# Case Study

# Topology Optimisation of an Aerospace Part to be Produced by Additive Layer Manufacturing (ALM)

## Overview

Additive Layer Manufacturing of metals is a relatively new technology in the early stages of development for application in aircraft structures. The main benefits of the ALM process are found in design flexibility, low material waste and low cost of producing parts from hard materials that are otherwise difficult to machine.

The design flexibility makes ALM a perfect application for topology optimisation. Here, the topology optimised shape can be maintained and the final weight and structural properties can be closer to those of the optimised shape.

EADS Innovation Works, in collaboration with industrial and academic partners in the TSB funded AVLAM project, wanted to understand whether there could be any technical and commercial viability of producing optimised ALM parts for aerospace. As an experiment they deployed HyperWorks' topology optimisation tool, OptiStruct, part of the HyperWorks suite of CAE products, to see if optimising an Airbus A320 part could lead to similar benefits for optimising other small-scale parts.

## Business Profile

EADS Innovation Works is the corporate research centre of EADS (European Aeronautic Defence and Space). With sites in France, Germany, Russia, Spain, Singapore, UK and a workforce of more than 600, it provides world-class capabilities in aeronautics, defence and space research topics.

*Fig. 1: Airbus A320 Nacelle Hinge Bracket (back) and the Optimised Design Produced by ALM (front)*

## Challenge

ALM is an emerging manufacturing technology which provides the potential for significant weight savings through optimisation due to the relatively relaxed design constraints imposed.

The part cost for ALM is independent of complexity, and so there is a 'virtuous circle' whereby weight savings through optimisation also result in cost savings as the amount of material used to make the part reduces.

The aim of the project was to demonstrate the potential weight savings achievable using the design freedom offered by ALM, while retaining identical performance to the original part.

***"OptiStruct allowed us to maximise the weight saving benefits of the ALM process."***

***Jon Meyer***

***EADS Innovation Works***

## Solution

EADS Innovation Works implemented an optimisation strategy to produce a viable part with as little material as possible, i.e. of minimum weight. They applied OptiStruct topology optimisation which consisted of a two-stage design process:

**First Design Cycle**

The robustness of the new design was tested with the selected conditions and the results were interpreted in CATIA v5. Improvements were made with new constraints and reshaped using HyperMorph within Hyperworks. OptiStruct was used to shape and size optimise the part. At this point the part weighed only 310g.

**Second Design Cycle**

The optimisation process was repeated with the new constraints that resulted from the first design cycle, with other improvements in the optimisation approach. The result is that the part now only used 16g more material than the first design.

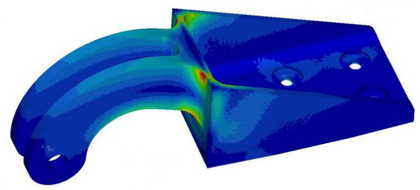

*Fig. 3: FEA of Original Hinge*

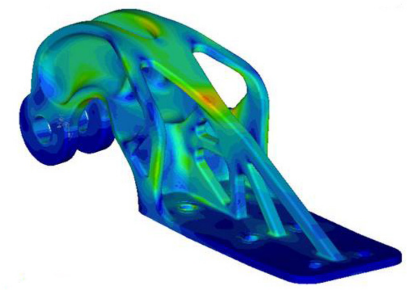

*Fig. 4: FEA of Optimised Hinge*

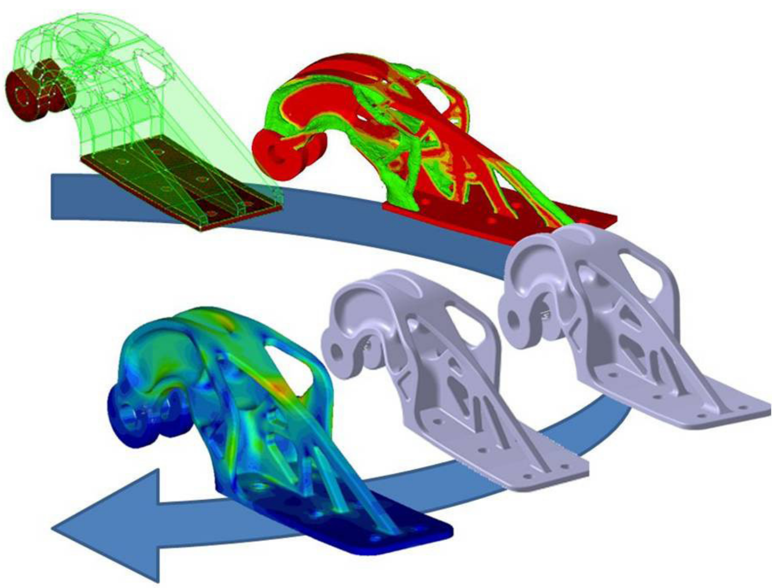

*Fig. 2: Validated Design Cycle*

## Results

The unique topology optimisation technology in OptiStruct demonstrated the substantial weight savings that can be gained in the optimisation of small ALM aircraft parts. The optimised design weighed only 326g, compared to 918g in the original - a significant reduction of 64%.

The optimised design retained the same characteristics in terms of stiffness and bolt loading, while reducing the stresses on the part.

These results therefore demonstrate a strong commercial case for optimising thousands of small-scale ALM parts across the whole aircraft. By taking advantage of this new technology and process now, opportunities exist for the aerospace industry to achieve considerable weight and cost savings.



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