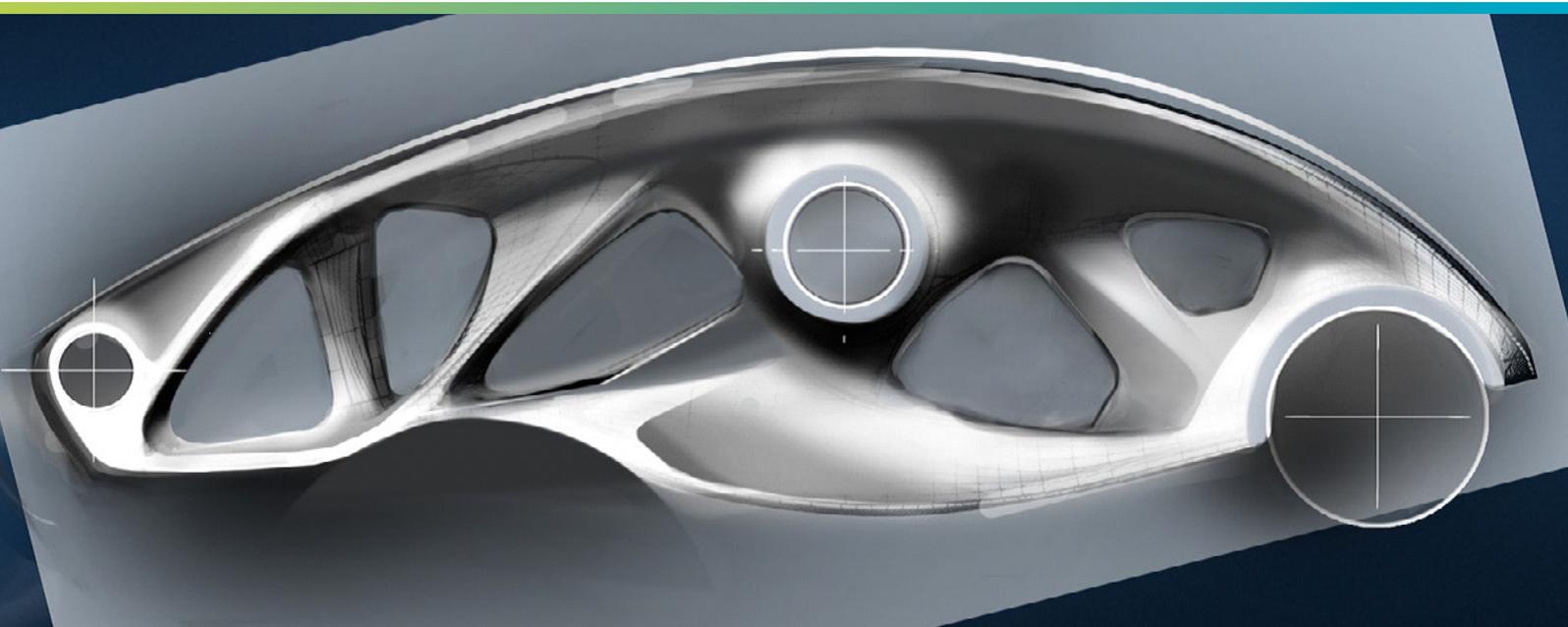


Easy handling of difficult tasks: Optimisation and design of light-weight crimping tool

Product design can be purely functional or primarily meet aesthetic criteria. Combining both these approaches, can result in highly functional and yet visually appealing designs



Grasp the pressing tool countless times a day and single-handedly crimp the sockets - a very strenuous activity over time. A lot of material is currently built into crimping tools to withstand the high pressing forces. This could become much easier in the future. Through optimisation, significantly better and lighter tools can be produced.

There are various methods for finding the right form. Sometimes the form follows the function. Sometimes emotions are targeted. In a cooperation project with Hexagon, design experts Tino Kalettka and Hendrik Nater experimented with the possibilities of generative design as a starting point for creating form.

Very high forces are needed to crimp fittings and sockets, which is why existing crimping tools require considerable amounts of material to transmit the necessary pressure. Simple, massive geometries are also significantly easier to produce with classic production machinery. That this leads to a higher burden on the user during daily work with the crimping tools is accepted. With an increasing focus on workplace ergonomics and new technological possibilities, designers Tino Kalettka and Hendrik Nater have collaborated with MSC Software to generate new concepts for lightweight yet robust tools. They used generative design in a form-finding process and then built on this to generate the actual design.



Optimisation challenge

In order to explore the possibilities of new designs, a standard crimping tool has been chosen to serve as a foundation for this project. An optimisation with MSC Apex Generative Design was carried out to analyse potential weight reduction. Due to the extremely high forces, it was initially uncertain whether an optimised design would result, and if so, how this could be realised. In addition to optimisation by software, manual design detailing should then be carried out. The lightweight organic design that emerged from the optimisation process should subsequently be transformed into a sustainable product design. With the resulting force flows from the optimisation, a design should be generated that also builds up the necessary confidence in the innovative crimping tool.

How to create lighter crimping tools

For optimisation, an optimisation model was initially created in MSC Apex Generative Design. The model could be built quickly due to its low component complexity and also because it is a symmetrical design requiring only one half of the crimping tool to be considered and calculated. A force analysis carried out in advance revealed considerably higher forces applied during the pressing process. These forces were applied at the corresponding points during model preparation and with their generated stress values they constituted the core element of the optimisation. With different optimisation parameters representing target stress and design complexity, different geometries were generated and these were then taken as a starting point for the design detailing.

Interaction of simulation and manual modelling

First, the designers determined the part's "design" and "non-design" areas. Non-design areas are mechanically necessary geometries. Creative design spaces then emerged between these areas.

Based on the generated shapes, the design team selected the most promising result and conducted further analysis in terms of identifying main lines and characteristic shape. A draft design was manually sketched from the combination of optimised geometry and main lines. In various side views, the designers developed design variations. In doing so, they observed naturally shaping methods such as the golden cut. They set angles and curve sweeps in relation to each other and blended surface transitions. In this way, all design aspects result in a common, appealing language of form.

This first redesign, however, was still characterised by striking, linear structures without pronounced depth. Through a simulation of this revised component, the strengths and weaknesses of the new part quickly became apparent.

Now the results of the second simulation again served as the basis for sketches and rough CAD models. The designers discussed different variations in a close exchange before finally modelling a design. The simulation of this design showed exemplary force flows and thus exceeded expectations.

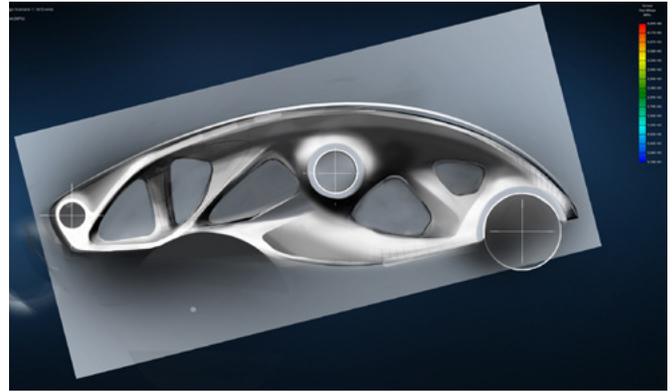
Why is modelling not simple superfluous decoration?

In the project, the two designers Hendrik Nater and Tino Kalettka manually reworked the mechanically optimised part to enhance perceived aesthetics. From a purely mechanical point of view, there is no reason to modify the highly efficient geometries - but why does it still make sense?

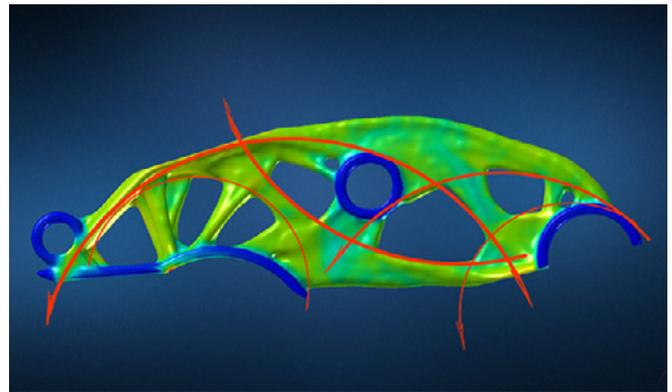
With our assessment of “beautiful” we express our positive perception of something. A situation, a process, a being, or a thing seems pleasant, attractive or good. In our culture, we make the assessment of “beautiful” on the basis of a wide range of different influences and assumptions. In our modern world, smooth, flawless, minimalist appearances are “beautiful”.

In contrast, the creatively playful, dreamy or expansive may not seem beautiful in a culturally modern sense, but rather in a mystical, natural sense. If nothing else, beauty also gives us security and escape from the daily routine of our complex world. By de-cluttering, by reducing chaos and order, we maintain an overview of our otherwise very complex environment. With plastic forming we have the possibility to organise the generated structures. In plastic forming, the principal lines are defined first and then all further logical themes are subordinated to them.

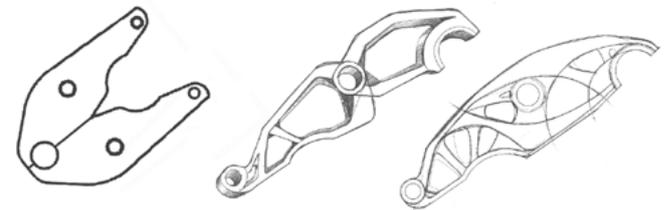
The generically simulated shapes, with their similarity to bone structures, require fine plastic adjustments. In this way, the designers create their modelled parts with the appearance of bones covered with skin and muscles. This forming gives the product a unique, positive and lively expressiveness, which combines a functional design with an aesthetically pleasing appearance and creates a sense of familiarity with the new shape.



Final result after simulation and manual design detailing. Its rounded features and depth of geometry picks up on the organic structures and transfers them into an appealing and compelling design



The optimisation result of MSC Apex Generative Design was analysed for main lines and characteristic shapes for the design detailing



Evolution of design variants from striking, linear structures to a design with pronounced depth

Key highlights:

Product: MSC Apex Generative Design

Industry: Tools

Benefits:

Reduced material & weight

Appealing design following force flow

Manufacturable with current process

Crimping tool result

The geometry modified by the software was subjected to a formal-aesthetic analysis in which the designers retained the organic form and were thus able to realise better transitions and force flows. With the findings gained, various design variants of the previously generated simulations were created and combined. In this way, they created an appealing design which, with its rounded features and depth of geometry, picks up on the organic structures and transfers them into an appealing and compelling design. Although the design has been significantly changed, the part can be produced current manufacturing process.

Summary and findings

The results of generative design can provide decisive impulses for formal ideas. In plastic forming, designers create relationships, whereby a characteristic feature can emerge from the relationships between individual facets. These intrinsic relationships can be addressed by optimising the geometry and visualising the force flows. Using the method, the component is not styled without context, but is semantically supported. Because the forms then emerge from an inner necessity, the design evokes familiarity; it is fully customised and validated by the software to meet the requirements and is appealingly and meaningfully crafted by the manual design process.



Evolution of design variants from striking, linear structures to a design with pronounced depth





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