Change by design

In the last editorial we introduced the notion of additive manufacturing (including stereolithography) and 3D printing. We gave an example about its medical use in surgery but its applications may also include medical devices and research.

Imagine the following scenario. A piece of an old X ray machine in a Sudanese hospital has broken down. The parts are no longer available and there are no funds to buy a new equipment. With a 3D printer the broken part can be scanned, repaired virtually and a replacement printed within hours. Whola! Besides, to avoid going through all this trouble, since there is also a Bolivian hospital ten thousand kilometers away who has that same X Ray machine, a replicator can transmit the same data pertaining to the repaired piece to Bolivia so that the hospital will have a spare. Just imagine this … or rather, simply realise that all this is occurring now, as we talk … is this not reminiscent of the science fiction series Stargate SG-1?

Other applications include portable small ultrasound scanners. The size, weight and cost of the imaging consoles has obviously shrunk along the years, but the transducer probe which is placed on the body has remained largely unchanged and is now the most costly part of the system. GE has now developed an additive system to print the transducer which is hoped to bring the costs down.

And imagine receiving your 3D printed tailor-made dental crowns or hearing aid shells while you are still at the dentist or ENT specialist!

The use of 3D printing in surgery has also paved the way for more accuracy in complicated operations, with a greater degree of success. For example, if a surgeon needs to remove a tumor from a patient but there is a high probability that a nerve or artery is damaged in the process, a 3D model of the tumor from the patient's CT scans can be created using a 3D printer (indeed, the materials that can be printed range from metals and ceramics to rubber-like substances. Some machines can also combine materials, making an object rigid at one end and soft at the other). The surgeon can then practise on the model before working on the patient. In this way, the surgeon will be able to make the necessary incisions with confidence. The benefit-risk ratio of the operation will thus improve.

Indeed some researchers are already using 3D printers to produce simple living tissues, such as skin, muscle and short stretches of blood vessels. There is a possibility that larger body parts, like kidneys, livers and even hearts, could one day be printed and if the bio-printers can use the patient's own stem cells, the body would be less likely to reject the printed organs after a transplant.

Another important contribution of this application is in the field of nanotechnology. Interestingly, nanotechnology products have been around for more than a decade now. A case in point is Titanium dioxide which is used to manufacture self-cleaning glass in buildings. It basically reacts with sunlight to break down organic dirt. In addition the material is also hydrophilic, attracting rain which washes the residue. However their boom which was heralded like the imminent second coming of Christ by foul-mouthed financial Farizees, never materialised. More than twelve years later this particular sector still remains an exciting research domain but in my opinion, maybe these nanotechnology products have lost some hype due to their prolonged infancy. Now, with the advent of additive manufacturing, the gap between product and manufacturing innovation will hopefully be bridged faster.

Furthermore, it will certainly also influence pharmaceuticals' manufacturing. A joint venture between the Massachusetts Institute of Technology and Novartis has recently been developed, pioneering a continuous manufacturing process for the pharmaceuticals industry, whereby raw materials are put into one end of a machine and tablets come out at the other end. It relies on a combination of chemistry and engineering, speeding up some processes and slowing down others to make them work together. The number of operations involved in producing a particular drug, has been cut from 22 to 13 with the processing time being reduced from 300 hours to 40. Besides, instead of testing each batch of material, each finished tablet is individually monitored to ensure it meets the required specification. In addition since the pilot line described above can fit into a shipping container, it could be moved anywhere. In fact Stephen Sofen, the project's director stated "Instead of a giant, purpose-built plant to supply the global market, you could imagine smaller, regionalised plants."

On the other hand Professor Lee Cronin, chair of Chemistry at Glasgow University, and his team has developed a new 3D printing process to synthesize chemicals. Prof Cronin believes his research could one day lead to low-cost chemical printers at home that would allow patients to print their own prescriptions. Such a scenario would certainly earthquake the healthcare industry as it could drastically bring the cost of care down for patients. As they wrote in the *Nature Chemistry Journal*, last April, "This would not only place traditionally expensive chemical engineering technology within reach of typical laboratories and small commercial enterprises, but also could revolutionise access to healthcare and the chemical sciences in general in the developing world."

Ian C Ellul