- How maneuverable must it be?
  - **Not very**

Calculate Wing Planform

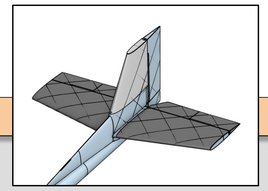
Planform- the top view of the wing.
- This plane aimed for **efficient** straight and level flight



- High Aspect-Ratio
- Lift=weight at best Lift to drag ratio.

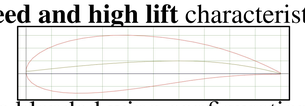
Calculate a Weight Estimate
- This is calculated with a rough estimate of the electronics and material.
- It is hard to get an accurate estimate because the size and shape is undetermined. Therefore, conservative estimates are essential

Calculate Tail Size
- Tail volume coefficients are used.
- The tail dimensions is determined by selecting desired tail volume coefficients from other planes.



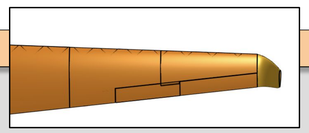
Pick Airfoil

NACA 4415 -Wing
& 5622 - Central Blended Airfoil
- These were selected for their **low speed and high lift** characteristics

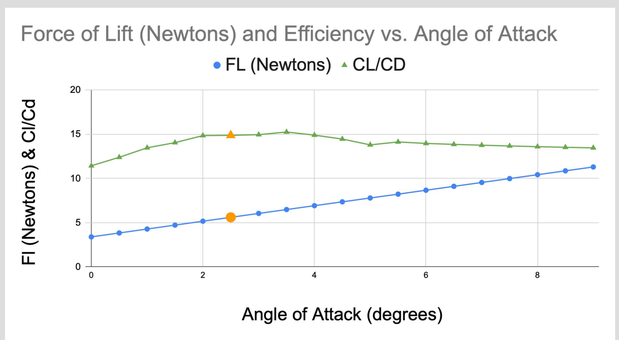


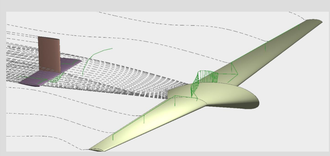
- The blended wing configuration required a thick central airfoil.

Calculate Control Surfaces
- The plane needs to be able to fly controlled and stable. Therefore, appropriate control surfaces need to be calculated.
- Tail - **Rudder =35%** Vertical area **Elevators =30%** Horizontal area
- **Ailerons ~20%** of total wing area and positioned near wingtip.

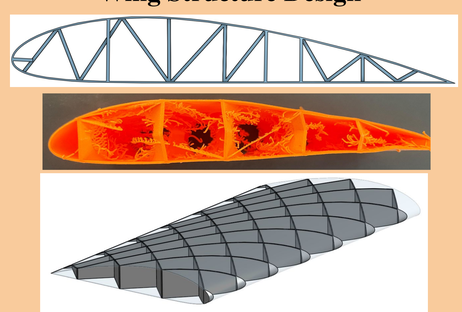


Calculating Wing Planform Continued





Wing Structure Design



CONCLUSIONS, IMPLICATIONS, AND NEXT STEPS

Is it worth it?

No, unless…
- The advantages of 3D printing do not outweigh the disadvantages for beginner hobbyists and engineers.
- The time required to learn the skills and implement them is far greater than required for building other types of remote control planes.

However,
- If someone has an exact idea, sufficient time on their hands, and is up for a challenge, 3D printing’s benefits can result in a much more complex and personalized plane.

ACKNOWLEDGEMENTS

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Works Cited: