

Fast Forward: Disruption and the Singapore Economy

# Now printing: A revolution in how things are made

3D printing and data analytics boost manufacturing capabilities and smarts

Carolyn Khew and Joanna Seow

Engineers here are using 3D printing to make a drone that's lighter, flies better and powers itself on energy from the sun — three improvements that would be either very difficult or impractical using mainstream manufacturing methods.

That is why 3D printing is being hailed as a force in advanced manufacturing or Industry 4.0, which is set to revolutionise the way goods are produced.

And yet, many people — including those running manufacturing firms — fail to grasp its full potential, says Professor Chia Chee Kah, a global expert in this field and head of the Singapore Centre for 3D Printing at Nanyang Technological University (NTU). 3D printing is "not just about faster or cheaper," he says. "It's about being able to do things that were previously not doable."

The drone or unmanned aerial vehicle (UAV) cited above shows how. Work on it is being done by NTU researchers in collaboration with aerospace and defence conglomerate ST Engineering. They are using a composite material of mainly nylon and carbon fibre, a type of plastic, to make the UAV. 3D printing makes it possible to print the whole UAV using this composite material, also known as additive manufacturing, it is a process of making three-dimensional parts by adding materials layer by layer.

It is unlike traditional manufacturing where different parts of an end product are made separately using different materials, and the right adhesives have to be found to later join these different parts together.

The research team estimates that 3D printing has cut the time it takes to make one of their drones from a month to a week. With 3D printing, the researchers are also able to print electronics directly onto the UAV, so the drone can tap and store solar energy to fuel its flight.

"3D printing," says ST Engineering chief technology officer Feng Sak Hai, "allows for the fabrication of very complex lightweight structures that have the potential to improve UAV performance in terms of aerodynamics, speed and endurance." He adds that, "In the future, we may even be able to 3D-print UAVs on demand in order to meet specific conditions, something current technologies cannot do."

The additive manufacturing industry is expected to grow from US\$3 billion (S\$4 billion) in 2013 to over US\$21 billion in worldwide revenue by 2020, according to Wohlers Report 2014, an authoritative source on 3D printing.

However, it is not the only technology to disrupt manufacturing. Two other forces are the Industrial Internet of Things, which allows machines to talk to each other, and data analytics, which enables rapid, real-time responses in the manufacturing process. Taken together, these drivers of advanced manufacturing will impact whole industries in a big way, as well as individual firms and workers. What will be gained and what will be lost in the process?

**BECOMING MAINSTREAM**

3D printing has been in use for over 20 years. Early adopters include Boeing, which has since the mid-1990s used 3D-printed plastic parts on its planes and has to date installed more than 20,000 of these parts, says Prof. Chia.

In recent years, advances have been made in 3D printing technology for metal parts and industries have started to look at their use. Demand for 3D printing is expected to be strong in the aerospace, defence and medical industries and what drives it is the search for lower-cost, customised products.

US engine maker GE Aviation, for example, has made headlines with its 3D-printing make fuel nozzle tip — a product which used to require the assembly of 20 different parts but now can be printed at one go and has been approved by the US Federal Aviation Administration.

As for medical devices, there are now about 100 printed devices approved for use by the United States Food and Drug Administration. These include hearing aids and cranial implants.

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So widespread is 3D printing in Europe and the United States that a 2015 survey conducted by Sculpteo, a French 3D-printing company, found that one in four respondents



SI PHOTO LAU FOOKKING

**TECHNOLOGY OF THE FUTURE**

Many companies are not familiar with this technology and the potential of what it can do for their businesses. It enables the freedom of design. It's not just about faster or cheaper, it's about being able to do things that were previously not doable.

PROFESSOR CHIA CHEE KAH, who heads the Singapore Centre for 3D Printing at Nanyang Technological University, with a 3D printed impeller used in the marine, aerospace and oil and gas industries.

**Fast Forward series**

With Singapore firmly focused on the Future Economy, The Straits Times' series, Fast Forward: Disruption and the Singapore Economy, helps you make sense of the big shifts that will change our entire sectors, reshape jobs and change lives. Every Saturday for 12 weeks, the paper's journalists will examine a disruptive force, its likely impact on the economy and how soon that will be felt. The series will be sent to performance in terms of aerodynamics, speed and endurance." He adds that, "In the future, we may even be able to 3D-print UAVs on demand in order to meet specific conditions, something current technologies cannot do."

said 3D printing was used for production, not just prototyping or proof-of-concept purposes. These polled numbers over 1,000 and included chief executive officers, engineers and designers. Prof. Chia is confident Singapore is poised to follow suit. He predicts that in five years' time, 3D printing will become mainstream in production here. What will help is the large sum of S\$1 billion that the Government has set aside to build advanced manufacturing and engineering capabilities, under its Research, Innovation and Enterprise 2020 Plan.

and medium-sized enterprises (SMEs), for example, are better able to supply parts to multinational corporations (MNCs) at the right time, in the right quantity and with better quality control. Mr. Deng, who is also chairman and co-founder of the Singapore Manufacturing Consortium, is hopeful Singapore will create a smart manufacturing ecosystem for the whole industry, a move that "says to MNCs 'come invest here, we have data'".

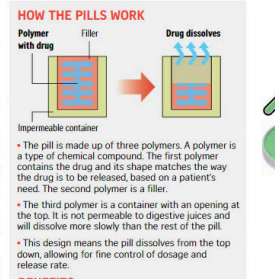
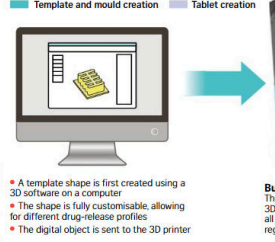
Over at the Agency for Science, Technology and Research's (A\*Star) Institute of High Performance Computing (IHPC), researchers are working with Sembcorp Marine and the University of Glasgow to tap simulation and modelling of data to design a new water-treatment

**A world of possibilities with 3D printing**

The additive manufacturing industry is expected to grow from US\$3 billion (S\$4 billion) in 2013, to more than US\$21 billion in worldwide revenue by 2020. From making customised hearing aids to bone implants and aerospace parts, the possibilities are endless with 3D printing

**3D PRINTED PILLS**

Devised by NUS researchers, customised prescription pills can also be made using 3D printing. We take a look at the process:



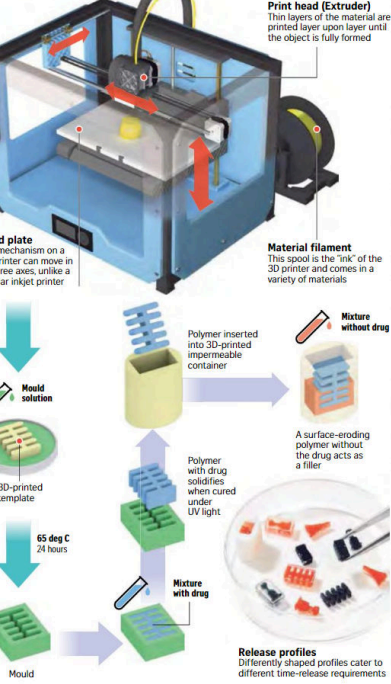
- BENEFITS**
  - Low cost
  - Technically simple
  - Versatile
  - On-the-spot creation
  - Customised to a patient's needs
- Controlled dosage and release rate
  - Multiple drugs can be combined into a single pill
  - Utilises commercial 3D printers

**OTHER BREAKTHROUGHS WITH 3D PRINTING**

**Biomechanical**  
Developed by NTU and A\*Star, the 3D-printed part is made of titanium and tantalum alloys, and can be used for hip or knee implants. The metal alloys help to improve its stress absorption.

**Aerospace - GE Aviation's fuel nozzle tip**  
Now 3D-printed in one piece instead of having to be assembled from 20 different parts, the fuel nozzle tip was approved last year by the United States Federal Aviation Administration. The lighter-weight nozzle tip will last five times longer, and will be used for its Leap jet engines.

**Biomedical sensors**  
NTU scientists are working on 3D-printing electronics on handgrips. This could act as a platform for sensors to find out how fast the sound is healing, or even be used for controlled drug release embedded within a drug patch.



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working with more than 30 MNCs and SMEs, mainly from the aerospace and heavy machinery industries, through its Advanced Remanufacturing and Technology Centre. ARTC provides a platform to embed smart manufacturing technologies, including 3D printing. It also works with companies to identify their needs and develop new parts to improve their efficiency.

It has, for instance, developed industrial heat exchangers that can be 3D-printed in as quickly as half the time than previously. These exchangers are used to cool oil refineries.

Working with firms here to develop and print such products helps them compete against rivals in the region without having to resort to price cuts, says ARTC technical director Nicholas Yeo. "Using additive manufacturing, local SMEs can compete in the high-value space where they are differentiated based on the products they make," he adds. MTI is committed to helping firms adapt to the new manufacturing landscape.

Continued investments in advanced manufacturing are necessary to maintain the sector's competitiveness and productivity, says its spokesman. As with any technology-driven disruption, some jobs will be at stake, but Prof. Chia points out that "3D printing is complementary to traditional manufacturing most of the time." That's because "as a rule of thumb, 3D printing is most suitable for high customisation but low-volume products, while traditional manufacturing is mostly for high-volume products," he explains.

Besides making production processes in sectors such as precision engineering and tooling more efficient, 3D printing increases business opportunities because of new products with complex shapes and features can be designed and printed, says Dr Ho Chua Sing, managing director of the National Additive Manufacturing Innovation Cluster.

And additive manufacturing is unlikely to completely phase out subcontractors. Forward-looking subcontractors who want to stay relevant in their business will have to look to invest in the right level of technology so that they can continue to differentiate themselves and service their customers in the right way, says Dr Ho.

Using the example of the video industry, Dr Ho says the reason Netflix has flourished as an on-demand streaming video content business, while Blockbuster is now a defunct brick-and-mortar video rental company which its peak had 9,000 stores, is that the former had foreseen and adapted quickly to shifts in customers' expectations through product innovation.

"Wherever it makes sense, subcontractors will always be needed," he says. "In order to provide end-to-end additive manufacturing services, these subcontractors will need to assess how to acquire the right level of expertise and infrastructure."

It is why 3D printing allows the manufacture of a product as an integrated whole, and data analytics allows manufacturers oversight over an entire production chain. The key to adopting a holistic approach to scaling the heights of advanced manufacturing, with researchers and businesses both local and multinational working together to gain the competitive edge, is the aim is to ensure manufacturing as a sector and those who work in it are not left behind. Just like the drone that kicked off this story and which, thanks to new technology, is lighter, faster and can stay in the air for longer.