

CASE STUDY

## US Air Force Optimizes CubeSat using Architected Materials



The U.S. Air Force Institute of Technology (AFIT) used nTopology to reduce the weight and cut production times of a CubeSat bus with additive manufacturing.

Leveraging architected materials, the engineering team developed a CubeSat bus assembly from Inconel 718 that was 50% lighter and 20% stiffer than the original aluminum assembly.

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### Background

CubeSats are small and relatively inexpensive satellites used for research and communications by government and private agencies. CubeSats enable the concept of **ridesharing**; a means to launch several satellites grouped on a single **structural chassis or bus** to counteract the high cost of sending a payload into orbit.

With traditional manufacturing, the CubeSat bus structure requires machining of **nearly 150 parts**. The conventional design demands **tight tolerances** and **close quality control** while creating 150 potential points of failure.

The goal of the AFIT CubeSat project was to develop a structure that fulfills all design requirements and can be manufactured using a **repeatable process**.

*Leveraging a computational, architected materials approach, this primary mechanical structure can be made lighter, stronger, and quickly re-sizeable to accommodate specific satellite loads.*

— **Ryan O'Hara**

Director of Aerospace and Defense at nTopology



**Weight reduction**

50% lighter



**Stiffness increase**

20% stiffer



**Lead time**

33% faster production



**Assembly consolidation**

From 150 parts to 25



**Material**

From Aluminum to Inconel 718



**Manufacturing**

Concept Laser M2 Series 5alumina

## What are Architected Materials?

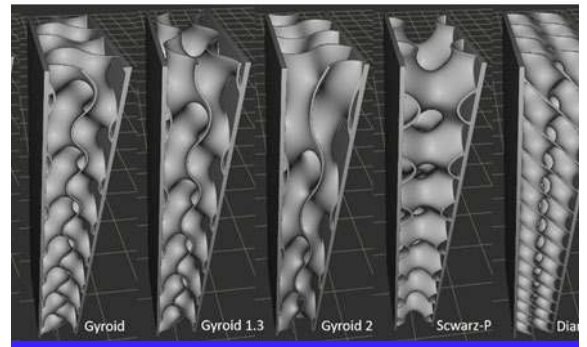
Architected materials are periodic lattices with closely controlled geometry that is optimized for a specific function. With architected materials, we can achieve previously unattainable material properties combinations and design structures with a targeted physical response. nTopology's implicit modeling technology provides engineers with the necessary level of control for developing these advanced structures.

## Architected Materials for Lightweighting

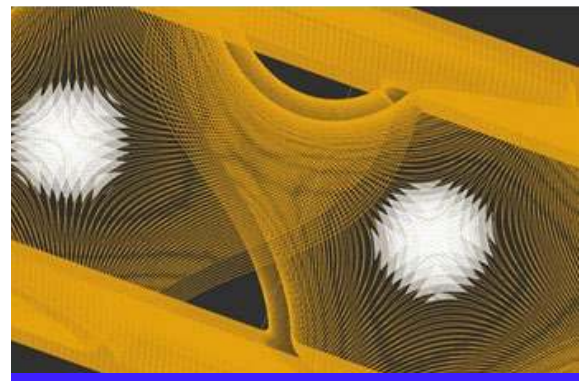
The R&D team explored multiple thin-walled TMPS and strut-based lattice structures and assessed their performance using engineering simulation. After several iterations, the team identified a design based on Inconel 718 (a nickel-based superalloy with 3x the density of aluminum) with a superior stiffness-to-weight ratio than bulk aerospace-grade aluminum and a lower coefficient of thermal expansion.

## From Design to Manufacturing

Using nTopology's direct-to-manufacture capabilities, the team bypassed the need to generate STL files. Instead, they created slices and tool paths directly in the design software. A 3D printed and finished CubeSat was ready for testing in only 3.5 business days. The structural bus was then evaluated and certified according to the NASA GEVS launch profile methodology.



Potential lattice structures that the team examined for this project



Close up of the slices and toolpaths generated in nTopology

## Business Value

- ✓ **Expedited production:** Cut production times of complex engineering products using digital workflows.
- ✓ **Simplified quality control:** Consolidate large assemblies to significantly reduce potential points-of-failure & quality control requirements.
- ✓ **Higher-performing products:** Leverage next-generation design and manufacturing technologies to develop revolutionary products.



[Request a demo](#)

## About nTopology

nTopology was founded in 2015 to enable engineers and designers to create any geometry – no matter how complex – and meet the requirements of high-performance products. Our software is used from research through production to create breakthrough processes and products for the aerospace, automotive, medical, and consumer industries. Our customers depend on nTopology's generative design capabilities to take full advantage of new hardware, optimize parts where performance is critical, overcome design bottlenecks, and augment their traditional CAD, simulation, and engineering software stack.