3D printing may seem surprisingly straightforward, but there are moral, business and technical issues that must be addressed before it becomes a part of everyday life.
By **Kris Sangani**

Make it to fake it

WHILE THEY MAY be predicted to disrupt current manufacturing models, 3D printing technologies are slowly beginning to infiltrate the consumer market. Makerbot was the first 3D printing manufacturer to bring out a sub-£1,000 model. Most recently, high-street retailer Maplin has been selling a 3D printer for only £700.

However, the term 3D printing conjures up images that the technology will be as simple to use as a normal inkjet or laser printer. This is far from the truth. Firstly, you will be dealing with the kind of issues that anyone has to deal with when creating solid objects. This will, among other things, require a significant amount of knowledge of computer-aided design (CAD) principles, which will require the user to invest time in developing their ideas into 3D objects that they intend to commercialise or use for personal consumption.

Nevertheless, 3D printing has captured the imagination of many would-be designers. Inventors can now see an easy avenue into bringing their designs and inventions to life in order to demonstrate them to the world, or to simply create one-off products for themselves which would never have mass market appeal.

Crowdfunding website Kick Starter is full of examples of designers and inventors who have created interesting devices and designs using some form of 3D printing. The website is eagerly touting these to get further funding to commercialise these products.

The Web is also awash with novices' attempts to create objects from computer-aided designs which do not work. They flop, warp or just look plain weird.

There are other minefields to consider for the industry as a whole. What is stopping somebody from scanning an existing design and creating a 3D CAD file from an object that is copyright, trademark or IP (intellectual property) protected? Would the organisation or person doing the actual printing find themselves liable for some form of IP infringement?

'We are familiar with the designs of the open-source 3D printable guns, and we can easily spot them'
Nick Allen, 3D Print UK

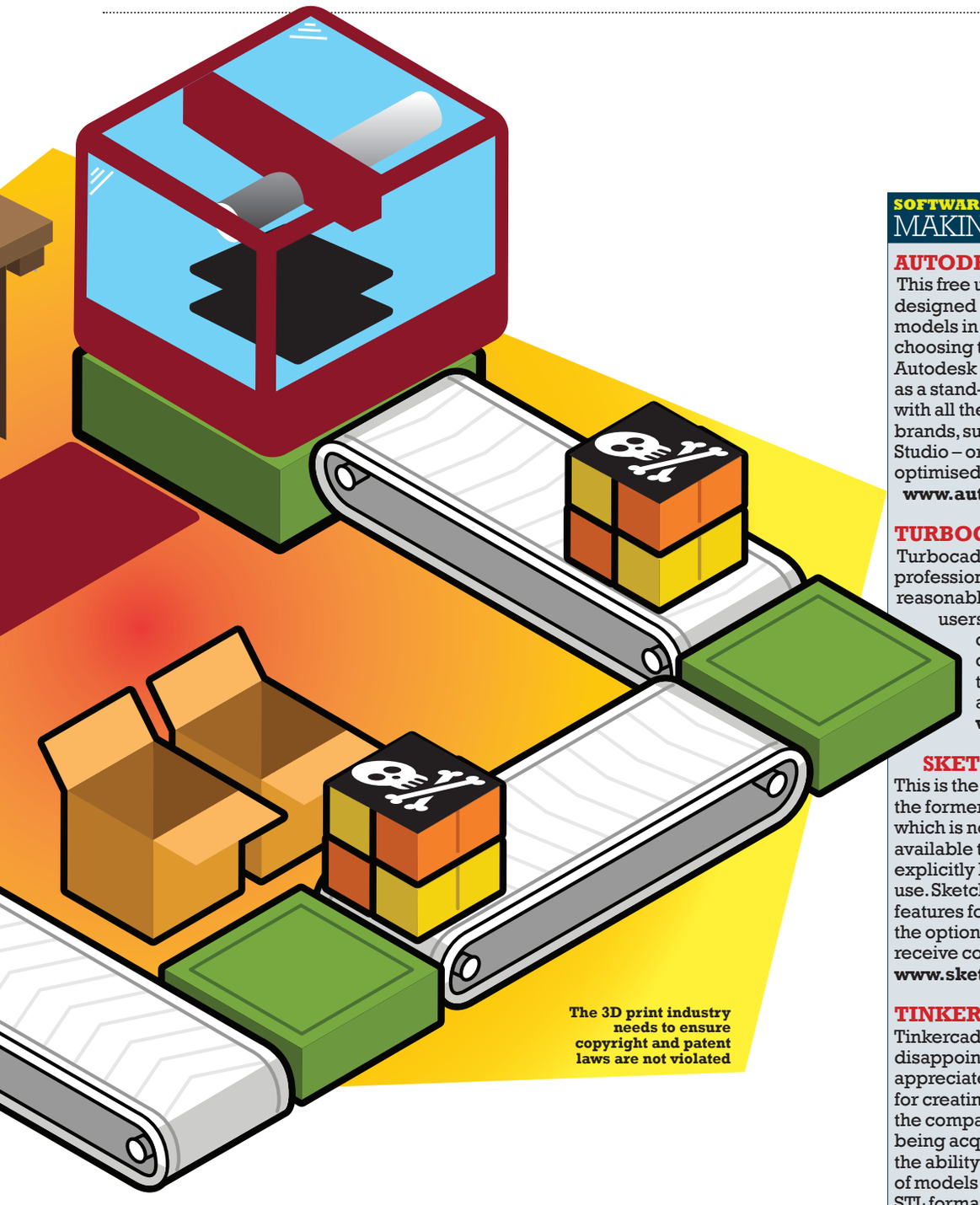
Contending with immorality

Gun advocate Cody Wilson created an open-source gun design that could be printed with an additive printing method. The design is now out there in the public domain and available on file-sharing websites among other illegal software and pirated media content.

"We are familiar with the designs of the open-source 3D printable guns, and we can easily spot them," says Nick Allen, founder of 3D Print UK, a 3D print bureau service based in South London.

Haydn Insley, manager of Fablab Manchester, a facility where anyone can be

CORBIS



The 3D print industry needs to ensure copyright and patent laws are not violated

trained in and use 3D printing equipment, points out that users at his facility are "closely monitored" for health and safety reasons.

There are other moral issues to contend with. For instance, the most unusual object that Allen has been asked to reproduce was a user-designed avatar from the online virtual world 'Second Life' which had six penises.

In the grand scheme of things, when you consider the firearm designs out in the world, Allen's company agreed that printing such an object for a user's personal consumption was acceptable.

It's possible, however, that these unusual requests may become more commonplace. Popular 3D-printing file-sharing site 3Dprinter-world.com states clearly on its usage policy that designs that are deemed 'not safe for work' are not acceptable. It cites a hypothetical example of "a 3D printable statue of a naked female contortionist seen from a compromising angle".

Another matter of obvious legal concern is that 3D printers may allow people to easily and secretly duplicate patented and copyrighted objects. A person could print up copies of toys, miniatures (for games such as Dungeons and Dragons) and parts. Thus, 3D printing at home will give people the ability to do with objects what they have been doing with music, movies and software, namely engaging in 'solid piracy' or '3D piracy'.

Copyright infringements

In the case of printing an object, a person is not stealing the physical object from the manufacturer. If one were to print a copy of a copyrighted action figure, for example, this is rather different from going to a toy shop and shoplifting that miniature.

Beatriz San Martin, a partner at law firm Field Fisher Waterhouse, points out that there could be "a bit of a grey area" when copying a component as the law has not yet been tested in relation to 3D printing.

"If you produce an exact copy of an action figure, then you are breaching copyright, >

SOFTWARE

MAKING IT WORK

AUTODESK 3D PRINT UTILITY

This free utility, A3DP for short, is designed specifically to print your models in 3D. You can use it by choosing the '3D Print' option in the Autodesk 123D apps or you can open it as a stand-alone application. It works with all the big 3D printer hardware brands, such as MakerWare or Objet Studio – or you can simply save the optimised 3D model as an STL.
www.autodesk.co.uk/a3dp

TURBOCAD

Turbocad is another full 2D/3D professional suite and is also very reasonably priced. Most novice users may find its interface too complicated, but with a strong community of users online there will always be someone available to lend a helping hand.
www.turbocad.com

SKETCHUP MAKE

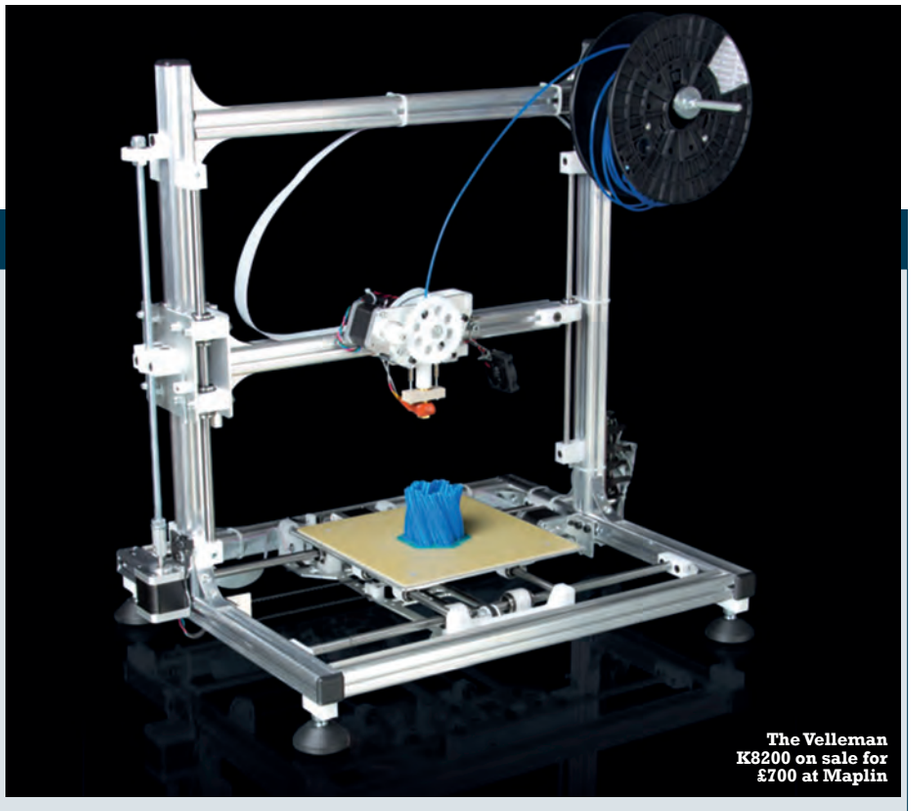
This is the free version of SketchUp, the former CAD startup from Google which is now owned by Trimble. It is available to the public at no cost, but is explicitly limited to non-commercial use. SketchUp Pro provides additional features for professional use. Users have the option to pay a $95 annual fee to receive continual support and upgrades.
www.sketchup.com

TINKERCAD

Tinkercad shut down in March to the disappointment of many makers who appreciate its simplicity and ease of use for creating 3D models in the cloud. But the company is back in business after being acquired by Autodesk. Users have the ability to store unlimited numbers of models and to import 3D meshes in STL format and 2D files in SVG format for editing within Tinkercad. Users will even have access to shape-scripting tools for generating 3D models parametrically.
www.tinkercad.com

CARRARA 8

This is a complete CAD solution at a budget price. It breaks down the stages of the modelling and creation processes simply. The software has been around for almost 30 years and has enthusiasts from professionals to amateurs, who are attracted by its amazing power to price ratio.
www.carrara.com



The Velleman K8200 on sale for £700 at Maplin

HARDWARE

THE PRINTERS

VELLEMAN K8200

At a price of £699 (including VAT), this DIY 3D printer kit can create objects up to 20x20x20cm using PLA or ABS filament (3mm plastic wire). The build-it-yourself product can handle printing at high speeds (300mm/s) and is compatible with all free RepRap software and firmware. It is made out of aluminium profiles and is easy to assemble. It leaves room for the user to freely alter the machine and modify it to their liking and also has a heated print bed.

STRATASYS FDM

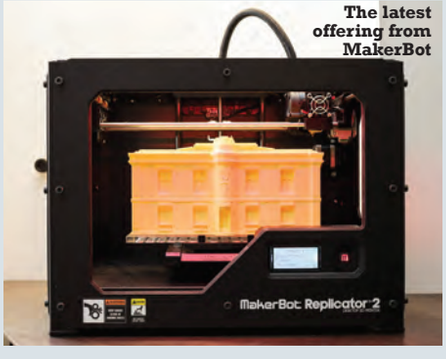
Fused deposition modelling squirts melted thermoplastic through nozzles to build up a model layer by layer. The Stratasys machines can dispense a variety of plastics in 130µm layers, plus a second disposable material as a support structure, and are intelligent enough to automatically create an internal scaffold. Similar technology is also used in a number of other 3D printers, most notably the open-source RepRap project, which started out at the University of Bath. RepRap-derived printers are sold commercially by MakerBot Industries, among others.

SELECTIVE LASER SINTERING

SLS uses powerful lasers to melt together a fine plastic, ceramic, glass or metal powder, gradually adding and scanning layers of powder to build up the part. It needs no support material, as the sintered part is surrounded by unsintered powder. Although the result is made up of grains of material sintered together, it can be remarkably robust, allowing SLS to be used for short-run manufacturing.

MAKERBOT

Makerbot's fourth generation machine has a resolution capability of 100 microns (as thin as a standard sheet of copy paper) and has a 410 cubic inch build volume, it is also compatible with 1.75/1.8 mm PLA filament. The Replicator 2 can create 37 per cent more volume than the original MakerBot Replicator that can be used to make bigger products or entire multi-part projects at one time; it has also been given speed improvements. By using PLA filament the Replicator 2 uses 32 per cent less energy than building with ABS plastic. It sports a powder-coated, industrial-strength steel chassis. The powder-coated steel is also resistant to changes in temperature and humidity.



The latest offering from MakerBot

ZCORP ZPRINTER

These lay down layers of powder, then print a binder (glue, in effect) on each layer. Resolution varies from 100µm to 400µm, depending on the machine. The bound powder builds up into a plaster-like object, while the unbound powder can be shaken, brushed or blown away and re-used. ZPrinter is unusual for its ability to print full-colour models. It is also fast and the material is cheap. The resulting models are not functionally robust, however.

OBJET

A photosensitive liquid plastic is delivered in layers as fine as 16µm using an inkjet-based print head, then cured with ultra-violet light. The company offers 17 different polymers with widely varying properties, and the technology can print multiple different materials within a single model. The machine can automatically add support material which is then washed away in post-processing.

3D SYSTEMS PROJET

Models are built by scanning a UV laser across layers of a liquid photopolymer, which cures into a hard and durable acrylic with a melt-away wax support material. These printers can have resolutions as high as 16m, although the company also offers desktop Projets with lower resolutions, print speeds and print volumes.

ENVISIONTEC PERFACTORY

A DLP (digital light processing) projector shoots voxels – volumetric pixels – into a vat of liquid photosenstiive resin. Voxels can be as small as 16 micron cubes. It produces very fine models, but there is no separate support material so any supports needed for the model must be manually cut off in post-processing. It can print materials.

By Robbie Graham and Bryan Betts

< but if you create a spare part for a broken figure that 'may' breach copyright if the originator's business model included repairing action figures themselves as part of their business model."

In practice, it would be rare for a toy company to bring action against someone who uses a 3D printer to create a spare part and, points out 3D Print UK's Allen, there are far more economical ways to repair an action figure.

In the medium-term, rather than consumers buying 3D printers to use at home it is far more likely that consumers will be using a 3D print bureau service or their local fabrication laboratory.

Fabrication laboratories

Fab labs are small-scale workshops equipped with computer-controlled tools including, but not limited to, 3D printing equipment that can make almost anything from a digital design easily and with assistance on hand. Fab labs were developed in US by the Massachusetts Institute of Technology and there are now more 250 around the world.

The UK's first Fab Lab opened in Manchester in March 2010 and is owned by The Manufacturing Institute. The services they offer are low cost in comparison to traditional tooling methods and ideal for producing prototypes or bespoke items unsuitable for mass production.

Manchester's Fab Lab has over 1,500 registered users. During the week, the centre helps businesses to prototype and design products. But over the weekend it is open to anyone to develop designs on the understanding that these are open source.

Haydn Insley demonstrating 3D printing at Fablab Manchester

"Part of a user's commitment is to be prepared to share the object throughout the fab lab network," explains Insley.

Users are encouraged to document their designs and create instructions so that others around the world can recreate the objects using 3D printing technology.

Getting to grips with 3D

The media hype would suggest that virtually anything can be printed on a sub-£1,000 3D printer, but this is not the case. "I spend a lot of my time advising clients on how to create designs that are 3D printable," explains Allen.

Additionally, CAD software can be very expensive. A single user license for Autocad 2014 will set you back more than £4,000. However, there is open source and less expensive software available.

Even so, you will require knowledge of the various materials and 3D printers to make sure that your design will be printable by a certain device. This is where the guidance of bureau services such as 3D Print UK or the technicians at your local fab lab will come in handy.

Allen is also keen to temper the ambitions of would-be entrepreneurs who may think that 3D printers could replace traditional manufacturing. He says this does not make sense if you want to mass manufacture.

"Just because you're a good cook doesn't mean that you would be able to run a kitchen in a busy restaurant," is his apt analogy. "3D printing is great for creating a proof-of-concept product, but the design would have to be completely re-engineered for mass manufacturing. We constantly have to educate clients to this important fact."

Thus it will be a while before 3D printers have a significant impact on existing manufacturing models. Manufacturers will still be making products on a conventional production line that has not really changed massively in the past hundred years or so.

With the increase in fab labs and 3D print bureau services available to those who may not have conventional engineering skills, it's not just the technical skills that the industry will have to contend with. Moral and legal issues will also be encountered by these hobbyist inventors who will not have access to expensive lawyers.

In the same way consumers are being educated the hard way through legal threats on the problems with downloading music and video files, they may find similar legal threats if they think they can just scan in a model of their favourite action hero and print it at their local store or at home. *

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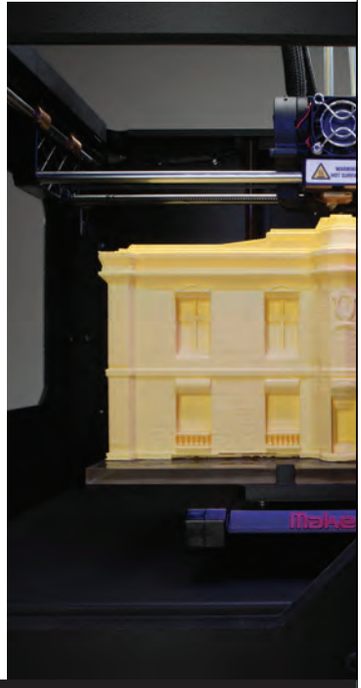

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