Online-based topology optimization in 3D printing

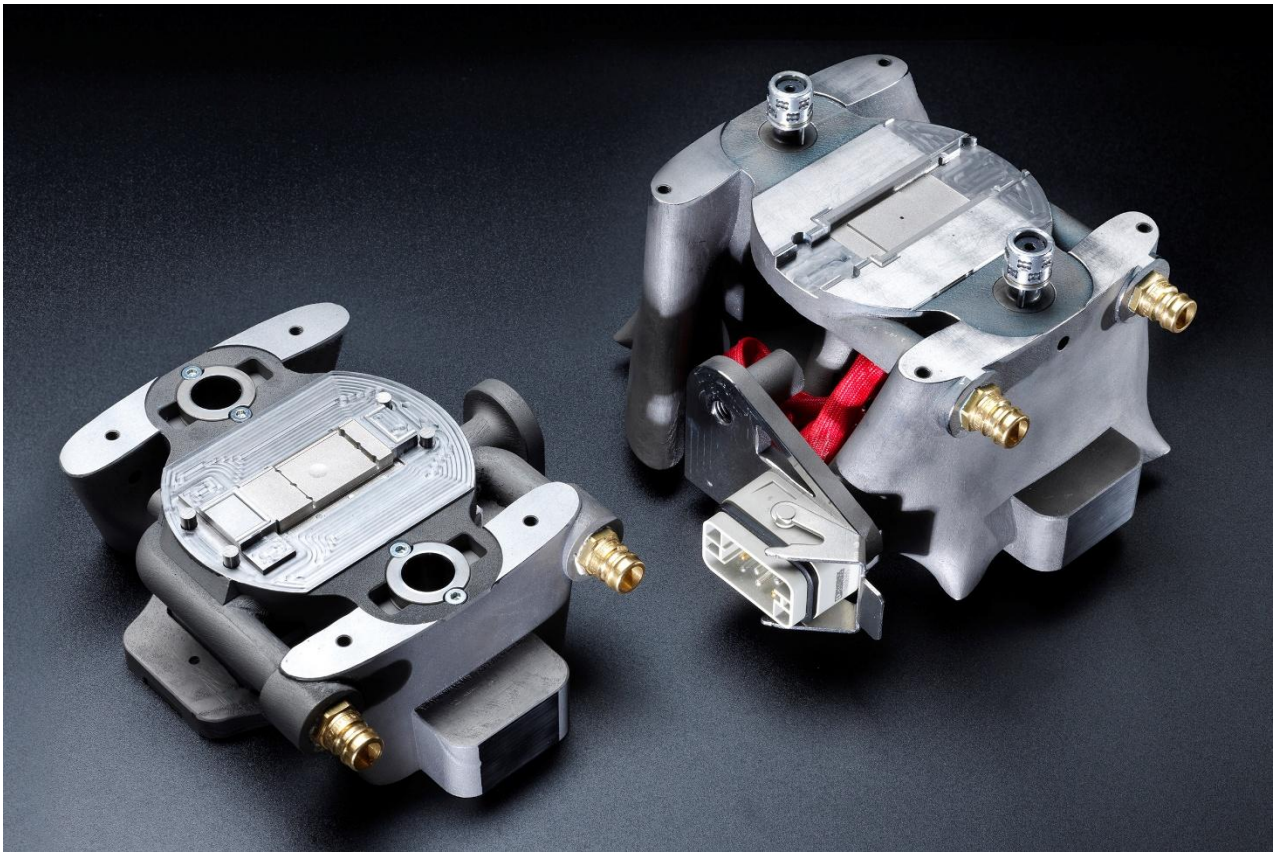
Maximum functionality with low material consumption and weight

(A technical article from 2019, author: Stefan de Groot, Technology Manager and Project Manager Additive Manufacturing, and Johannes Lohn, Head of Development and Engineering, Protiq GmbH, Blomberg)

Additive manufacturing opens up new possibilities for improving the geometry of components as part of product development. Compared to conventional manufacturing methods, it is not bound by process-related production restrictions. 3D models can now be optimized quickly and easily online on the Protiq platform.

User-friendly topology optimization of tomorrow: With the intuitive online topology optimization on the Protiq platform, the customer can quickly and easily create a force flow-compatible design

In product development, designers and engineers have always had to take process-related limitations into account. In additive manufacturing, however, a component is not machined from a block of material, but built up layer by layer from a shapeless starting material. This allows product developers to focus entirely on the functionality of an object when designing it. The two-dimensional layer-by-layer structure in 3D printing thus solves the three-dimensional challenges and problems of conventional processing. Based on topology optimization, basic shapes can be generated taking into account defined boundary conditions and stress restrictions in such a way that they combine maximum performance characteristics with low material consumption and weight. The combination of topology optimization with additive manufacturing and innovative materials therefore offers designers new opportunities to rethink the design and associated functional scope of products.

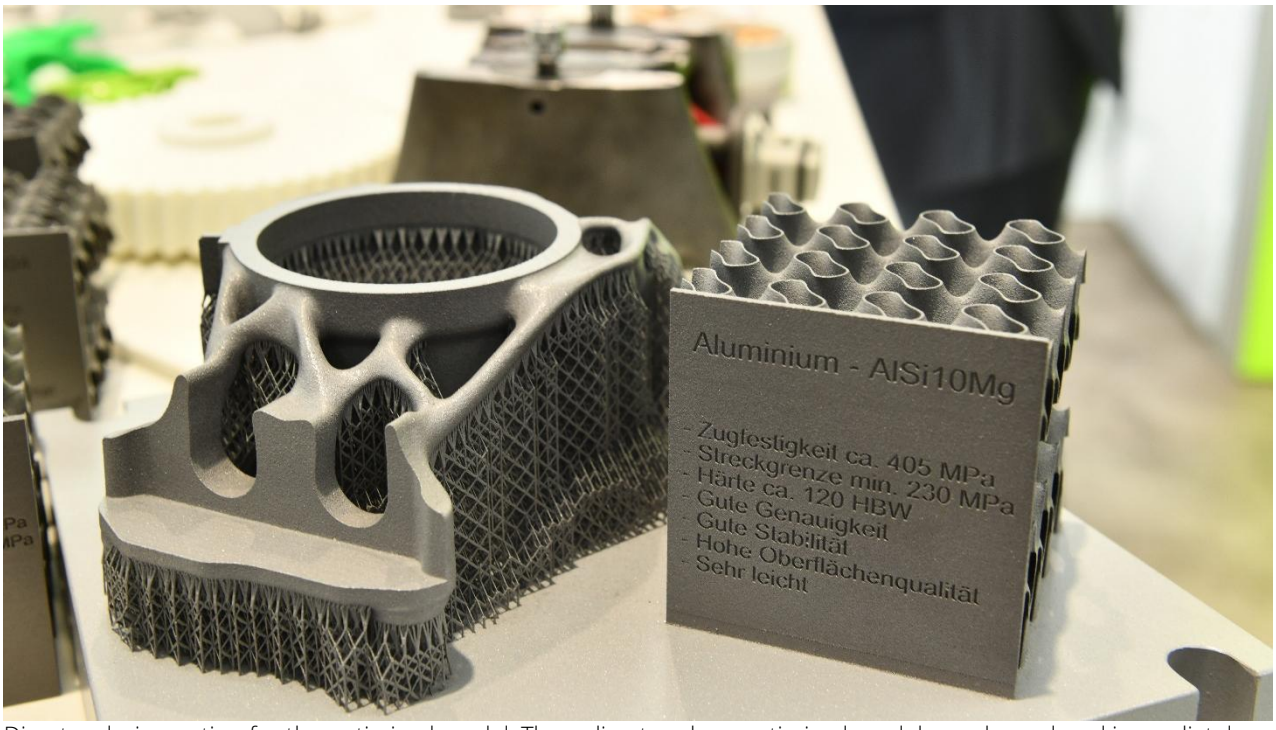


Topology-optimized injection mould: Through topology optimization, Protiq has developed and manufactured an injection mould with a fraction of the weight and higher performance at the same time

Industries for which weight reduction plays a major role are among those that benefit from force flow-oriented design. These include, for example, the automotive industry and aerospace. Topology optimization is a computer-based calculation method that can design mechanically loaded component structures in such a way that the greatest possible rigidity is achieved with the minimum use of material. Only those areas of a component are generated that are required for the necessary force flow and stability. This results in complex structures that cannot be realized with conventional production processes, or only to a limited extent.

Self-explanatory user interface

The demand-specific creation of industrial components creates functional added value for customers, while suppliers differentiate themselves from the competition with innovative solutions. Web-based configurators are available on the Protiq platform, which customers can use to adapt and directly order individual plastic or metal components in just a few minutes.



Direct ordering option for the optimized model: The online topology-optimized models can be ordered immediately on the Protiq platform based on live pricing and manufactured from the desired material within a very short time

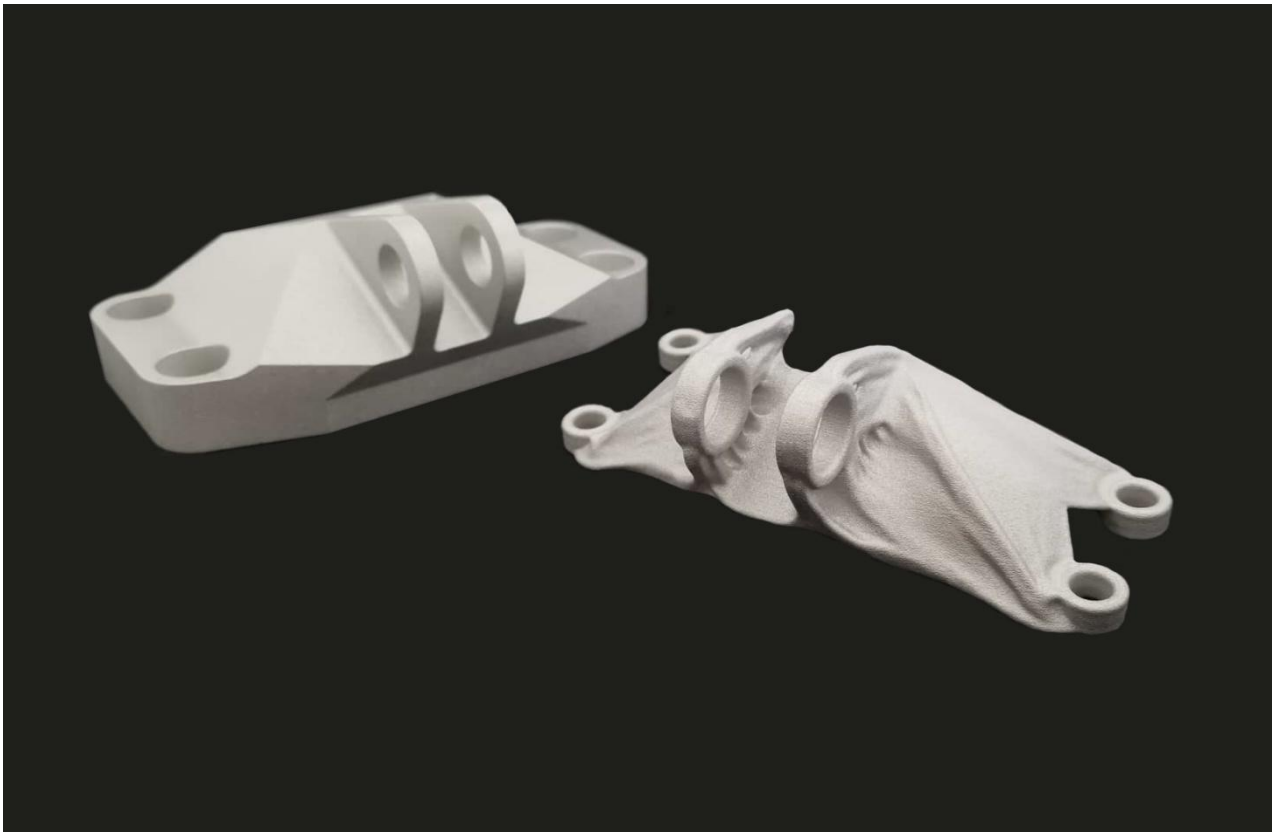
This gives interested parties the opportunity to intuitively and quickly create data models that fully meet the specific requirements without any special knowledge of CAD design. In this context, the platform now offers a further option to meet customer requirements and market demand: Protiq has implemented easy-to-use software that can be used to optimize the topology of components.

In direct comparison, the conventional improvement of component design requires a comprehensive and detailed understanding of how to use the standard application software. The new solution on the Protiq platform makes topology optimization comprehensible and conclusive even for the layman. To this end, the self-explanatory user interface allows complete traceability of the individual steps at all times, as the customer is guided through the entries with a large number of explanatory and informational texts. In addition, the entire topology optimization process can be run through and tested in advance using sample components in combination with an introductory tutorial.

Directly printable model

So how exactly does topology optimization work? First, the customer defines the maximum design area that is available for shaping the improved geometry. In this context, there is the option of defining an unrestricted space so that optimized structures can be generated wherever the force flow requires it. Alternatively, the design area can be limited so that the automated design and improvement process is carried out in a predefined space. This restriction proves useful when neighboring components within an assembly limit the available space. One example is the cramped engine compartment in a car. For such a restriction, the maximum design area must be created and uploaded.

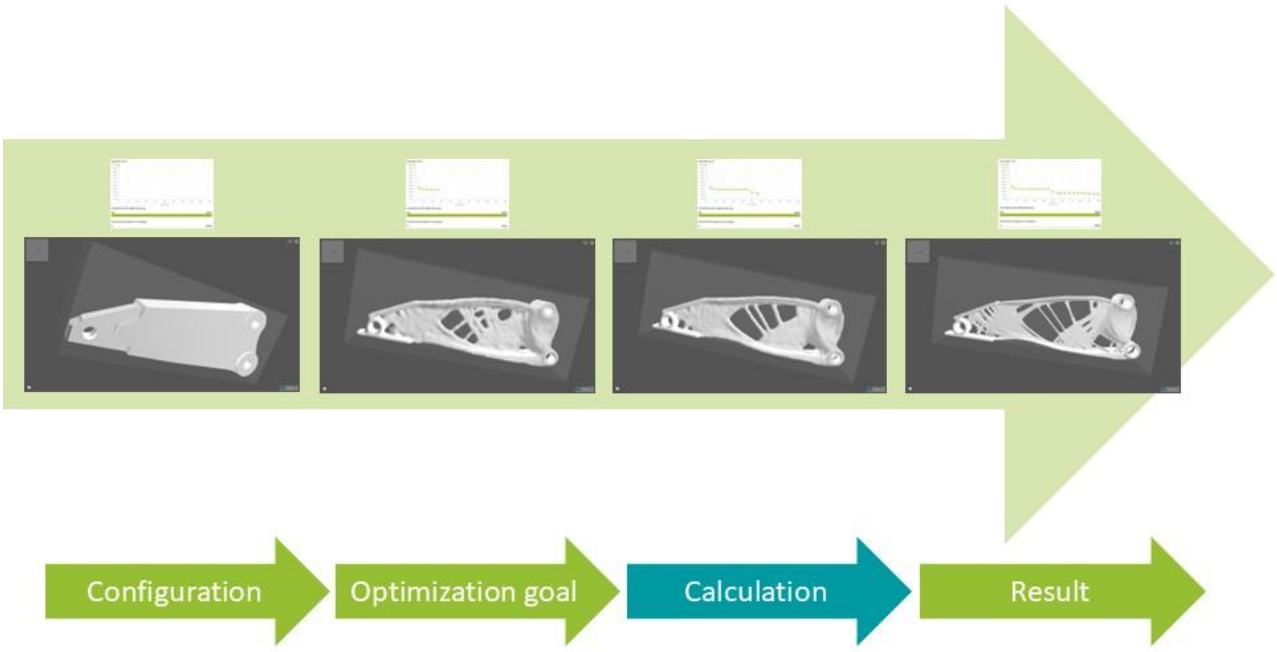
Once the design area has been defined, various load situations - so-called load cases - must be considered, which the object must withstand in the application. A load case describes a situation in which different forces can act simultaneously and which includes existing bearing points. Of course, each component is exposed to different load conditions. A model can therefore be influenced by numerous load cases. The software analyzes the forces acting on the model, taking into account the connection points, also known as bearing conditions. The software automatically removes all areas that are not subject to any load and have no other use from the 3D model.
The result is reminiscent of bionic structures and combines high functionality with low weight and material costs. The 3D model generated in this way can be printed directly, meaning that no manual subsequent processes are necessary. "In future, the components will also be automatically optimized for additive manufacturing. This is tantamount to a revolution," explains Dr. Ralf Gärtner, General Manager of Protiq GmbH.



Conventional versus power flow-oriented design:
With topology optimization, completely new designs can be produced in lightweight construction, which also impress with better performance in direct comparison

Consistent live pricing

The online tool provided on the Protiq platform makes topology optimization considerably easier and faster.
Previously, the process required extensive knowledge of special application software, meaning that even simple use cases often took days or even weeks to complete. With the online-based topology optimization, long waiting times are now a thing of the past, as the Protiq software does not require any specific knowledge to improve a 3D model, but just a few mouse clicks.
This not only significantly reduces the amount of material required, but also the time needed - while maintaining the high quality and performance of the products.



Topology optimization of a hydraulic spreader: During topology optimization, the customer receives a continuous visualization of the current status of his optimized model in combination with the weight savings on the Protiq platform

Once the optimized 3D model has been generated with the tool, it can be saved as a project design, purchased as a CAD model or ordered directly from Protiq. The component is then manufactured in industrial 3D printing using selective laser melting or laser sintering. The continuous live pricing, which is constantly updated during the project, is particularly appealing. The customer therefore not only receives an improved design. Additive manufacturing also significantly reduces production costs, because "every printed gram costs money", as Dr. Ralf Gärtner explains.

Further information:

https://www.protiq.com/en/topologyoptimization/

Standardized certification course

It is a logical consequence: new technologies require new knowledge.
Those who acquire this know-how quickly have the best chance of succeeding on the job market. 3D printing is a specialist area that is still in its infancy despite its current relevance. However, the number of companies working with such processes is growing rapidly and will continue to do so in the future. Protiq GmbH is therefore expanding its commitment to research and education in cooperation with the IHK Lippe zu Detmold by offering a nationwide certificate course. After successfully completing the course, participants can call themselves specialists in 3D printing technologies (IHK).

The IHK seminar, which takes place at Protiq's premises in Blomberg, is divided into six modules spread over a total of 64 teaching hours. Topics covered include the basics of 3D printing, rules and guidelines for the design and construction of the various processes and the creation of complex 3D components. At the end of the training course, graduates will be able to use various 3D printing technologies and open up further manufacturing possibilities. Prerequisite for participation in the course is a completed industrial-technical vocational training or several years of relevant professional experience. Please register at www.detmold.ihk.de