Reverse engineering an RC plane part to evaluate the 3D engineering space

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Introduction

Products from Apple and John Deere are expensive and hard to repair. One emerging solution for consumers to replace their broken parts independently is the 3D engineering space. To understand this process, the core technologies must first be examined.

The process of 3D scanning involves sending multiple beams of light to bounce off an object, then using tracking software to determine where the light beams are stopped. This data is translated into a computer-generated 3D plane (Haleem et al., 2022). The points are connected to form polygons, ultimately creating a full body mesh that is the 3D model, which can be sent to a 3D printer. In traditional 3D printing, filament is heated and extruded in layered paths until the object is created (Shahrubudin et al., 2019).

An application of these methods could be the replacement of RC plane parts. RC planes are model aircrafts which receive digital signals through a transmitter to perform certain tasks such as directional flight or aerial photography (Hedge et al., 2014). The purpose of this study was to reverse engineer an RC plane part via 3D scanning, modeling, and printing to evaluate the 3D engineering space, its utilities, and applications.

Materials and Methods

A DEERC four-channel plane was painted white and broken up into its main components: motors, receiver, controls rods, and secondary foam pieces such as the ailerons (fins) and covering for electrical components (Figure 1). The Creality CR-Scan 01 3D Scanner was used to get a full render of the disassembled original plane. The render was then exported to Autodesk Meshmixer software as a 3D model (Figure 2). Artifacting was removed and face simplification was applied to reduce polygon count and overall mesh complexity.

Within Autodesk Meshmixer, automatic and manual mesh simplification was performed on the plane to ensure a smooth print workflow.

Figure 1: The disassembled shell of the original RC plane, painted white for scanning. White paint was chosen as it reflects the most light as opposed to the original black painting on the part. To avoid noise on the render, ambient light had to be minimized through a dark environment.

Materials and Methods (continued)

The model was separated into four main sections: the fuselage, the nose, and the left and right wings (Figure 3). These sections represent the plane's core structural components. Dividing the model allowed each piece to fit within the available printer space. Boolean subtraction operations in Autodesk Fusion were used to create recessed sockets within the mesh geometry. This peg-and-socket design was selected for precise alignment between sections during assembly.

Figure 2 (left): The plane's full scan, rendered in Autodesk Fusion. Reference markers, known as tracking boxes (in pure white), were rendered alongside the plane and used by the scanner to maintain positional accuracy.

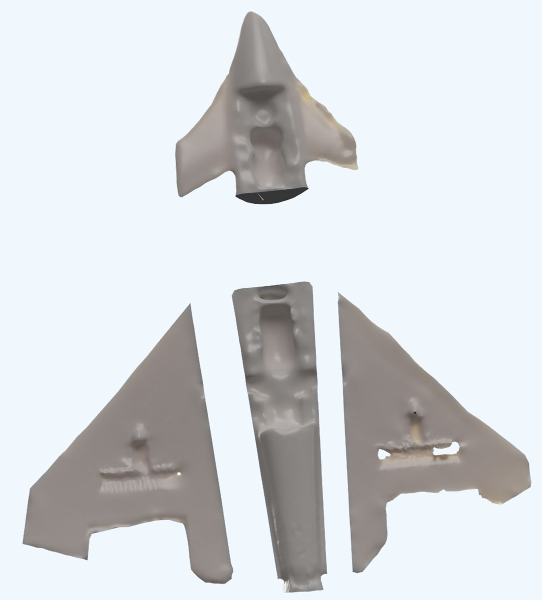


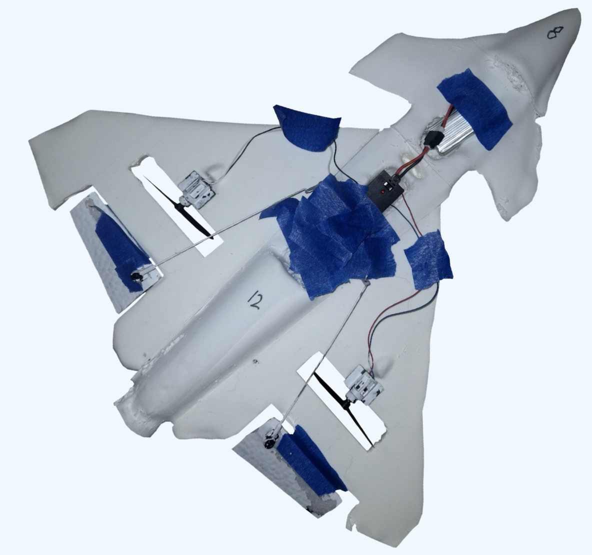
Figure 3 (right): Full 3D model of the plane portion within Autodesk Meshmixer. A fuselage cavity, extending from the main body to the nose, houses the primary electrical and structural plastic mounts and are protected by a secondary foam covering.

These final four portions were printed on a Bambu Lab P2S printer using a lightweight filament known as PLA Aero, which weighs 50.5% less than standard PLA. The fuselage and nose were printed completely hollow with single-wall layers. The wings, due to fragility and electrical attachments, were printed with two-wall thickness, ensuring durability through flight and construction. The recreated plane was assembled using the previous plane's components (receiver, motors, etc.). Sections were assembled using painter's tape and cyanoacrylate adhesive (super glue). After reconstruction, the plane parts were subjected to test flights and evaluated for dimensional accuracy relative to the original model.

Results

The upfront cost of the replica plane part (excluding costs to purchase a 3D printer and scanner, but including filament, cyanoacrylate adhesive and tape) was $10.34 (Figure 4), as opposed to the original plane's $80. Combined print times totaled approximately 11 hours and 35 minutes. Two prototypes were produced, differing in adhesive type: one assembled with hot glue (133 g) and one with cyanoacrylate adhesive (88 g).

Results (continued)



Scan inaccuracies necessitated additional material during reconstruction, resulting in a 19 g weight excess over the original's 69 g, insufficient for the plane's motors to generate enough lift to sustain flight. Neither version achieved sustained flight, eliminating quantitative flight performance comparisons.

Figure 4 (above): Completed replica of the original RC plane (using cyanoacrylate adhesive) after original components were reinserted. The control rods, due to scan inaccuracies, interfered with the motors and caused crashes during test flights.`

Conclusion

Portions of the original RC plane were replicated successfully at a lower cost to manufacture, showing that the 3D engineering space is a valuable area for customization, replication, and specialization. This pipeline keeps costs below replacement thresholds to directly support the right to repair movement. A primary limitation is the effort and inaccuracy of the scanning and modeling process, causing less alignment and overall imperfections in design and function. Improved scan quality would reduce render noise and decrease post-processing time. Weight restrictions of the filament hindered the plane's design, placing stress on structural integrity and dimensional accuracy. Applications where weight is not a limiting factor may yield significantly higher replication accuracy. Improved accessibility of this technology would strengthen 3D engineering as a practical right to repair solution.

References & Acknowledgments

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Special thanks to Taylor Cunningham for his resources and time.