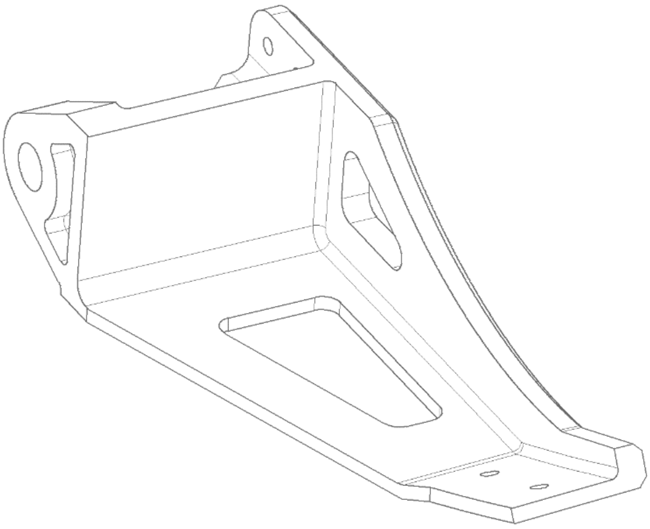
Case Study

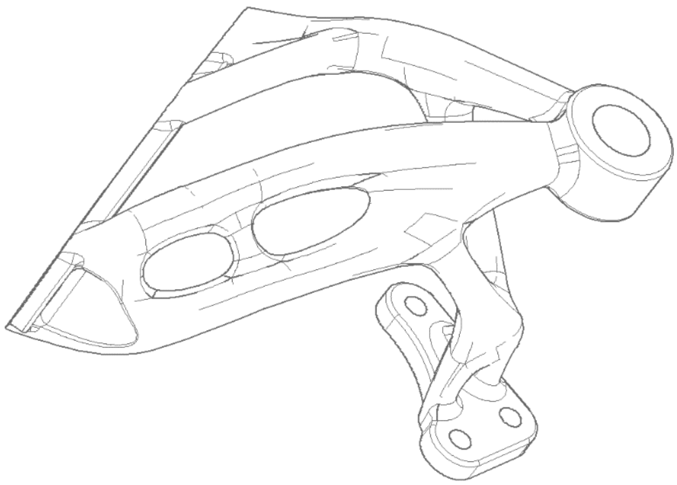
Optimised Aircraft Fitting

Topology Optimisation and Additive Manufacturing of Actuator Support Fitting

Printed on the EOS M 280 in AlSi10Mg, this aircraft bracket has been topologically optimised in conjunction with Altair to improve its original design. Manufacturing geometry such as this is only achievable through additive methods.

Keywords: Additive Manufacturing, Topology Optimisation,
Equipment/Software: solidThinking Inspire, EOS M 280





Additive manufacturing offers exciting advantages in the development of aircraft fittings. Designed to be both lightweight and strong these components are traditionally CNC machined from billet material, however when optimised for additive manufacturing their performance can be significantly improved. In this particular example a 58% reduction in mass was achieved, whilst improvements were made to the max stress (-51%), stiffness (+52%) and buckling load (+200%).

The actuator support fitting was redesigned by Altair using solidThinking Inspire and manufactured by AMAERO Engineering on the EOS M 280. Manufacturing of the complex organic geometry exhibited in the improved design would be unachievable using traditional manufacturing processes, however through AMAERO's world leading Selective Laser Melting (SLM) capabilities its creation was made possible.

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In order for Altair to improve the design it was first necessary to understand the performance of original part including the static, modal and buckling phenomenon. Figure 1 shows the Von Mises stress distribution under different loading conditions.

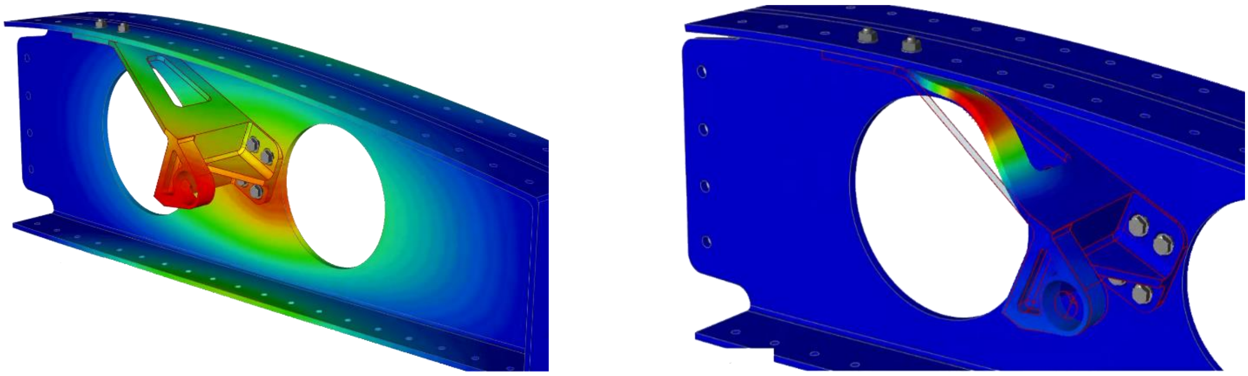

Figure 1: FEA Analysis on Conventional Fitting

Additional material was then added to the part as well as additional fasteners to allow for a wider search for a more optimal solution. The solid body shown in Figure 2 illustrates the allowable design envelope with 5 additional fastening locations.

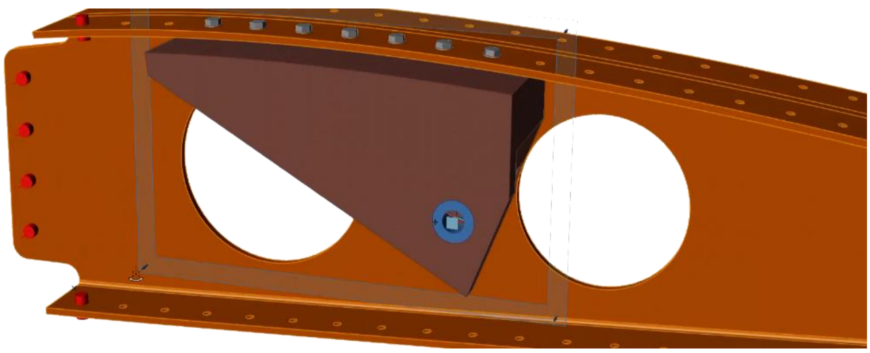

Figure 2: Allowable Design Envelope with Additional Fastening Solutions

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The solution was computed in STL format and the result was traced over using PolyNURBS modelling. This intuitive design method fits smooth, watertight NURBS versions of the geometry to the optimised topology. The result can be exported in CAD format and further refined in the users preferred parametric software package. This process takes under an hour for an experienced user.

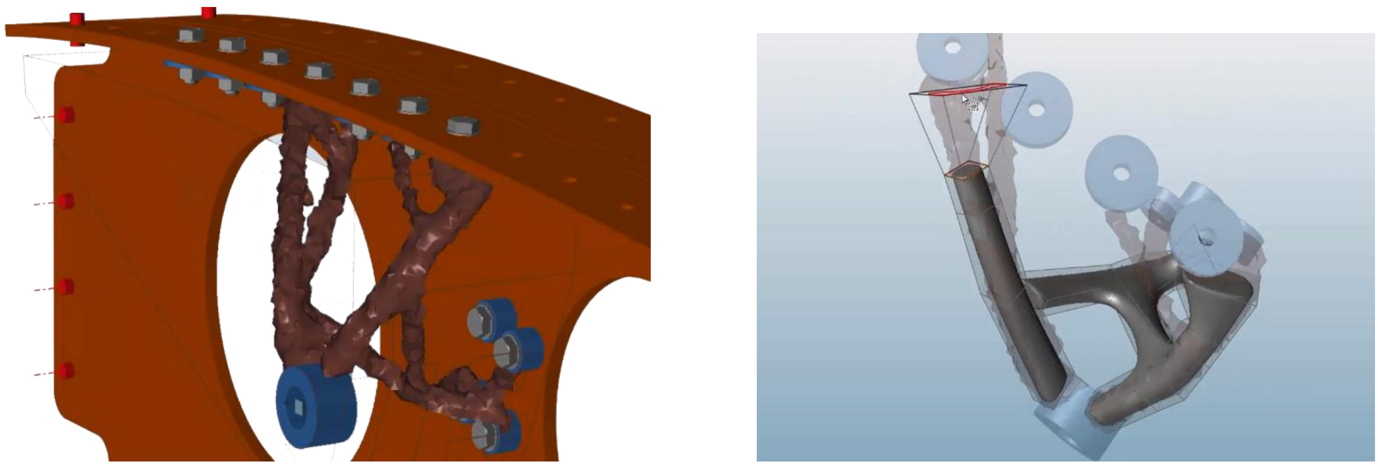

Figure 3: Optimised Topology (Left) and PolyNURBS modelling (Right)

The finished CAD model was then delivered to AMAERO and a build was prepared. Careful consideration was applied to the generation of support material to ensure dimensional accuracy and ease of removal. Build parameters were optimised to ensure material compliance with stringent aerospace standards. Occupying a space of 130 x 100 x 140 this fully functional component occupied only 10% of the available build volume.

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Figure 4: Rendered Models of the Conventional and Optimised Fitting

Post build the part was heat treated through a hot isostatic pressing process and bead blasted to improve the surface finish. The finished actuator fitting was geometrically conformant to standard aerospace dimensional tolerances.

The finished part featured the following functional improvements:

- 58% reduction in mass
- 51% reduction in max stress
- 52% increase in stiffness
- 200% increase in buckling load

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Figure 5: Finished Aircraft Fitting

AMAERO Engineering would like to thank Altair for their collaboration on this project.