Now printing: A revolution in how things are made

3D printing and data analytics boost manufacturing capabilities and smarts

Carolyn Khew and Ioanna Seow

Engineers here are using 3D printing to make a drone that's lighter, flies better and powers itself on energy from the sunthree impro ments that would be either very difficult or impractical using mainstream manufacturing

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 Chua Chee Kai, a global expert in this field and head of the Singapore Centre for 3D Printing a 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

Work on it is being done by NTL researchers in collaboration with aerospace and defence onglomerate ST Engineering. They ainly nylon and ultem, a type of 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 BD printing has cut the time it takes o 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 LIAV so the drone can tan and store

solar energy to fuel its flight. "3D printing," says ST Engineering chief technology officer Fong Saik Hay, "allows for the fabrication of very complex lightweight structures that have the potential to improve UAV erformance in terms of aerodynamics, speed and endurance." He adds that "in future, we may even be able to 3D-print UAVs on demand in order to meet

The additive manufacturing industry is expected to grow from US\$3 billion (S\$4 billion) in 2013 to over US\$21 billion in worldwide venue by 2020, according to rs 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?

RECOMING MAINSTREAM

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

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 i expected to be strong in the aerospace, defence and medical industries and what drives it is the search for lower-cost, customised

US engine maker GE Aviation, for example, has made headlines with its 3D-printed 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 About one-third of the world's aring aids are made here and Group, which makes the Siemens brand of hearing aids, among others, says 3D printing has been ised to make custom-made in-the-ear hearing aids at its

Singapore plant since 2003. With this advance, orders can be processed and shipped within a day. The raw impression of a client's ear can be scanned and modelled digitally and, once confirmed, the image will be sent to

the 3D printer and multiple hearing aids printed at one go. So widespread is 3D printing in Europe and the United States that a 2015 survey conducted by Sculpted a French 3D-printing company, found that one in four respondents



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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

Print head (Extruder) Thin layers of the material an printed layer upon layer until the object is fully formed Template and mould creation Tablet creation A template shape is first created using **Build plate** Material filament The shape is fully customisable, allowing

for different drug-release profiles

 The pill is made up of three polymers. A polymer is a type of chemical compound. The first polymer contains the drug and its shape matches the way the drug is to be released, based on a patient's need. The second polymer is a filler

The third polymer is a container with an opening at the top. It is not permeable to digestive juices and will dissolve more slowly than the rest of the pill.

 This design means the pill dissolves from the top down, allowing for fine control of dosage and release rate.

BENEFITS

 Technically simple • Vorcatile

On-the-spot creation

 Multiple drugs car be combined into a Utilises commercia

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 This spool is the "ink" of the 3D printer and comes in a

advanced manufacturing are necessary to maintain the sector's competitiveness and productivity says its spokesman.

OPINION | A43

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 testbed 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 car

be 3D-printed in as quickly as half the time than previously. These exchangers are used to cool oil

Working with firms here to

As with any technology-driven disruption, some jobs will be at stake, but Prof Chua 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

Besides making production precision engineering and tooling more efficient, 3D printing pecause of how products with complex shapes and features can oe designed and printed, says Dr Ho Chaw 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 alway look to invest in the right level of technology so that they can continue to differentiate themselve and service their cust right way, says Dr Ho.

Using the example of the video industry. Dr Ho says the reasor Netflix has flourished as an on-demand streaming video content business, while Blockbuster is now a defunct brick-and-mortar video renta company which at 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 asses how to acquire the right level of expertise and infrastructure."

Just as 3D printing allows the manufacture of a product as an integrated whole, and data analytics allows manufacturers versight over an entire production rocess, so Singapore is adopting a olistic approach to scaling the heights of advanced manufacturing, with researchers, public sector officers and pusinesses both local and multinational working together to

keep pace with change. The aim is to ensure manufac-turing as a sector and those who vork in it can keep flying high, jus like the drone that kicked off this story and which, thanks to new technology, is lighter, faster and

OTHER BREAKTHROUGHS WITH 3D PRINTING



Developed by NTU and A*Star, the 3D-printed part is made of titanium

Aerospace - GE Aviation's fuel nozzle tip Now 3D-printed in one piece

instead of having to be assembled from 20 different narts the fuel nozzle tin was approved last year by the United States Federal Aviation Administration

fast the wound is drug release if embedded within a drug patch

Biomedical sensors

working on 3D-printing electronics on bandages. This could

act as a platform for sensors to find out ho

NTU scientists are

Sources: ASSISTANT PROFESSOR SOH SIOW LING (NUS FACULTY OF ENGINEERING), NTU, MAKERBOT Photos: NUS, NTU, GE AVIATION STRAITS TIMES GRAPHICS

Release profiles Differently shaped profiles cater to

A surface-erodin

polymer withou the drug acts as

can stay in the air for longer. ough out the initial inv

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 shake up entire sec-tors, reshape jobs and change lives. Every Saturday for 12 weeks, the paper's journalists will examine a disruptive force its likely impact on the econo-my and how soon that will be felt. From robotics, 3D printing and smart buildings to dire demographic trends, the global skills revolution and the Asean growth story. Next week, find out more about smart hon

said 3D printing was used for production, not just prototyping or proof-of-concept purposes. Those polled numbered over 1,000 and included chief executive officers.

engineers and designers. Prof Chua 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 \$3 billion that the Government has set aside to build advanced manufacturing and engineering capabilities, under its Research, Innovation and Enterprise 2020 Plan.

Right now, large companies are taking the lead. Multinational technology and engineering giant Emerson Process Management 3D-prints valve components with designs that might not be possible with traditional manufacturing

processes. It plans to start printing such valve components here in the near future.

Valves serve as the "muscle" of a

production process, physically ontrolling the flow of materials says Mr Ron Martin, Emerson's president for Asia Pacific (Singapore). Better-designed valves help make production processes more efficient.

INCREASED CONNECTIVITY

Chemical company Denka Singapore uses steam to manufacture polystyrene resins. In the past, workers had to monitor the 8 steam traps in use by walking ough the facility with a portable tester. Now, a continuous stream o data from sensors on the steam is sent to be analysed remotely by equipment experts. Denka's steam consumption has gone down

NTU professor Yeong Wai Yee developed a 3D-printed drope together with ST Engineering. PHOTO DANIEL NEO FOR THE STRAITS TIMES

by 7 per cent as a result, an example of how data analytics improves the manufacturing process. "This allows issues to be detected in minutes, and corrective actions can be recommended faster, before these issues turn into big problems," says Mr Martin of Emerson, which provides remote monitoring services to Denka Having a fully interconnected

production system gives firms greater control over the schedulir of manpower, inventory and production, says Mr Willson Deng. chief executive of start-up Arcstone, which provides analytic

and medium-sized enterprises (SMEs) for example are better able to supply parts to multi-national corporations (MNCs) at the right time, in the right quantity and with better quality

> 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 tha 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 Sembooro Marine and the University of Glasgow to tap simulation and modelling of data to design a new water-treatment

process for ballast water used to stabilise shins at sea The water can carry invasive species such as bacteria and

microbes from one part of the world to another, causing ecological problems. Using data, more accurate models can be built to test product: and processes virtually befor totypes are made and

saving time and money. The models can simulate harsh conditions like those faced by vessels at sea or in the sky to test different scenarios and predict tcomes, says IHPC's executive rector, Professor Alfred Huan. Given the transformative power the industrial Internet of Things

(IoT), a national effort is on to

developing and testbedding

of Trade and Industry (MTI) says. It cites the Manufacturing Control Tower at A*Star's Singapore Institute of Manufacturing Technology. This tower will deploy IoT and sensor technologies to create a networked production environment, providing manufacturers with a panoramic

oversight of the production chain IMPACT ON SURCONTRACTORS

As with any disruptive technology both data analytics and 3D printi upturn old ways of doing things. Some SMEs that have for years at risk of being phased out of the production process when big players at the top of the

manufacturing infocommunications manufacturing chain shift towards and IoT technologies which could play a critical role in developing Factories of the Future, the Ministry 3D printing. GE Aviation's move to 3D-print

example, led to the phasing out of subcontractors which used to make different parts of the nozzle tip.
That is why government agencies here are hard at work helping local SMEs adapt to this new technology and ride the wave of change. Small firms are unlikely to experiment on

cost of buying one.

their own since a 3D printer can cost millions of dollars, and that is not counting the cost of integrating the printer into the supply chain. At the National Additiv Manufacturing Innovation Cluster, SMEs are able to gain access to the industrial printers in local universities without having to

A*Star has also stepped in. It is

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 CHUA CHEE KAI, who hear