Can 3D printing change face of Singapore’s public housing?

As with the term “robot”, which was coined by Czech writer Karel Capek long before its first technical implementation, 3D printing entered our collective imagery by the backdoor of fiction. In the late 1960s, cult television series Star Trek presented us with two chimerical devices: The transporter and the replicator, both of which involved dematerialising matter and reconstituting it in another form elsewhere.

11 JULY

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Although today’s state-of-the-art 3D printers look like toys compared to the fictional atom assemblers, their capabilities are, nevertheless, impressive and very useful to some industries. The fast production of 3D-printed plastic prototypes is, in fact, fast becoming integrated in the workflows of industrial designers and mechanical engineers.

The technology’s popularity has also been propelled by the emergence of specialised businesses providing fast, reliable, on-demand 3D printing over the Internet, dramatically increasing its cost-effectiveness. In short, 3D printing has the potential to empower the individual to make almost everything — regardless of economies of scale.

The cult of 3D printing has many followers. In his latest State of the Union Address, American President Barack Obama said he believed 3D printing technology “has the potential to revolutionise the way we make almost everything”. By investing in it, he wants to ensure that the next revolution in manufacturing will be “Made in America”, bringing production back to the United States by replicating the success story of the digital revolution.

A BRAVE NEW WORLD

But while the advances of 3D printing propel our longing for a world where economies of scale do not matter and everybody is turned into a potential designer, they also raise challenging questions that reach far beyond the issues of intellectual property or privacy, and can get very physical indeed.

Despite being in favour of stricter gun control, what Mr Obama did not mention in his speech is the fact that Defense Distributed, an American company, has allowed its clients access to design files for 3D printing of gun components. As a result, more than 100,000 people all over the world have now downloaded blueprints of gun components from its website. That is potentially dangerous.

On the other hand, motivated by the critical shortage of organ donations, researchers have started to investigate the feasibility of printing biological tissue. Although this is still at the fundamental research stage, the goal is to print custom, fully functional human organs.

Yet another revolutionary idea is to allow patients to print their medicine. Instructions could be downloaded from the Internet or delivered on a daily basis according to the prescription given.

3D printing has inspired the imagination of many industries, especially fashion, which is charting new ground with complex and differentiated fabrics, fostering the emergence of novel aesthetic expressions. But the most far-reaching and radical implication of the additive paradigm — at least as a designer — is that is allows for fabrication of functionally graded materials (FGMs).

FGMs allow designers to customise components for a specific function down to their local material characteristics. They allow designers to make more efficient use of the materials, increasing effectiveness while being more sustainable.

WHY WE CAN’T JUST ‘PRINT A HOUSE’

So how does 3D printing relate to architecture? The prospect of eventually being able to “print a whole house” is currently firing the imagination of the construction industry. With the current
Technology, however, it would simply take too long and thus be too expensive to print architecture.

Architecture’s intrinsic “bigness” turns material efficiency into an imperative, fostering the development of ingenuous construction techniques. As a result of thousands of years of techno-cultural evolution, architecture has accumulated a wide range of processes, materials and components, each possessing its specific logic, implicit intelligence and applications.

This richness contrasts with the simplicity of current 3D printing processes, which are limited to the two-dimensional layering of material at a fixed resolution.

Speed can be increased, material properties tuned, and the worry about an impoverishment of the discipline dismissed as nostalgic — but the character of 3D printing represents a severe limitation at the building scale. The standardisation of the material deposition logic and printing resolution makes it difficult for the process to cope with the specific complexity of architecture.

Is there another option?

The Swiss Federal Institute of Technology has identified robotic fabrication as not just an alternative but, more importantly, an appropriate architecture equivalent to 3D printing. In robotic fabrication, complex custom processes of material deposition, manipulation and assembly are carried out by industrial robots.

While these robots are generic as a mass-produced machine, the fabrication process is specific. The physical manipulation of the material becomes a constitutive part of the design process.

This genre of robotic fabrication processes will foster the evolution of a rich variety of new material systems just as it updates traditional ones.

MORE VARIED HIGH-RISE DESIGNS

Robotic fabrication technologies are especially relevant to Singapore, as high-rise building forms have typified Singapore’s urban fabric.

Most of these Housing and Development Board (HDB) flats are assembled from prefabricated large concrete panels produced off the building site.

What robotic processes can offer is a completely new way of constructing HDB buildings.

This means that we will be able to build very differentiated building structures at exactly the same speed and quality as under the current prefabrication paradigm.

Most importantly, these design-specific processes will follow the desires and sensibility of the architect, instead of being determined by a piece of standardised machinery.

Although robotic processes are only used in traditional construction processes, such as bricklaying currently, it has the potential to become truly three-dimensional.
Researchers at the Future Cities Laboratory in Singapore have been working on applying robotic processes to constructing form-work, so that concrete structures can be fabricated on site.

This not only improves efficiency, but also allows for more design possibilities in high-rises, including the development of truly contemporary architecture — contributing to the liveability of Singapore.

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