Digital Design Network+
Case Study 1 Individual Report Template

Name	Francesco Ciriello
Email	francesco.ciriello@kcl.ac.uk
Institution	King's College London
Team	2
Focus	Better, Faster, With Less
Design Process	Computational Design & Automation for Manufacturing
Tools Used	nTop, Autodesk Fusion
Links	Demo in presentation

Executive Summary

Within D2N+ Team 2's digital design workflow, I contributed to the development of an automated CAD process for 3D printable aircraft. My work focused on auto-segmenting aerodynamic surfaces to fit specified build volumes, and generating topologically optimised shells, spars, and ribs conformal to the internal geometry. This supported the wider team's disruptive end-to-end workflow, which extracted concepts from patents, used LLM-based agents to refine designs, incorporated VR for sculpting and operator interaction, and ultimately accelerated the manufacture of prototype airframes.

Problem

The existing aerospace design process for small UAVs is slow, specialist-driven, and optimised for certification-heavy programmes rather than rapidly evolving commercial drone applications. We sought to challenge this model by developing digital design tools that could reverse engineer and recombine existing aerospace knowledge into "good enough" manufacturable aircraft concepts. The aim was to enable faster exploration of unconventional, quieter, lower-cost, and payload-adaptable drones, while also creating workflows accessible for rapid prototyping, experimentation, and engineering education.

Digital Design Solution

My contribution focused on developing automated geometry generation workflows for additively manufactured aircraft structures. The solution combined three linked stages: auto-segmentation, conformal shell generation, and internal structural optimisation.

First, aerodynamic surfaces were automatically segmented into printable sub-components based on the available additive manufacturing build volume. This enabled large airframe geometries to be manufactured using smaller-format printers while maintaining alignment and assembly logic.

Second, the workflow generated lightweight conformal shells that followed the aerodynamic outer surface while maintaining a controllable wall thickness. Rather than relying on uniform solid bodies, the shelling process created structurally efficient skins tailored for additive manufacturing constraints.

Third, internal spars and ribs were procedurally generated using topology-aware methods. These structures conformed to the internal geometry of the aircraft and adapted automatically to changes in external form. The resulting framework provided stiffness and load transfer while minimising material usage and print time.

Together, these processes formed part of a wider automated digital workflow that linked concept generation, geometry refinement, and rapid additive manufacture of prototype UAV airframes.

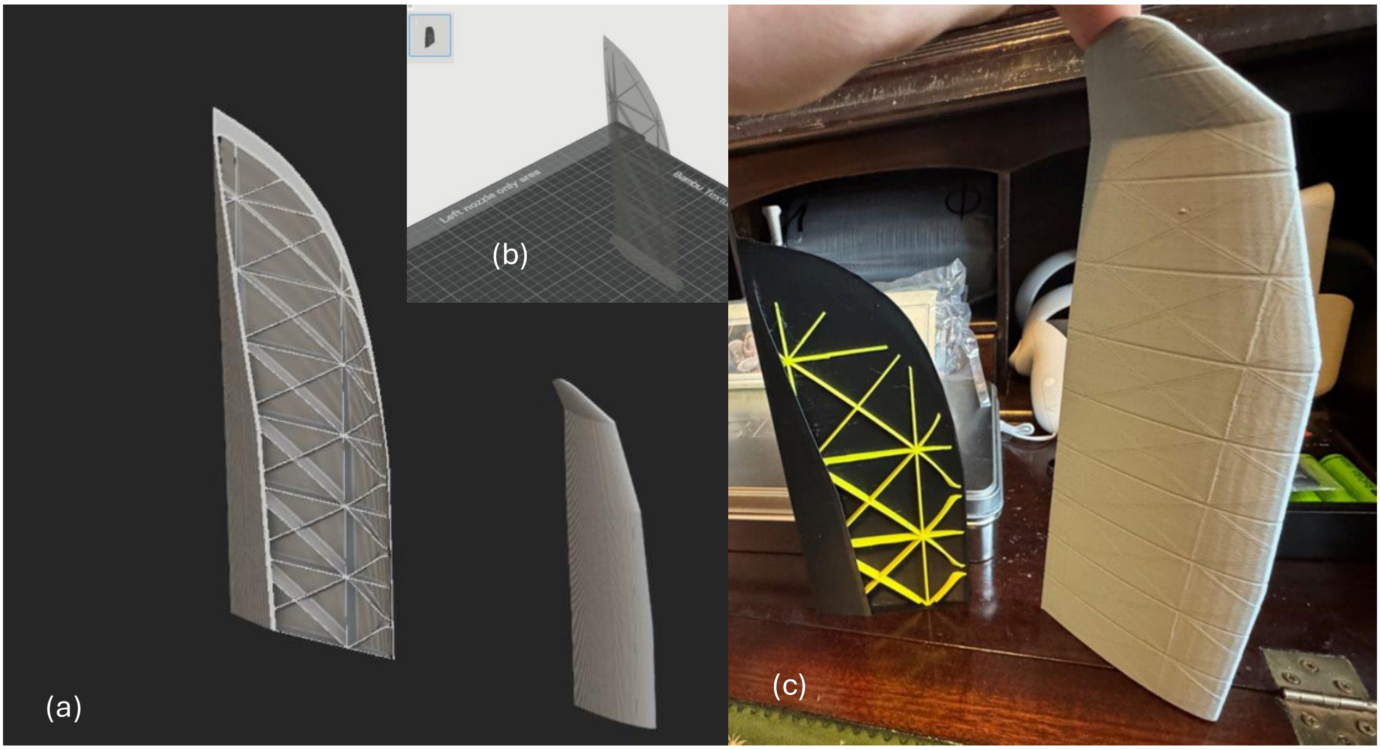

Figure 1: (a) Example implementation in nTop, (b) sliced in Bambu lab, (c) and printed for the demo.

How it makes Digital Design Better, Faster and/or With Less

The solution improved the design process (that we can also use in our Flight design module at KCL Engineering) by automating the conversion of conceptual aircraft geometries into manufacturable 3D printable structures. Automated segmentation, shelling, and generation of conformal spars and ribs reduced manual CAD effort, material use, and print time, while enabling faster iteration of unconventional UAV concepts.

Reflections

A key learning was that automated geometry generation alone is not sufficient unless downstream manufacturing constraints are tightly integrated into the workflow. Thin-walled additive structures remain challenging to print reliably, particularly at larger scales where warping and print variability become significant. Another challenge is the automated generation of robust joining features between segmented components. Future R&D could focus on intelligent lip-and-groove or interlocking mechanisms that reduce assembly time, improve alignment, and minimise adhesive use, enabling more scalable and reliable manufacture of modular UAV airframes.