

Fast and cost-effective production of customized products

(A technical article from 2024, author: Max Wissing, Technology Manager Additive Manufacturing, Protiq GmbH, Blomberg)

Additive manufacturing, often referred to as 3D printing, has been steadily gaining importance and visibility for years. While the technology was initially used mainly for visual models and rapid prototypes, 3D-printed parts are now used in many fields, including medical technology.

Users can now choose from numerous additive manufacturing processes and materials. Parts can be produced from engineering plastics, high-strength metals or exotic materials – for example medical-grade silicone and zinc. What all additive manufacturing processes have in common is that the parts are built up layer by layer by adding material. Unlike many conventional production technologies – such as turning, milling or EDM – no material is removed; instead, it is added selectively. This is why additive manufacturing processes are characterized by a high degree of design freedom and flexibility.

The parts are produced directly from the designer's 3D data and can be individually adapted to the respective application. Combined with fast and cost-effective production of small quantities, this flexibility makes additive manufacturing the method of choice, especially for medical applications. The parts can be tailored to the shape and needs of the patient, which proves advantageous both for the patient and for the treating physicians.

Complex and rigorous certification processes

The Protiq Marketplace, operated by the eponymous Protiq GmbH, is an online platform that bundles these advantages and makes them accessible to users. The platform focuses on industrial 3D printing and serves as an interface between numerous service providers, offering a wide range of different additive manufacturing



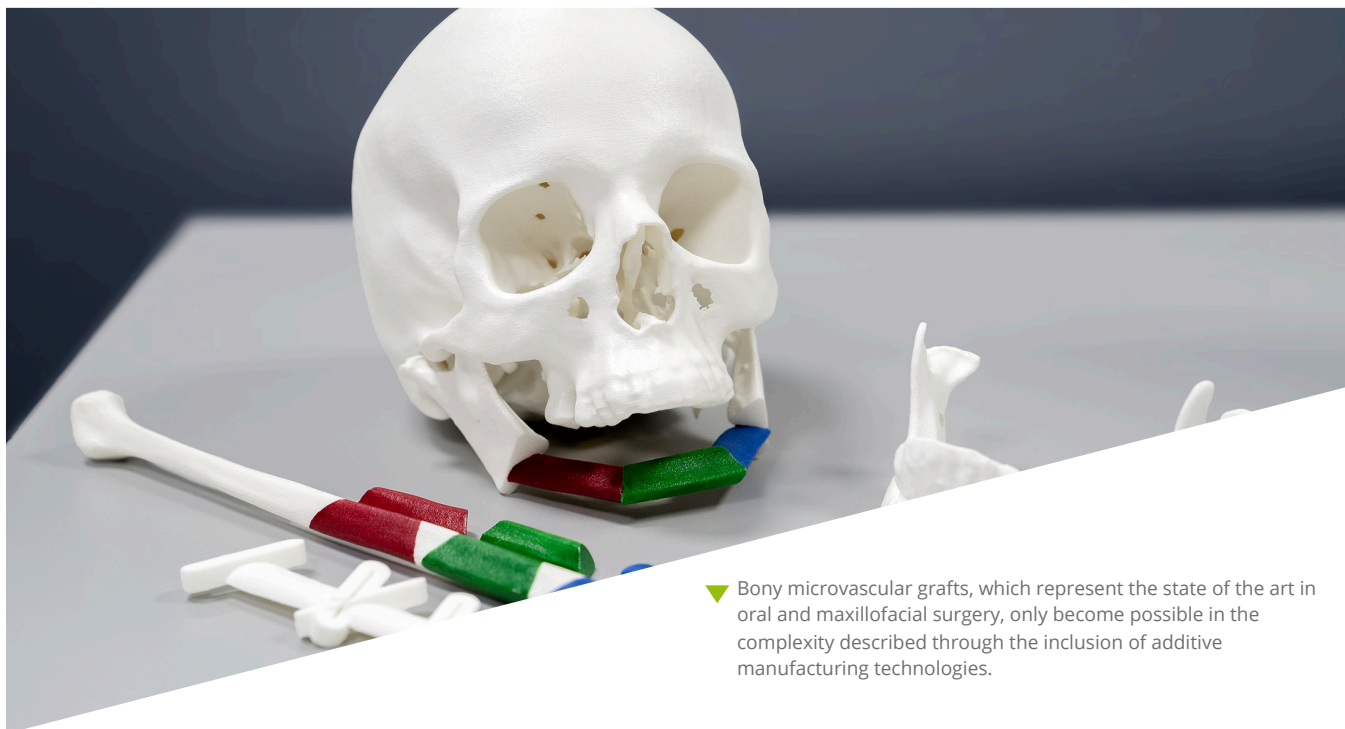
▼ Additively manufactured helmet made of PA11, individually adapted to the shape of the wearer's head. The innovative lattice structure improves the fit and distributes loads evenly. Design study in collaboration with Nils Sorger.

processes and materials, and the corresponding customers. The requirements of the medical industry are addressed through high quality standards, data security and maximum transparency. As a subsidiary of Phoenix Contact GmbH & Co. KG, Protiq is also represented on the marketplace with its own production.

The possible applications of 3D printing in medical technology are as broad as the field of human medicine itself. They are found on the body as well as inside it. For use inside the body, it must of course be ensured that the materials used meet the high medical requirements and standards. Companies manufacturing for this field of application undergo complex and rigorous certification processes. Manufacturing partners holding such a certification are highlighted on the Protiq Marketplace by a selectable filter function and are therefore easy to find.

Wide range of applications in dentistry

Well-known examples of applications in medical technology include customized prostheses, which are precisely adapted to the needs of the patient thanks to the design freedom of 3D printing. In dentistry in particular, addi-



▼ Bony microvascular grafts, which represent the state of the art in oral and maxillofacial surgery, only become possible in the complexity described through the inclusion of additive manufacturing technologies.

tively manufactured implants and dental crowns are already widespread. One example of a manufacturing partner on the ProtIQ Marketplace is CADdent GmbH. The company, which specializes in, among other things, the 3D printing of biocompatible titanium and cobalt-chromium as well as the CNC machining of ceramics, has many years of experience in the industry. For the production of medical plastic components with all necessary medical certifications, the Dutch partner Oceanz B.V. offers its services on the ProtIQ Marketplace.

By comparison, the larger field of application for additively manufactured parts lies less inside the body itself and more in supportive orthoses and medical aids. These only rest against the body and therefore require less stringent certification. In dentistry, for example, dental splints produced additively using the SLA or SLS process are a common application. They are used to treat tooth misalignments or nighttime grinding. The 3D-printed splints are designed and fitted using patient-specific 3D scans of the tooth position. The materials – for example the engineering plastic PA12 – and the manufacturing processes on the ProtIQ Marketplace meet all requirements for temporary use in the oral cavity in this context.

Additively manufactured guides for facial surgery

Additively manufactured cutting and drilling guides, known as cutting guides, enable fast and fully digital surgical planning in reconstructive facial surgery.

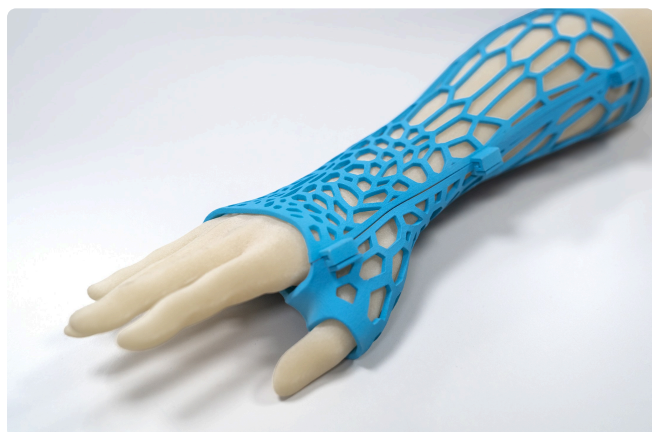
If a large part of the jawbone has to be removed due to a tumor or an accident, it can be replaced with parts of the patient's own calf bone – the fibula. The complex U-shaped geometry of the jaw can be reconstructed by segmenting the graft into several lengths and angles. The digitally planned and 3D-printed cutting guides indicate the exact positions of the cuts to be made, the length of the grafts to be harvested and the required cutting angle, so that the shape of the jaw can be restored as planned.

The additively generated guides can be sterilized and certified as Class 1 medical devices for short-term wound contact.

Until the transplanted segments have successfully healed in, they are screwed to a titanium plate and thus fixed in position. This implant is usually a standard product that is bent into shape using a 3D-printed auxiliary geometry. Alternatively, directly 3D-printed titanium implants can now also be used, which can already be adapted digitally to the patient.

Tailor-made orthoses in orthopedics

One field of application for 3D printing that deserves special mention is the orthopedics industry. It increasingly relies on orthoses in its work and benefits from the ability to adapt 3D-printed parts to the individual patient. Prominent examples include splints for immobilization as well as specially adapted helmets or shoe lasts in orthopedic shoemaking. The splints, helmets and other orthoses are created by the respective orthopedic specialists on the basis of the patient's 3D scan data. Apart from the improved fit, 3D printing makes it possible to implement features such as better ventilation and greater wearing comfort. In addition, additive manufacturing impresses with its speed and flexibility. The orthoses are produced using the SLS or MJF process from the non-petroleum-based plastic PA11. This engineering plastic offers a good combination of strength and high elongation at break.



▼ Medical orthoses – for example splints or helmets – can be individually adapted to the patient. The engineering plastic PA11 provides the necessary strength and elongation at break to withstand even higher loads without breaking.

Custom-made orthopedic shoes normally take several weeks to produce. A decisive time factor here is the individual production of the lasts used to manufacture the shoes. 3D printing can significantly shorten this lengthy

process. To this end, ProtIQ provides a free configurator on its online platform for creating the 3D data of the customized lasts. In this way, the otherwise complex model generation is integrated directly into the digital ordering process, and the last is then produced within a few days from the engineering plastic TPU using the SLS process.



▼ The 3D-printed orthopedic lasts made of TPU behave like conventional wooden lasts. Processing steps such as stapling, gluing, shaping and pressing are possible without restriction.

Diverse involvement in research projects

A look into the future gives reason to hope for many new innovations in the field of medical additive applications. The technology is evolving at a rapid pace. ProtIQ, for instance, has been involved in several public research projects for some years now, for example on the topic of additively manufactured prostheses made of zinc. The metal is considered to be readily resorbable by the body and could be used for implants. The body breaks these down naturally once the patient has healed. The future therefore remains exciting.

Further information:

www.protiq.com