TOPOLOGY-OPTIMIZED KINEMATIC LEVER FOR A BUSINESS CLASS SEAT

Task

The potential for symbiosis between additive manufacturing and topology optimization shall be depicted on the basis of a kinematic lever of a business class seat by Recaro. In contrast to subtractive manufacturing, the manufacturing time and process costs of Additive Manufacturing are affected, in large part, by the volume to be built. Topology optimization is a process to design components oriented to the loads they must carry; unnecessary volume will be removed until the optimization results in a perfectly adapted part. The outstanding geometric possibilities of Additive Manufacturing can be used to contribute to the production of complex optimization results, which are difficult or impossible to produce conventionally. Thus, Additive Manufacturing and the topology optimization form an ideal symbiosis so as to design functional components for Additive Manufacturing at comparatively low component costs.

Method

Conventionally, the kinematic lever is milled out of the aluminum material 7075. As a central component of the business class seat, the kinematic lever makes a complex movement to place the chair in a reclining position. The dynamic load of the component occurring in this movement is divided into five load cases used in topology optimization; these cases, in turn, take into account the peaks in tension at different times during the movement. A so-called optimization dummy was constructed which defines the maximum available space so that its required collision-free movement can be guaranteed.

The optimization software Abaqus ATOM was used to determine material data, structural supports and fixed regions of the component (e.g. joints to other components). The target for optimization aimed to reach the maximum possible stiffness of the component at a predefined volume reduction. The optimization result was then slightly smoothed by Meshlab and validated anew in a final FEM. The final optimization result was prepared for Additive Manufacturing by means of SLM, produced on an EOS M270 and then reworked.

Result

The final optimization result exhibits peaks in tension of approx. 300 MPa, which are below the yield stress of 410 MPa of aluminum alloy 7075. In comparison to the component optimized with a milling process, the SLM component is about 15 percent lighter. Since the kinematic lever is a component for the aerospace industry, its lower weight can lower fuel consumption, thus reducing operating costs.

Applications

Major fields of application include the aerospace and automotive industries.

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2 Topology-optimized kinematic lever a of business class seat by Recaro.