Optimised active flow control actuators manufactured with SLM for aircraft with UHBR engines

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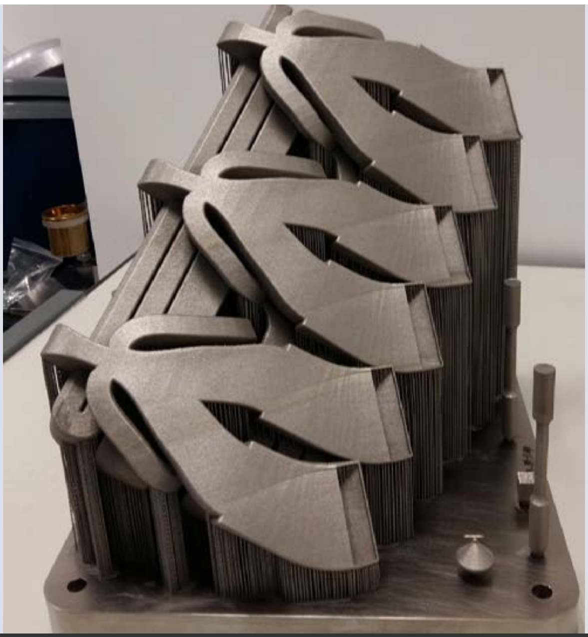

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Sector: Aeroespace
Challenge: Development of new flow control actuators (FCA) with innovative aeronautical designs to improve fluid flow in future UHBR engines.

Solution: SLM manufacturing of flow control actuators with optimised and complex designs, to be installed in areas with reduced dimensions of aircraft with high-efficiency engines.

CHALLENGE

The aeronautics industry needs to develop engines that are more ecological and economic. This requires adjusting the Bypass Ratio (BR) and Fan Pressure Ratio (FPR), which are the parameters for engine design. Optimised UHBR engines are equipped with a very large nacelle, requiring close coupling with the wing, resulting in a larger cutout and greater separation of flows.

Airbus has opted for AFC actuators of the PJA (Pulsed Jet Actuator) type to install in future UHBR aircrafts to reduce separation of flows. These actuators are very large and complex in shape because they contain internal channels and hollow areas facing different directions, which makes the manufacture of these components by SLM a serious challenge. Despite the advantages offered by SLM technology, its limitations must also be borne in mind. One of the notable limitations are the cantilevers or low angle surfaces that require placing supports for construction. These supports cannot be used in non-accessible areas, which in this case are the channels, since they cannot be removed after manufacturing is completed.

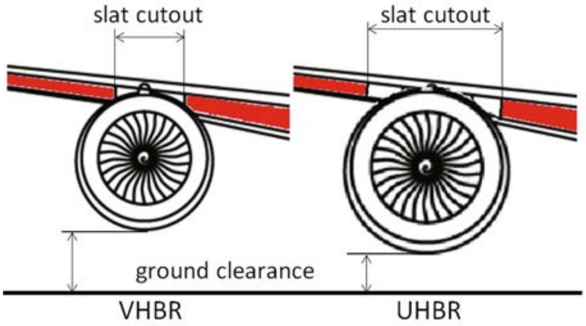

Figure 1: Comparison of VHBR and UHBR engine positioning under the same wing.

SOLUTION

The design of a PJA-type actuator was developed within the framework of the European FLOWCAASH project, based on geometric shaping that improves mass flow. Given its relatively large size and highly complex geometry consisting of hollow channels combined with cantilevers, it was necessary to find the best possible position on the construction platform to enable manufacturing of a single part and avoid having to place supports on the inside of the channels.

Optimal positioning to manufacture the PJA is shown in Figure 2. This position was obtained by using the results from the distortion prediction simulations for SLM manufacturing. Support strategies were also proposed to minimise certain dimension deviations observed in the simulations. The result was the use of a combination of solid and non-solid supports (with higher or lower density).

The PJA was manufactured in the optimised position using a scheme of supports that minimised distortions. To this end, the Ti6Al4V alloy and optimal parameters were used to minimise defects. A dimensional analysis was conducted subsequently to control quality (Figure 4), comparing the results with the initial CAD design. The dimensional control detected that the areas with the highest deviations were the air flow outlets, as was foreseen in the simulation. This indicates a good correlation between the experimental results and simulations. A series of tests, including aerodynamic assays, were conducted to determine whether the deviations were acceptable.

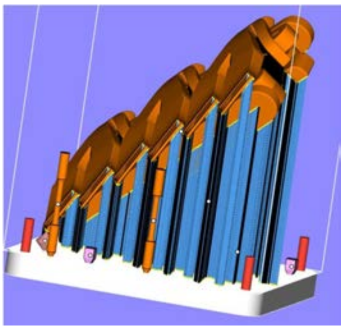

Figure 2: Optimal positioning of the PJA on the construction platform with the support structure.

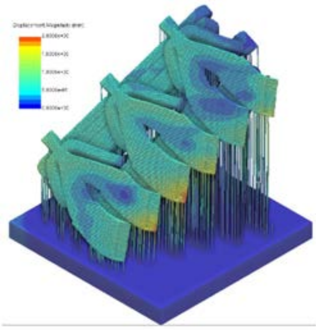

Figure 3: Prediction of distortions obtained by simulation.

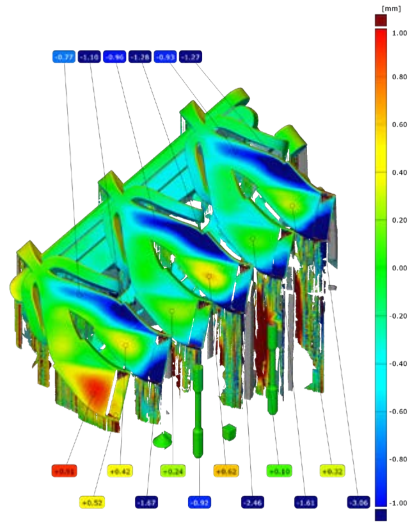

Figure 4: Dimensional analysis conducted on the PJA in the optimal position and with an optimal support scheme.

ADVANTAGES

SLM manufacturing of an aeronautical component of highly complex shapes was achieved, which is impossible to manufacture using other, more conventional techniques. Additive manufacturing has made it possible to eliminate connections that would entail weaknesses subject to pressure leaks and that would be necessary if a different manufacturing process were used.

A priority set during the development of the PJA was to minimise component mass and obtain a part that was as light as possible. The selected alloy, Ti6Al4V, has a high specific resistance and is ideal for obtaining light parts. These are very important features for the aeronautical industry, given that they enable obtaining environmentally-friendly components, reduce CO2 and NOx levels and reduce fuel consumption, thereby complying with the aeronautical challenges posed.

In addition, good aerodynamic performance is expected of the PJA since it is based on an optimised aeronautical design. The scheduled aerodynamic tests will validate the design or serve to apply design improvements.

Lastly, Figure 5 shows the PJA manufactured with SLM and post-processing.

Figure 5: PJA actuator manufactured by SLM and post-processed.