Success Story
Aerospace

LIEBHERR

First Metal 3D Printed Primary Flight Control Hydraulic Component Flies on an Airbus A380

Source: Liebherr

The new additively manufactured valve block offers the same performance as the conventional one, but is 35 % lighter and is made from a titanium alloy.

Challenge

Substitute a conventional primary flight control hydraulic component with an additively manufactured part – fulfilling all certification requirements for flight.

Solution

Manufacturing of a lightweight 3D printed component with fewer parts and an efficient process chain.

Results

Light: 35 % less weight

Simplified: 10 parts eliminated

Safe: fulfilling all certification requirements for flight

Efficient: identical functionality to the conventional part

EOS

World Premiere in Civil Aviation **with EOS Technology**

Today, the dream of flight revolves around producing aircraft components using industrial 3D printing technology. Every company aims to open up opportunities to differentiate themselves in the marketplace – in terms of new customer benefits, potential cost savings and sustainability targets. Thanks to EOS additive manufacturing technology, Liebherr is getting closer to achieving this goal. The realization of a high-pressure hydraulic valve block using EOS metal 3D printing technology marks an important milestone. This valve block has now been successfully tested on a flight with an Airbus A380 aircraft.

Challenge

Against the background of increasing ecological awareness, rising fuel prices and a lack of alternative energy sources, the aerospace industry needs to find new technologies in order to remain competitive. Powder-bed based industrial 3D printing has the potential to bring about a fundamental change and facilitate innovative components. Liebherr launched their additive manufacturing program as early as six years ago. Now they have proven that EOS metal 3D printing technology is applicable to hydraulic aircraft manifolds. Together with Airbus and a research team from the Chemnitz University of Technology, Liebherr initiated a project funded by the Federal Ministry for Economic Affairs and Energy (BMWi). The objective was to substitute a conventional primary flight component, a high-pressure hydraulic valve block, with an additively manufactured one. Aboard an aircraft, many components work together to ensure a safe flight. A spoiler actuator moves the spoiler to the desired position to decrease the lift of the airplane. These kinds of primary flight control components demand the highest standards of quality and precision during production. Conventionally, valve block manufacturing starts from forged raw material, which is then machined, trimmed, drilled and finally assembled. This process chain is time-consuming and complex, leaving little room for optimization.

The conventionally manufactured valve block (left) and the optimized metal 3D printed valve block (right). (Source: Liebherr)

Short Profile

Liebherr-Aerospace is a leading supplier of systems for the aviation industry and has more than five decades of experience in this field. The range of aviation equipment developed, produced and serviced by Liebherr includes flight control and actuation systems, landing gear, air management systems and gears and gearboxes.
The 3D printed hydraulic valve was developed by Liebherr in collaboration with both Airbus and the Chemnitz University of Technology in Germany, and was partly funded by the German Federal Ministry of Economic Affairs and Energy.

Further Information
www.liebherr.com

However, the sheer number of process steps illustrates the room for the possible improvements that can be achieved by metal 3D printing. Clearly, substitution alone is not enough; the new part must be lighter, resource-efficient and eco-friendly to demonstrate the feasibility of additive manufacturing as a promising technology of the future.

Solution

The solution was to develop a design and process chain for implementation in the aviation industry using the reliable and high-quality industrial 3D printing technology by EOS. First, the conventional part was analyzed. Hydraulic structures were identified and auxiliary sections were removed. The positioning of the main components was reconsidered in light of their installation space and interface requirements with the aim of optimizing intelligent, short connection lines. This laid the foundation for the design of the new part. "With industrial 3D printing, complexity is suddenly no longer an issue. On the EOS M 290 system, components are built up from a large number of thin layers, each 30 to 60 µm thick, which enables us to build complex geometries," explains Alexander Altmann, Lead Engineer Additive Manufacturing, Research & Technology at Liebherr-Aerospace Lindenberg GmbH. "The functional elements were directly connected to one another using curved pipes. This avoids the need for a complex system of pipes with lots of transverse bores, saving time in production."

The material of choice, a titanium alloy, is particularly suitable for aviation since it offers a range of advantages. It enables weight savings to be achieved, as well as cost efficiency during operation, since it is very light and mechanically stable and has very good corrosion resistance. Post-processing steps include e.g. heat treatment for stress relief, as well as a special treatment for the hydraulic channels.

„Finally there must not be even the slightest doubt as to the reliability and safety of the components and the material from which they are made. With EOS technology, we are able to reliably manufacture highest-quality titanium components, which is a prerequisite for the next step of serial production," explains Alexander Altmann.

Results

The new additively manufactured valve block offers the same performance as the conventional one, but is 35 % lighter and made from fewer parts. It was possible to integrate 10 functional elements into the new valve block, eliminating the complex system of pipework with lots of transverse bores. "That might as well be the tagline for additive manufacturing — making the same things but with less mass and fewer parts — however this is a significant step for us at Liebherr-Aerospace," says Altmann. The new 3D printed part has now been successfully trialled in a test flight of the A380 aircraft. Industrial 3D printing is less complex and extremely material-efficient compared to the traditional milling process and helps to keep titanium waste to a minimum. "Today, it takes about a day to manufacture a valve block and we see the potential to decrease building time by more than 75 % with the EOS M 400-4," says Alexander Altmann. But that's not all – the lightweight 3D printed valve block and future 3D printed parts will also contribute to reduced fuel consumption and reduced CO_2 and NO_X emissions.

The demands placed on aircraft components are extremely high, which is why Liebherr puts a firm focus on understanding additive manufacturing methods down to the last detail in order to establish production processes that are absolutely reliable. In EOS, Liebherr has a technology provider and partner who facilitates quality assurance during the additive manufacturing process. By participating in a pilot phase, Liebherr was able to contribute to the development of EOSTATE Exposure OT, a new module of the EOS monitoring suite that enables seamless and real-time component inspection. "In the future, this will speed up the identification of material defects during the industrial 3D printing process and will help to reduce the need for downstream quality assurance processes such as computer tomography," says Alexander Altmann.

"The 3D printed valve block has proven that additive manufacturing with EOS technology is feasible for building critical primary flight components."

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