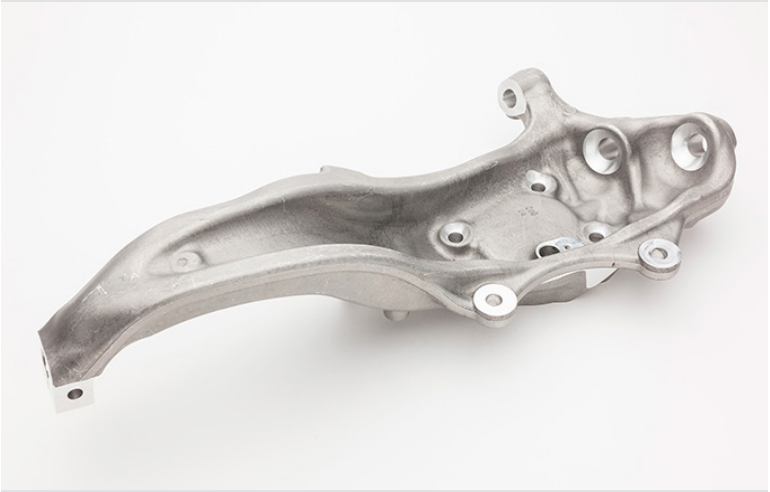
AM-Steering Knuckle

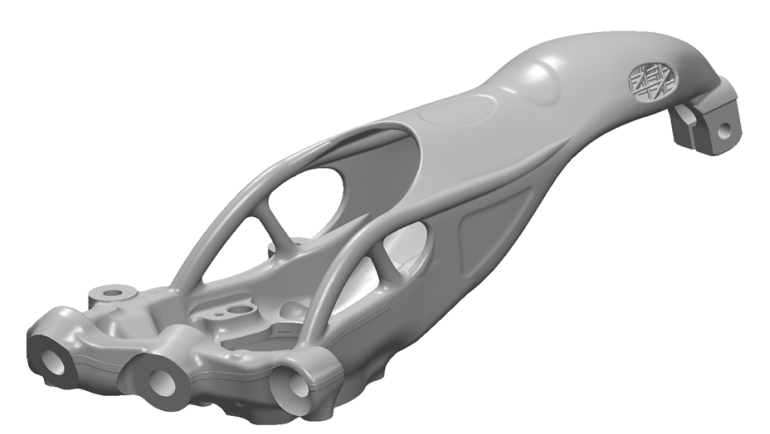
Lightweight design and additive manufacturing



Current version of the forged aluminum steering knuckle.

The Hirschvogel Automotive Group, headquartered in Denklingen (Germany), is a family-owned enterprise and among the world's largest automotive suppliers in the area of steel and aluminum forging and machining. Our customers include all renowned automotive manufacturers and suppliers worldwide.

We work constantly on technical innovations and continuous improvements across the Group in all processes. Our vision is to continually improve and to provide competent answers to new questions which always arise with growing demands. And thus we put our heart and soul into each and every one of our products.



AM-Steering Knuckle developed by ELiSE.

The Need for bionic lightweight design

Additive manufacturing develops into a new core technology that challenges present processes and provides hitherto unparalleled freedom of complexity in shaping. Therefore, Hirschvogel seeks out to make use of that great freedom of manufacturability for developing innovative lightweight automotive components.

The unique characteristic of ELiSE is the integration of bionic concepts based on complex stiffening structures of microscopic plankton organisms (diatoms). Their shells are evolutionary optimized over millions of years. The combination of AM and the technical transfer of the bionic lightweight design principles leads to maximum lightweight design potential.

Unbound of conventional manufacturing constraints it was even possible to lift the optimization on a higher level and implement complex lattice structures for the stiffening of critical high stress areas.

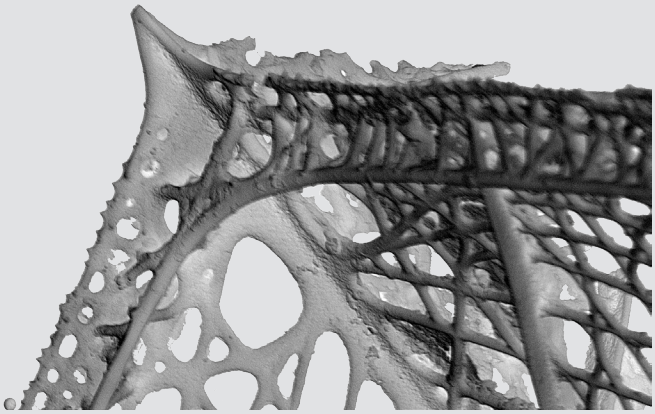
ELiSE

Hirschvogel Holding

How did our solution help?

At the beginning, the technical specifications were worked out in cooperation with Hirschvogel. Then, the ELiSE team developed different concepts for the neck of the steering knuckle, based on a first topology optimization, the definitions of load cases and specific requirements for the considers additive manufacturing process and the machinery.

Our bionic lightweight design product development is based on the evolutionary optimized lightweight shell structures of microscopic plankton organisms (diatoms) which serve as natural archetypes. The mechanical stiffening principles of the project specific selected diatoms were transferred into technical applications of which the most advantageous led to the first concept drafts. The resulting concepts were evaluated focusing the mechanical performance, weight and the best design for AM application. A combination of the most promising design features led to an integrated concept for the final lightweight optimization step. The best performing design of the final optimization was chosen as final AM-Steering Knuckle design.



Biological archetype: *Callimitra spec.*
A load adaptive lattice structure stiffens the edges and merges smoothly into crossing ribs for surface support.

The Result

The final design of the AM-Steering Knuckle defines an innovative step for Hirschvogel regarding the design of additively manufactured automotive components. The advantages of additive manufacturing provide unleash the full mechanical potential of complex bionic lightweight design structures resulting in a weight reduction of 41 % of the substituted component neck.

> „...The bionic design of an innovative automotive component has given us new and future-oriented approaches. We are very excited about further future projects.“
>
> Michael Dahme
> Leiter Hirschvogel Tech Solutions

Applied Engineering Tools

Following engineering tools and methods have been used for this project:

ELiSE Screening
ELiSE Concept
ELiSE Engineering

- CAD construction with Solid Works 2016
- FE-Analysis with ANSYS Workbench
- Topology optimization with Altair OptiStruct
- Parametric optimization with OptiSlang
- Optimization with DoE and evolutionary algorithms

ELiSE AM

- Construction algorythms for load adaptive lattice structures
- Lattice structure optimization for AM

ELiSE

Hirschvogel Holding