

Ready to print?

3D printing has begun to make bold marks on the construction industry. MATT PACKER finds out where this building method is flourishing, and asks whether it is ready to replace bricks and mortar

Could the traditional brickie become a thing of the past? If we take at face value the buzz around the construction industry's move towards 3D printing, then the answer would appear to be an emphatic 'yes'.

Regular readers of *Project* may have noticed the news story in the Winter 2016 issue mentioning the imminent construction of a 3D-printed laboratory in Dubai. But that is not the United Arab Emirates' first foray into this brave new world of building: it already boasts a 3D-printed office, made by Chinese firm Yingchuang Technology, which covers 250m² and stands 6m high. Opened in May 2016, the facility heralded Dubai's aim to become a global hub for 3D-printing technologies by 2030. That ambitious vision includes plans for numerous other structures built in the same revolutionary way.

Other such projects that are either completed or pending a green light include:

- **CHINA** Specialist 3D-printing construction firm WinSun has won copious coverage with its innovative builds, including two courtyards in Shandong Province inspired by the Classical Gardens of Suzhou, a UNESCO World Heritage site. Perhaps even more impressively, the firm has also built a set of 10 houses in Shanghai that, it claims, were printed in a single day. As well as costing less than \$5,000 to make, each house was partially made from recycled industrial waste.
- **US** 3D-printing firm Branch Technology has designated 2017 as the year it will print its eye-catching Urban Architecture Studio. The concept came from global design outfit WATG, which won a Branch Technology contest to design the world's first 3D-printable, 'freeform' house. In keeping with that artistic brief, the project aims to rethink traditional aesthetics and ergonomics from the ground up.

- **NETHERLANDS** In 2013, award-winning Dutch architect Janjaap Ruijsseenaars announced plans to 3D print his 'endless house' concept: a novel structure based on a Möbius strip, a shape with no discernible beginning or end. In June 2016, Ruijsseenaars' firm Universal Architecture finally unveiled the task, designed by Italian 3D-printing technology guru Enrico Dini. Known as the D-Shape, it can print over areas measuring up to 6m².

LAYERS OF INNOVATION

So, how does construction-based 3D printing actually work?

"First, the building concept is developed in a computer-aided design program," says Konstantin Nefedev, spokesman for 3D-printing construction firm Apis Cor. "Then, using slicer software, it's translated into control code that directs the printer. Construction-based printers primarily use concrete mixes adapted for 3D printing. They have shorter setting

times, and can be sequentially layered to form the desired structure."

Nefedev explains that, while some construction printers typically create a building in modular parts that are later assembled, his firm's technology "utilises a mobile approach and can print houses as monolithic structures directly on site".

To give you an idea of what that machine looks like, imagine a small-scale crane fitted with a concrete-extruding nozzle, mounted on a pivot that elevates as layers are printed. Apis Cor's printer sits within the footprint of the structure it is working on. Other construction printers take a different angle, bestriding and overhanging the printing site so the work is all done from outside the perimeter.

"3D printing will make affordable housing available to more people around the globe," says Nefedev. "It will also make custom architectural designs available to the general public and increase the overall quality, speed, efficiency and sustainability of construction. Costs and the amount of manual labour involved in the process will be reduced, and sites will be much safer and cleaner to work in. Plus, automated construction will help to reduce the possibility of human error."

TOO MUCH TO LOSE?

All of this sounds great. But how long until it becomes industry standard?

Quite a while yet, according to Laurenz Kalthoff, business development chief at one of the construction sector's top market-intelligence firms, Building Radar.

"For 3D printing to really take off in the industry," he says, "equipment costs would have to decrease significantly. That's a major bottleneck. However, the biggest obstacle is the sector's tendency to sit back and wait until technology has been tested and proven to a satisfactory degree in other

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One of 10 houses Shanghai-based WinSun constructed from 3D-printed parts in less than 24 hours



ALAMY

The world's first functional 3D-printed building is in Dubai

A 3D-printed house at Suzhou Industrial Park in Jiangsu Province, China



industries. As such, 3D printing is unlikely to spur immediate, radical change throughout construction. Its growth will be slower, more incremental."

Here, we return to the issue of whether the industry's move towards 3D printing should be taken at face value. Kalthoff even goes so far as to say that there are "serious doubts" among experts over the capabilities of WinSun's technology, and that, because of the lack of proof that 3D printing works at scale, it is "not yet a viable means" of constructing habitable houses. In fact, he notes, many of the 3D-printing methods currently active in construction are in an "experimental state".

Only a handful of 3D-printed structures have been certified solid – such as the office in Dubai, which had to pass both UK and Chinese stability tests before it could welcome anyone in. So, is the message for project managers that this is very much a method in its infancy?

"Indeed it is: on one hand, because the technology has yet to be thoroughly developed, and, on the other, because the stakes in construction are so high that any delays or complications on any given site may trigger a lot of losses for different parties," says Kalthoff.

He elaborates: "Given the large investment volumes, long development cycles and tight deadlines in basically all

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 "Given the large investment volumes, long development cycles and tight deadlines in basically all commercial construction projects, too many parties have too much to lose to adopt technology that has yet to prove itself"

commercial construction projects, too many parties have too much to lose to adopt technology that has yet to prove itself. That is why construction firms are hesitant to pick up something like 3D printing. Expect adventurous architects to lead the way, because of the opportunity to profile themselves as innovative pioneers. "However," he adds, "I believe it's just a matter of time before we see the first habitable buildings created by 3D printers. Maybe three to five years – then another decade for the infrastructure to gain a foothold." □

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MATERIAL WORLDS

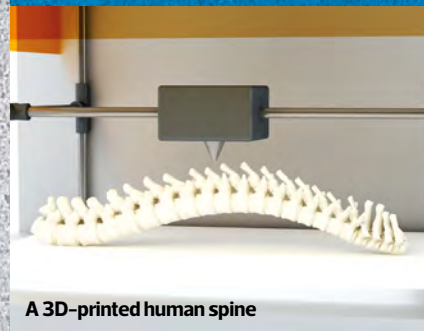
Five other areas where 3D printing has proven its versatility

FOOD

Michelin-starred Barcelona dining venue Enoteca crafts an array of exotic dishes with a 3D printer, while US Italian restaurant chain Ribalta prints a delicious pizza. Taiwan hardware manufacturer XYZprinting has emerged as the Morphy Richards of this field.

WOOD

Two firms are vying for supremacy in the race to popularise 3D-printed wood products: i.materialise, which uses powdered source materials, and 4 AXYZ, whose printing devices slot small pieces of solid wood together in intricate layers.



A 3D-printed human spine

ORGANIC TISSUE

Researchers at Wake Forest Baptist Medical Center, North Carolina, have printed samples of human bone, ear and muscle matter and implanted them into animals. Regenerative treatments for injured soldiers are their next goal.

CLOTHING

Dutch fashion designer Iris van Herpen has created catwalk styles and Björk stage costumes with shapes, volumes and textures that would be impossible to achieve with traditional tailoring. Print-to-order garments could happen.

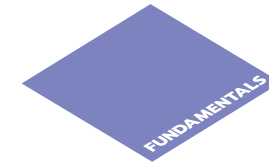
SOLAR TECH

Australian innovation hub the Victorian Organic Solar Cell Consortium has devised a way to print cheap, efficient solar panels onto rolls of flexible plastic, opening up a new avenue of energy resources for the developing world.



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