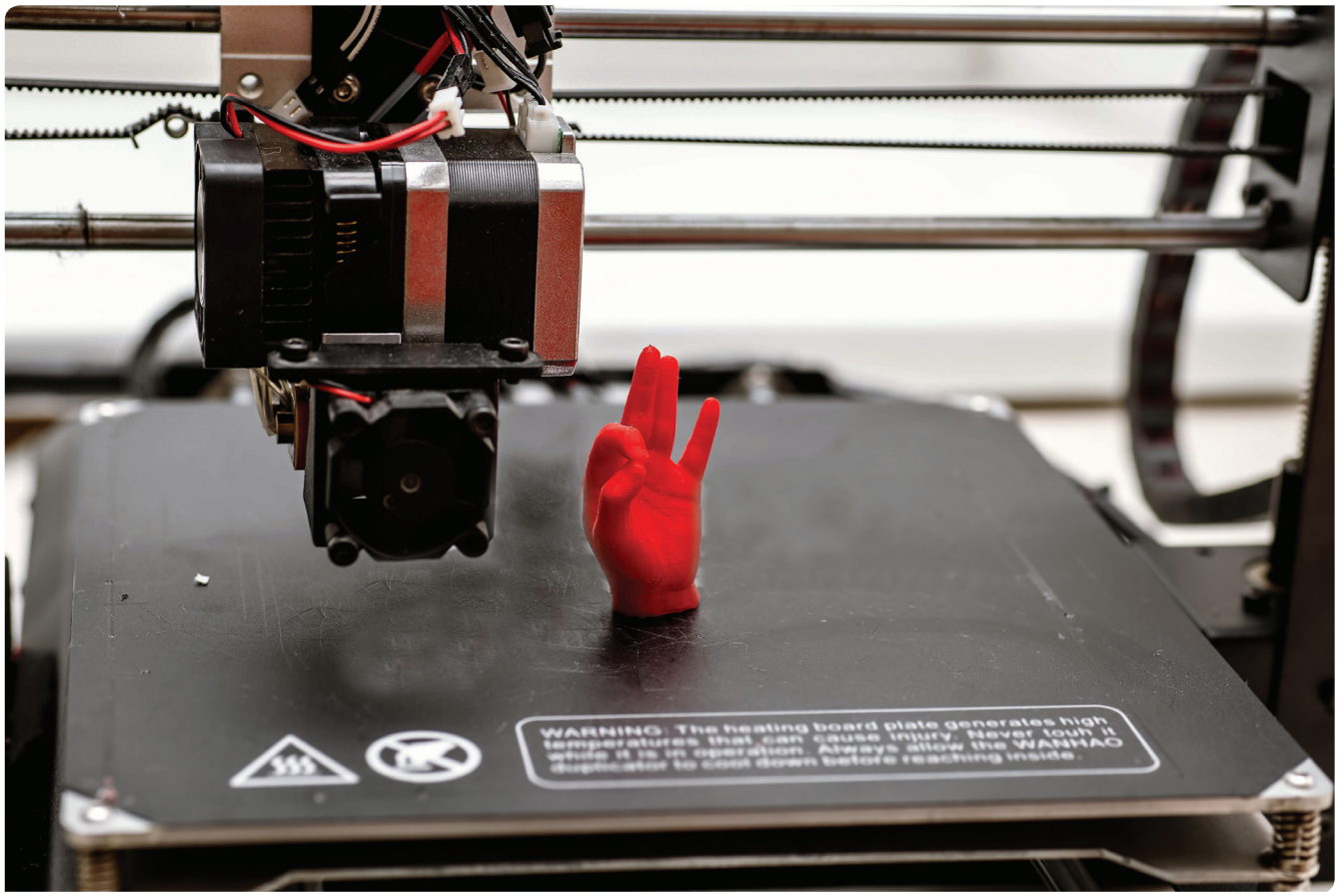
No industry is immune from developments in technology, not least of all the medical sector. European Business Magazine looks at how life science innovation is developing, assisting manufacturers, buyers, researchers and humanity.

Click of a Button

By Patricia Cullen

The technology for 3D printing, or additive manufacturing, isn't some new, recent discovery, but has been around since the early 1980s. A few decades ago the technology was called rapid prototyping technologies, and the first patent was issued for stereo lithography apparatus for Charles Hull in 1983. Focused on building an object in really thin slices from the ground up, it's like layering a load of plastic *Digestives* until you have a sleek, effective prototype. This technology was music to the ears of investors, who could now test their designs without committing to a colossal upfront investment in manufacturing of parts for the aerospace, automotive and defence industries.

In 1992, *3D Systems* put their patent into practice and built a SLA printer, by the noughties things had gone unashamedly ski-fi, and in 2008 the first 3D printed prosthetic was manufactured. The process centred around creating solid, three dimensional objects from digital files. What once may have cost £100,000 suddenly only cost a fraction of that price, and this affordability, alongside the expiration of a key patent, caused the market to sky rocket in 2009. Over the years digital design software has developed, scanners are now readily available and desktop printers are no



longer just a pipe dream for the enthusiastic entrepreneur. This niche technology transformed from something that once only existed in labs into the mainstream, and subsequently the technology was within reach of the growing army of makers that were eager to implement their expertise and know-how.

Houses. Jet engines. Jewellery. That's the attractiveness of 3D printing – you can create almost anything! Big names such as *Hewlett Packard* and *General Electric* have been associated with the technology in 2016, and most markets are still seeing a huge growth rate, with the global 3D printing market expected to reach approximately $23 bn by 2022. This technology can be beneficial for any sector, but the medical industry is flying the flag, from using imaging data and creating 3D models to producing patient specific implants, it is revolutionising healthcare.

With the promise of lowering waiting times and decreasing costs, how we *deliver* this healthcare is also changing. Back in 2012, a 3D printed lower jaw implant was fitted into a woman's face, doing the groundwork for more 3D printed patient specific parts. Things are moving fast as medical 3D printing shifts towards bio-compatible implants that allows the patient's own bone to renew before the 3D framework disappears. These improvements show that it is not just about *changing* the method of how we make a product – it's about producing brand *new* products, with completely *new* properties that were just not achievable with the old methods.

From custom prosthetics to living tissue, 3D printing provides a way of offering economical and tailored care for patients. For example, if you wear a hearing aid you are already part of this 3D rhetoric. The majority of hearing aids are now 3D printed, transferring on the lower cost and production time benefits. Broken bones are a pain to both physician and patient, and despite efforts to correct the fracture, up until recently we have had to wait it out and let nature repair at its leisure. But step forward the 'hyperelastic bone' – a bone that can be manufacture on-demand and works almost as naturally as the real life original. Created by scientists at *Northwestern University*, this synthetic mix of ceramic dust and polymer is a viable alternative and doesn't seem to upset the immune system.

Prosthetics, in some form or another have been around forever, with humans using a variety of

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apparatus to fine tune hand and foot functionality over the years. In the developed world, 25% of prosthetics and orthotics clinics use custom made devices over plaster casts, with an adjustment in delivery time of 48 hours and up to two weeks respectively. With prosthetics, choices were limited – a stiff cosmetic add-on, a hook that may leave the user feeling self-conscious or a pricey robotic attachment. 3D printing technology offers a number of positive changes in the world of prosthetics, like lower cost, faster fittings and amendments, reduced social stigma, versatility and full customisation.

Possibly one of the most life-changing elements of the 3D printing revolution in the medical sphere is using it to assist transplants. Pankaj Chandak, the transplant registrar at *London's Guys and St Thomas's Hospital*, was the first surgeon in the world to *plan* for a paediatric kidney transplant using 3D technology in November 2016. Using 3D replicas of the specific body organs, the surgeon was able to prepare for the complicated operation, minimising risks and affording him insight into whether or not the donated organ would fit. Simplifying the planning stage and reducing apprehension over unanswered questions in the earlier part of the process is of huge benefit, and this method has already won the *Cutlers Surgical Prize* and an award from the *Royal Society of Medicine*. Likewise *Kobe University Hospital* in Japan incorporates 3D printing technology into its methodology by producing model replicas of patients' organs, eradicating mistakes made from 2D CT or MRI scans. Doctors can examine the precise organ model, pinpoint suitable treatments and establish the best operating technique, cutting the operative dangers and chance of infection during complicated procedures, while reducing unnecessary exposure to anaesthesia.

A British scientist has discovered ways to use a 3D printer to create living tissue and it is expected to change the way in which we deal with regenerative medicine. Stem cells have brilliant regenerative properties and they are now being bioprinted in *Heriot-Watt University of Edinburgh*. Custom made living body parts is a significant breakthrough in regenerative medicine and this innovation could lead to printing out actual body organs. And while this may be at least a decade away from becoming a working reality, medical researchers and scientists are making real headway, with the genuine hope of using living issue to repair the body. Bioprinting is based on bio ink, which is made of living cell structure. This technology displays a feasible prospect of producing patient specific tissue, facilitating the development of precise, focused and custom-made treatments, with one company already selling 3D printed liver and kidney cells for research.

3D printing is also used to print medication. *Spiritam*, a seizure

drug for those who have trouble swallowing, is the first *FDA* approved 3D printed medication, and is dispensed as an instantly dissolvable powder. Medicine has always been an exciting, fast-paced and progressive industry, and we have seen some amazing developments in bioprinting, prosthesis manufacturing and customised medical implants. 3D printing solutions will enhance medical outcomes, revolutionising every aspect of this sector. Saving time, lives and money, this technology presents medicine with a sharper assessment before operating, developing the techno-medical relationship even more.

Only thirty years ago, 3D printing was an unfathomable phenomenon, a novelty with inadequate application, holding little real expectation in everyday living. While the consumer 3D printing hype didn't necessarily pan out, whole industries are re-examining how they operate because of this exciting technology.

Made to Order:

An Australian hospital is set to receive a dedicated 3D-printing facility, printing new cartilage and bone. Next step? The hospital visualises a tissue printing machine next to every operating table, lessening the need for tissue donors, while promoting further studies. On demand organ printing, now that's a surgeons dream.

Case Study:

The Royal Hospital for Sick Children in Edinburgh is using 3D technology to make new ears, empowering manufacturers to produce customised products. A perfect template is used and from this the surgeon generates a new ear from the rib cartilage of the patient. This technology can enrich lives and in many cases hearing can be achieved.