TOPOLOGY-OPTIMIZED COMPONENT DESIGN

Task

Topology optimization methods enable the geometry of a component to be tailored to functional requirements (e.g. force initiation, strength). In this way, for instance, very light yet very stiff components can be designed. The resulting design tends to boast a filigree, bionic structure, which may also include internal hollow structures. Since this kind of design cannot be manufactured using conventional manufacturing processes, the results of topology optimization are used only as a starting point and the design needs to be manually modified so that it can be cast or machined. In the process, components once again become more solid and heavier, i.e. the possibilities of topology optimization are only utilized to a certain extent. Additive manufacturing processes enable virtually any geometry to be manufactured so that the full potential of topology optimization can be exploited.

Method

As part of manufacturing using Selective Laser Melting (SLM), the topology optimization algorithms have to be adapted to the manufacturing possibilities offered by SLM. To this end, filter functions and lattice parameters are set to reflect minimally feasible feature sizes. This kind of topology-optimized design needs to be smoothed only slightly in order to be subsequently built up directly using SLM.

Result

The starting point is the design for a stub axle which was optimized for high-speed machining. Compared with this design that has been repeatedly optimized over many years, the SLM-specific topology optimization reduced the component weight by approx. 18 %. The SLM-optimized stub axle measures approx. 220 mm x 160 mm and was built up using High Power Selective Laser Melting (HP-SLM) with a laser output power of 500 W from a high-strength aluminum alloy (AlMgSc).

Applications

Applications for additively manufactured, topology-optimized components include automotive engineering and, in particular, the aerospace industry, where component weight plays a major role.

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3 Additively manufactured, topology-optimized automotive component.