

THE REVOLUTION WILL BE 3D PRINTED

Imagine a world in which gadgets aren't made by hand or constructed by robots, but printed. In one piece. In your own front room. It's going to happen – and sooner than you think

Words Stephen Graves MakerBot pics Matthew Beedle

Holodecks, hoverboards, gravity guns. Just a few of the sci-fi gadgets we're still waiting for. But we do have the *Star Trek* replicator, or rather its real-world equivalent: 3D printing. OK, so you can't yet rustle up a baguette from thin air, but in the next few years it's going to revolutionise manufacturing and change everything from the way you do your shopping to the way you fix your washing machine. Of course, it won't be good news for everyone. Physical products being replaced by digital files? We've been here before, as the music industry will attest. Turns out ones and zeroes are a lot easier to pirate than atoms. But then again, living in the future was always going to require sacrifices... ▶



For a tech that's so hot right now it made *Stuff's* Cool List last issue, 3D printing is surprisingly venerable. It was born in the 1980s, in fact, when the excitingly named Fused Deposition Modelling was invented. Given that its official title now is the only slightly sexier 'additive manufacturing', it's probably just as well someone thought up the term '3D printing'.

Whatever you call it, the process involves creating an object by building up layers of material, rather than by carving them out of a block. Home hobby devices such as MakerBot's Replicator use reels of thin plastic cable for this task, while industrial setups such as Objet use an inkjet head to spray UV-sensitive plastic before curing it with UV light. Another method, called laser sintering, sees layers of powdered metal fused together by a — you guessed it — laser. Designer Enrico Dini has even created an architectural 3D printer that can produce entire buildings from sandstone.

The technique may vary, but the result is the same — a super-exciting technology

Practical magic

Away from the home, incredible advances are already being made. When building Concorde in the '60s, aircraft engineers had to painstakingly mill aluminium to create lightweight but ultra-strong components. Now, companies such as EADS Innovation Works are able to get similar results with a few button presses on a 3D printer. British bike company Charge has already produced dropouts (the bit your bike's rear wheel attaches to the frame with), hinting at the imminent possibility of a 3D-printed bike.

"There's almost no geometry that we can't print," says Andy Middleton, European head of 3D printer manufacturer Objet. "I have this example on my desk — 24 gears that fit into each other in a spherical shape, with no assembly taking place at all. It's an almost insurmountable task for conventional methods."

"You see some fantastic things, like tables and stools that can fold and change shape — and they're all printed in one piece," says Jeffries. "There is no way of doing that other than 3D printing."

Supply and demand

The process is about to turn manufacturing on its head too. Conventional practices such

"THERE IS ALMOST NO GEOMETRY WE CAN'T PRINT" ANDY MIDDLETON, OBJET

that's potentially the most revolutionary since the birth of the internet. All we need now is a Google moment...

There's no place like home

In the early days, 3D printers were huge and expensive. Even the cheapest are still the best part of a grand, but they're now small and sleek enough that the likes of the Cubify Cube and MakerBot could sit neatly on your desk next to your iMac.

"Look at 2D printing," says Robert Jeffries, 3D technical specialist at Inition. "For a long time you used to have to go to a reprographics centre to get prints done, because you just couldn't afford a printer. I think the next wave of 3D printing will be based on more accessible bureau centres, so that in every city or town there'll be a place you can visit for 3D prints. Eventually it will filter down to the home."

For now, home 3D printers are the preserve of geeks and hobbyists — and the low-definition plastic objects they produce are mainly curios. But the tech is promising to become much more sophisticated.

as injection-moulding need large production runs in order to make them cost-effective. But with 3D printing, you can produce a much smaller number of products without the wastage that would normally entail, opening the door for people to produce personalised items for a limited audience.

Services including Shapeways, Cubify and Sculpteo are springing up, letting you upload 3D files and have your objects produced in a professional 3D printing setup. As well as being handy for you, they're good for the environment — rather than ship products from overseas manufacturing plants, businesses can just ping 3D files to regional plants for local manufacture and distribution.

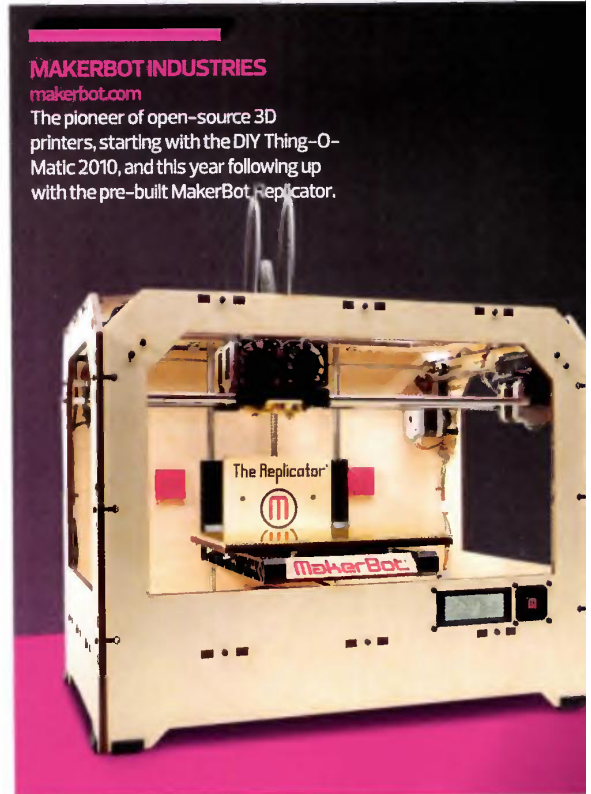
Going spare

Another plus is that 3D printing does away with the need for warehouses full of spare parts. Let's say your washing machine breaks down — big deal, the manufacturer can just send you the 3D printer file for the relevant component, you can take it to a 3D printing service, and you'll soon have your

MAKERBOT INDUSTRIES

makerbot.com

The pioneer of open-source 3D printers, starting with the DIY Thing-O-Matic 2010, and this year following up with the pre-built MakerBot Replicator.



SCULPTEO

sculpteo.com

This French service lets you design or upload 3D creations to its site in most file formats, then pops a three-dimensional version in the post to you.

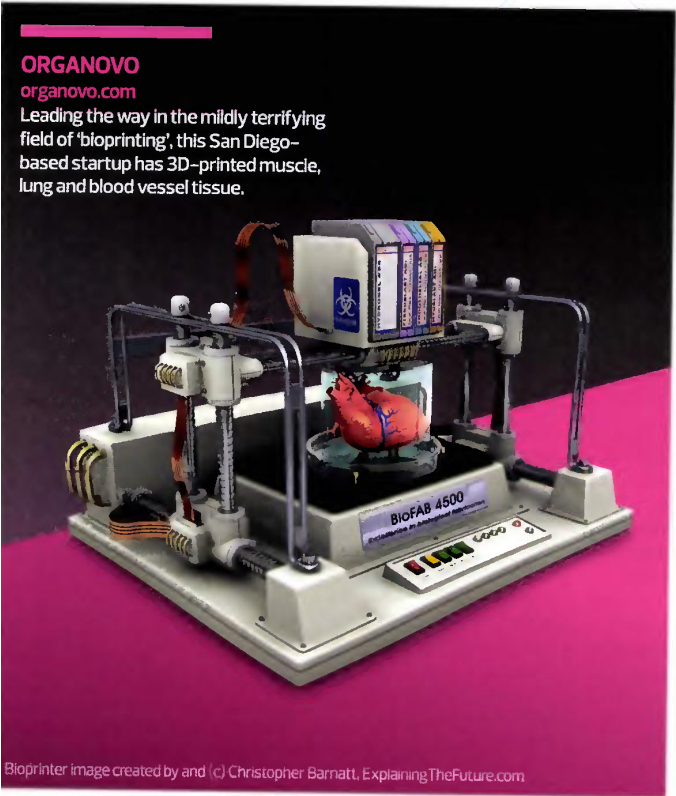




CUBIFY

cubify.com

The Cube's makers also offer an online store that lets 'Cubify artists' sell 3D designs or print models with its Cloud 3D Print Service.



ORGANOVO

organovo.com

Leading the way in the mildly terrifying field of 'bioprinting', this San Diego-based startup has 3D-printed muscle, lung and blood vessel tissue.

Bioprinter image created by and (c) Christopher Barnatt, ExplainingTheFuture.com

good slacks ready for your in-laws' visit. A few years down the line, you'll even be able to print it yourself. Although whether you can fit it on your own is a different matter.

"People have created spare parts for a coffee machine," says Clément Moreau, director of Sculpteo. "What surprised us was that the spare part was made available as a public object on the website and that other people have now reordered it."

But don't go thinking you can just print off your own spares for anything. "That assumes many things," says Middleton. "One: that the specifically approved materials are available. And two, how does that affect the manufacturer's warranty or guarantee on that part?" But if those issues can be overcome, a brave new world beckons: "The next step will be that brands will finally understand that they don't need to create spare parts by themselves," says Moreau, "they just need to push the 3D file on to one of the platforms."

Bespoke too soon?

One of 3D printing's most exciting features is the ability to create bespoke, customised products. Already, firms including Sculpteo and Shapeways let you add a personal touch to products – creating a world in which narcissists can pop a 3D profile of their face on to a mug and hipsters can turn a sound wave into a customised iPhone case. A bit gimmicky? Sure, but the possibilities are endless – 3D printing has even been used to create a customised jaw transplant for a woman who'd had part of hers removed due to cancer.

Fortunately for designers, we will still need their expertise. Let's face it, the second anyone starts bandying around terms such as 'mechanical stress' and 'tolerances', most of us will glaze over and start thinking about whether to have chips or curry for dinner. And nor is a few rounds of *Draw Something* a substitute for artistic talent. "Even if 3D printing gives you the right tools, it doesn't make you a designer," says Moreau. But the relationship between you and the product designer will change.

"The designers will be more of a service to the buyer," says Middleton. "Rather than the designer saying, 'This is the design, take it or leave it,' it will change to the customer saying, 'This is what I want, can you do it for me?' So the balance will shift to the consumer." Take that, Sir Jonathan Ive.

Let's get physible

Beyond revolutionising the Christmas present, 3D printing's biggest impact will arguably be to turn many manufacturers from traders in physical products to information brokers. Their key resource will not just be the products they sell – it will be the information that describes those ▶

3D PRINTING: WHO'S WORRIED?

GAMES WORKSHOP

games-workshop.com

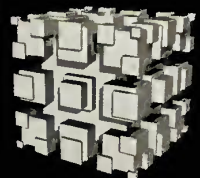
Games Workshop sells expensive solid objects with no moving parts, to people that tends towards the geeky – so it's not too surprising that their miniature designs were copied and uploaded to Thingiverse.



PARAMOUNT PICTURES

paramount.com

When 3D printing fan Todd Blatt uploaded a replica of the alien cube prop used in the film *Super 8* to Shapeways, he was slapped with a cease-and-desist from Paramount Pictures within 18 hours.



IKEA

ikea.com

If it's not worried about 3D printing yet, the Nordic furniture maker should be. Its business model is built around warehouses full of cheap plastic goods – the sort of thing at which 3D printing excels. Still, they'll always have the meatballs.





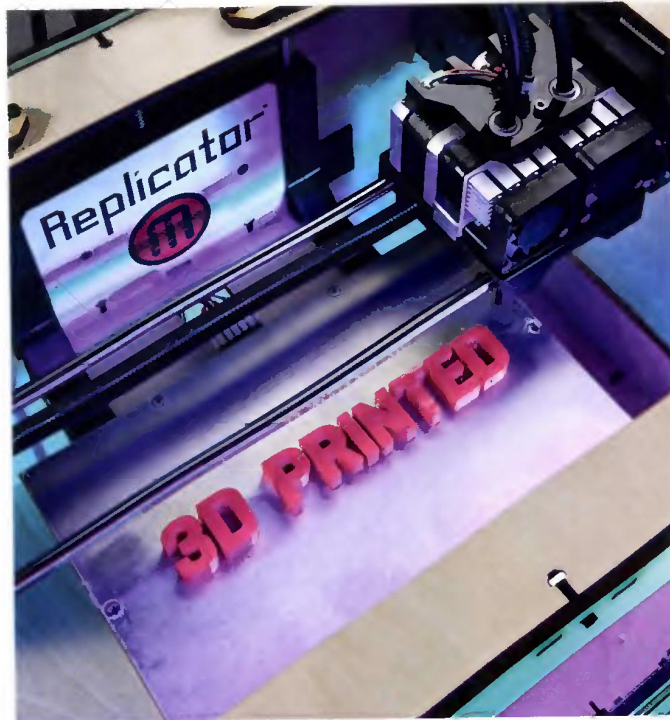
products. And information can be copied and distributed very easily on the internet.

The Pirate Bay has already sailed into these choppy waters, launching a new section for 3D printer files – or 'Physibles', as the site's dubbed them. Oddly, one of the first businesses to be affected by the arrival of Physibles is Games Workshop – the chaps who create those little metal orcs and goblins for tabletop wargames (don't pretend you don't remember).

In 2011, it discovered that someone had been creating tanks and Space Marines for Warhammer 40,000 that were based on the company's designs, and sharing them on the 3D printing website Thingiverse. Games Workshop swiftly moved to shut down the pirates, stating that "We are very protective of our intellectual property." Almost exactly the same response as that of the record companies to Napster, then.

Copyright infringement is only the start of it. When home 3D printers become sophisticated enough to create working machines, users will start having to worry about patent infringement. If you thought the tit-for-tat games of Apple and Samsung were holding innovation back, just wait until the patent trolls start targeting ordinary folks who've unwittingly broken the rules with their home 3D printers.

"A lot of industries that are focused on making physical things are going to face a similar dilemma to that faced by creative industries in the last 10 years – there's going to be a new way to distribute their key product," says Michael Weinberg, author of the 3D printing white paper *It Will Be Awesome If They Don't Screw It Up*. "They can spend a lot of time and money fighting that change, or they can spend less time and money making use of that change."



The USS1750 MakerBot Replicator does its thing. We were going to program it to print this entire feature, but unfortunately we ran out of plastic.

Stuff says

The seismic digital waves that have swept through the music and movie industries are starting to rumble manufacturing – and will ultimately have the same revolutionary impact. As 3D printing becomes more widespread, copyright and patent infringement wrangles will grow, and only manufacturers willing to embrace it will survive. For them, it's disruptive change. For us, a brave new world of personalised products and collaborative design awaits. And some really great Christmas presents. ■

3D PRINTING: WHO'S LOVING IT?

EADS

eads.com

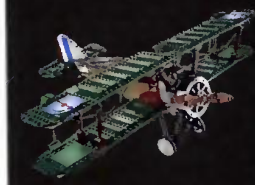
Aerospace and defence manufacturer EADS has created the Airbike: a nylon bicycle that's stronger than steel or aluminium. The wheels, axle and bearings were all built inside the bike during the printing process.



LEGO

lego.com

Lego's bricks are out of copyright, so anyone can make one so long as they don't use its logo. Its value instead lies in its brand, community and platforms such as ReBrick (rebrick.lego.com). Other companies could learn a lot from it.



IRIS VAN HERPEN

irisvanherpen.com

The designer behind some of Lady Gaga's outlandish couture makes intricate dresses in Photoshop, then turns them into 3D models with the help of an architect. The 3D printing firm Materialise then renders them in polymer.



HOW THE EXPERTS THINK 3D PRINTING WILL CHANGE THE WORLD

Clément Moreau

Founder, Sculpteo
All products will become customisable



"Big brands will integrate 3D printing into their offering, because it enables them to create a unique experience for the customer. Take the iPad for instance: the electronics will be manufactured the regular way, but some parts of the object will be 3D printed – for example, the cover and the casing – and can be offered with a lot of diversity."

Limor Schweitzer

Founder, RoboSavvy
3D printing will let you make your own spare parts



"At the moment, 3D printing is about creativity. In the future, it'll be about printing replacements for broken parts. Soon, I'll be able to get my phone, take a picture of the part, and my phone will tell me, 'That's part CB2792, you can source it from here, it costs £7 – or you can 3D print it, and here is the 3D model, which costs 20p to license for a single unit!'"

Michael Weinberg

Vice President of the Institute for Emerging Innovation at Public Knowledge
3D printing will create new ways of distributing products



"Industries will no longer be able to conduct business as usual. I hope that when faced with this opportunity these industries learn something from the hard lessons that the music and movie industries have learned and really try to embrace this change."

Dejan Mitrovic
 Founder, Kide
3D printers will teach children how to create their own toys



"Kide (playkide.com) is about introducing kids to design, and about empowering them to express their creativity. I believe that every kid is creative – they just need to have a tool which allows them to express themselves, and that's exactly what I'm aiming to do with 3D printing."