Expanding the scope of 3D printing

By FRANK CARSTEN HERZOG

Additive manufacturing (AM) is nowadays used for a wide variety of applications. A green technology, AM is bringing about increasingly disruptive changes in traditional manufacturing strategies. The benefits of a procedure not bound to a specific form, such as geometric freedom, re-engineering, and resource conservation, are complemented by great economic advantages and excellent availability. But the essential merits are not just the copying of conventional parts but rather the new designs and bionic design approaches. Time-to-market as well as quick availability and idle time reduction also come into play. In light of the debate about long supply chains as a side effect of globalisation, AM is also a viable approach for local production. Local production also means that value creation, product development, and product manufacturing will take place closer to the customers. Reducing logistic overhead contributes to achieving climate goals.

AM providers in the industry, however, are currently in a consolidation phase. The enormous growth of the past ten years in particular, its numerous innovation pushes, and the consolidation of prices are taking effect. While major players such as Stratasys, 3D Systems, SLM Solutions, HP, EOS, GE Additive, or MarkForged may feel a stronger effect, small start-up companies are still pushing into a dynamic market with creative solutions. A market that is still far from saturation or fights for survival. For users, on the other hand, things are still going extremely well. That is true for the medical industry as well as others.

Medical 3D printing takes off

Materials play a decisive role in medical technology. Classic material groups include metal, ceramics, and plastics. In the LaserCUSING procedure, a powder bed-based metal laser melting process developed by me (market share approx. 80 % of all metal AM systems worldwide), very early adoption for medical applications was possible because we were always able to use certified original materials in powder form. A similar approach also works for ceramics-based solutions. The process is a little more complicated with polymers due to the variety and material behaviour of that group. When we now shed some light on the medical industry, we will see many isolated application clusters: hip, joint, or spinal implants, cranial or dental prostheses in dental technology. Medical devices, laboratory equipment, or components used in high-tech medicine are added to the mix; currently, the operative word would be valves for reanimation and ventilation devices. Even veterinary medicine knows a range of applications for implant technology by now.

Protective equipment for healthcare professionals was a major global challenge when the SARS-CoV-2 pandemic broke out. Firstly, there were only emergency stocks lasting 2–3 weeks, and secondly, a lot of it was not produced in the European area. Supply chains and delivery times were too long. Prices skyrocketed unrealistically, and the quality was often dubious. Political and healthcare officials were alarmed in light of the rapid increase of infections. In this uncertain situation I was approached by the emergency room of the Bamberg clinic asking whether there was a 3D printing solution for face shields. Basically, this is a very simple design consisting of a headband and a sheet of acrylic glass. We were, of course, unable to recreate any certified models. But what we could do was produce makeshift equipment consisting of a face shield, protective gown, and respirator mask. And another thing was absolutely clear to me: This can only work in a proper network, because 3D printing can only ever be part of the solution and not the solution itself. In my case, this network was the Lichtenfels Center of Next Generation Digital Technologies (Forschungs-

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Respirator mask for the Bamberg clinic (image source: Innocept)

3D printing as used in the production of medical supplies during COVID-19 outbreak.

und Anwendungszentrum für digitale Zukunftstechnologien

Innocept, a Neuses-based company, developed a new type of respirator mask. The idea was to design a reusable respirator mask that was comfortable to wear, consisting of two soft polymer half-shells between which various filters could be inserted. The benefits: The respirator filter does not sit directly on the face, making it much easier to breathe compared to makeshift fabric masks. Moreover, the large batch production of the respirator mask allows for favourable manufacturer's prices. It is environmentally friendly because not the whole mask must be disposed. To speed up the development process, we produced five prototypes overnight using the multi-jet fusion HP technology at the company Hofmann – Ihr Möglichmacher in Lichtenfels. Two and half weeks later, the product reached maturity. The patent was filed by Innocept. Moreover, the Weidhausen-based company Verpa developed a simple protective suit made of foil. Hofmann – Ihr Möglichmacher produced miscellaneous items of facial protective equipment but also ventilator valves for mechanically ventilated patients in intensive care units, and provided them free of charge. In this case the HP multi-jet fusion technology allowed us to produce individual but affordable much-needed products in the shortest possible time. But there is another essential advantage to digital processes: STL printing files can be used as a common basis on many printers regardless of the manufacturer. We provided them centrally via the Bayern Innovativ network, among others. A neutral institution of the Free State of Bavaria, Bayern Innovativ pools relevant expert knowledge particularly for small and medium-sized companies, so they can successfully put their innovations into practice. At the same time, Coburg University, a partner of the FADZ, produced more than 120 face shields for the Coburg clinic. This protective equipment has by now gone on sale. A just-in-time supply chain can be established in the future.

Future prospects: pro digital

"Pro digital" means: We will see higher construction rates due to multi-laser and binder jetting technologies and larger part sizes as well as improved exposure and QA or new materials. Step by step, this technology will become more effective and efficient, even though the development stages are now somewhat more moderate than ten or twenty years ago. We are certainly going to see new bionic products, new designs, new materials, more sustainable products, and a broadening of applications.

Training and development of the "Generation 3D Printing" will be the key to the future. A training and development will give everyone anywhere in the world the advantage of site, because AM is a key way to develop and build products locally. I am also saying this in light of the debate about long supply chains all the way to China. AM permits us to manufacture locally, close to demand. There is no need for long transport routes or dependencies. Digital AM plants around the world have similar cost structures. The technology itself is already resource-efficient, but the local approach is also more climate-friendly. So we need local AM centres, "digital hot spots". For this to happen, we must provide the technology with developers, draughtspeople, designers, and operators who understand 3D printing and are able to use it. That is the only way for us to translate traditional manufacturing strategies into the new possibilities offered by 3D printing, and to fully utilise future innovation opportunities.

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