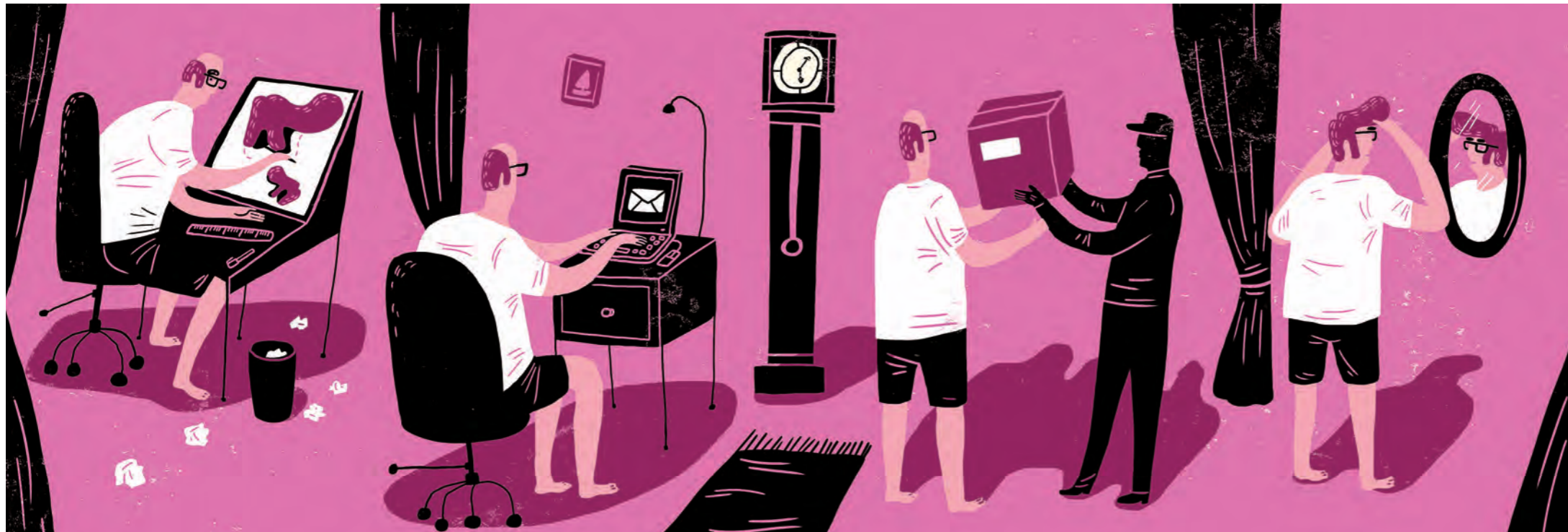


The Connected Business

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Power to the people on product design

The web is enabling smart ways to make inventions real and involve customers in development plans, writes *Richard Waters*

Reaching break-even on a new car programme when vehicle sales approach 100 would sound like a pipe-dream at most automobile companies.

That is not the case at Local Motors, an automaker based in Arizona. The rugged, off-road Rally Fighter has already hit that target, says John Rogers, chief executive: sales from here start to make a profit.

It does not hurt that the car, which cost \$3.5m to develop, sells for an average of \$120,000, including optional extras. But the company would not have got to this point were it not for a radical new business approach that is also seeding wider experimentation among other manufacturing and online start-ups and starting to percolate up into the thinking of more established companies.

Companies such as Local Motors hope to draw their customers into their product development and make a long-held dream in manufacturing – mass customisation – a reality.

Traditional car companies “have

lost the ability to innovate based on what people want,” says Mr Rogers, who adds that he is fighting the “jugernaut of scale”.

Local Motors’ tiny production runs will not give the world’s big carmakers any sleepless nights, though its business model highlights new methods that are behind a wave of hardware start-ups.

Two elements have combined to get the company to this point. The first involves the harnessing of an online community of enthusiasts to act as a combination of idea generators, designers and early customers.

Crowdsourcing – also known as co-creation – is nothing new in industries such as software, where the open-source movement first came to prominence with the rise of the Linux

operating system a decade and a half ago. It has taken longer to move into the hardware world. But new ways of moving from design, through rapid prototyping to full production have changed that.

“Part of this is about the democratisation of design, where people have got more access to design tools that are increasingly inexpensive,” says David Stonehouse, technology and innovation expert at PA Consulting. “With the development of 3D computer-aided design (Cad) tools such as SketchUp on the web, and schoolchildren starting to play with 3D printers, everybody believes they can be part of the design process.”

Quirky, a New York-based company that uses crowdsourcing to build consumer products, has come up with

more than 100 based on designs suggested by its outside inventors, from simple plastic kitchen utensils to a WiFi-controlled air conditioner developed in partnership with General Electric.

Other companies offer variations on the theme. For example, designers can send their 3D files to Shapeways, based in New York and the Netherlands, choose from a range of materials and then wait for the postman to deliver the real thing, made on the company’s sophisticated 3D printers.

Designers can also set up a shop on the Shapeways website, and the company will 3D print the product each time an order is received.

A key element in the success of

Continued on Page 3

Consumer WiFi routers may be best route for smaller companies



Paul Taylor

Small businesses typically do not have IT departments to take care of their technology requirements, forcing them to rely instead on consultants and value added resellers whose interests may, or may not, be aligned with their own.

One increasingly popular alternative for smaller companies seeking to avoid the pitfalls of owning their own IT infrastructure is to use cloud-based services. Unfortunately, however, that is not always possible.

As the unofficial technology adviser to my son’s expanding UK-based ecommerce business, I get to see these problems up close and personal.

For example, when my son wanted to move his financial, HR and warehouse operations on to a single, unified software platform, he eventually chose a cloud-based service rather than the on-site system recommended by consultants that would have cost tens of thousands of pounds to set up and maintain.

However, he also needed to deploy a WiFi network to support a new “pick and pack” system that will be used by his warehouse employees to fill his customers’ pet food orders and reduce the risk of costly errors.

When the estimates for setting up the system came in, they looked rather high, prompting me to question whether he really needed to invest in a costly system built around an enterprise-class WiFi router, or could rely instead on a cheaper consumer router.

Today, it is possible to buy a dual-band consumer WiFi router based on the latest (and fastest) IEEE 802.11ac standard from one

of the leading network equipment makers, such as Asus, Belkin (which recently acquired Cisco’s Linksys unit), Buffalo, D-Link or Netgear for about \$100 or less.

Even if you want a top-of-the-line consumer router with all the bells and whistles, it is unlikely to cost more than about \$200.

Typically, these routers focus on delivering the highest speed downloads, though remember that in the real world, WiFi routers never deliver their “advertised” speeds.

Most of them target the rapidly expanding requirements of families for streaming cloud-based services such as Netflix, Amazon Instant Video and Spotify wirelessly throughout the home and include other nice-to-have features such as USB (Universal Serial Bus) ports that can be used to plug in a USB printer or hard drive for extra storage capacity.

But can one of these relatively low cost consumer WiFi routers also meet all the requirements of a small and growing business – including scalability, security and extended range – or should you invest in a WiFi router designed specifically for small and medium-sized enterprises?

Until a few years ago, the answer was a relatively simple no.

You really needed to pay the extra for a business router if you wanted a

rock-solid WiFi router that supported at least the IEEE 802.n standard (the precursor to 802.11ac), with a built-in four-port Ethernet switch for wired connections, multiple antennas to expand coverage, a built-in firewall and WiFi encryption for enhanced security, and the ability to prioritise different types of data and selectively block certain connections or service.

Today, however, most higher-end consumer WiFi routers offer all these and other features including Radius (Remote

A top-of-the line consumer router with all the bells and whistles is unlikely to cost more than about \$200

Authentication Dial-In User Service) or WPA-Enterprise security – a feature that used to be reserved exclusively for business WiFi systems.

In fact, in some respects, consumer WiFi routers have overtaken their business counterparts, which typically had only fast Ethernet (10/100 Mbps) ports rather than gigabit ports and lacked the dual-band capabilities of routers designed for media streaming.

What distinguished

business WiFi routers was their enhanced security features including WPA2 and Radius support, and expanded support for VPNs (virtual private networks).

Other features often found in business WiFi routers include: support for multiple virtual networks that can be used to segregate WiFi traffic from different departments; support for IPv6, which allows companies to create a much larger “pool” of IP addresses; dedicated DMZ ports that can isolate a server accessed by customers from the rest of the network; content filtering that enables companies to block access to certain websites; and support for WDS (wireless distribution system), which enables a wireless signal to be echoed or repeated several times, expanding the range of the router.

But when I went looking for these features recently, I found many of them in top-of-the range “consumer” WiFi routers.

If you do not need all the business bells and whistles, a high-end consumer router such as the Linksys WRT1900AC dual band gigabit WiFi router, which I have been testing, is a good choice.

Alternatively, consider a WiFi router such as the Buffalo AirStation Pro 802.11n Gigabit Concurrent Dual Band PoE Wireless Access Point, which is designed specifically for small businesses.

While the AirStation Pro supports the 802.11n WiFi standard rather than the faster 802.11ac standard, it includes many of the most important features that small businesses should be looking for.

These include scalability, virtual networking and Radius support.

It also supports the 802.3af power over Ethernet standard, which allows it to be operated without the need for a separate power cable and positioned in places where there may not be a power outlet, for example, in the middle of my son’s warehouse ceiling.

On FT.com »

Big data drives Disney shake-up
Paul Taylor’s video interview with Vlad Rak, senior IT executive at the US company
www.ft.com/disney



Missing a vital component?

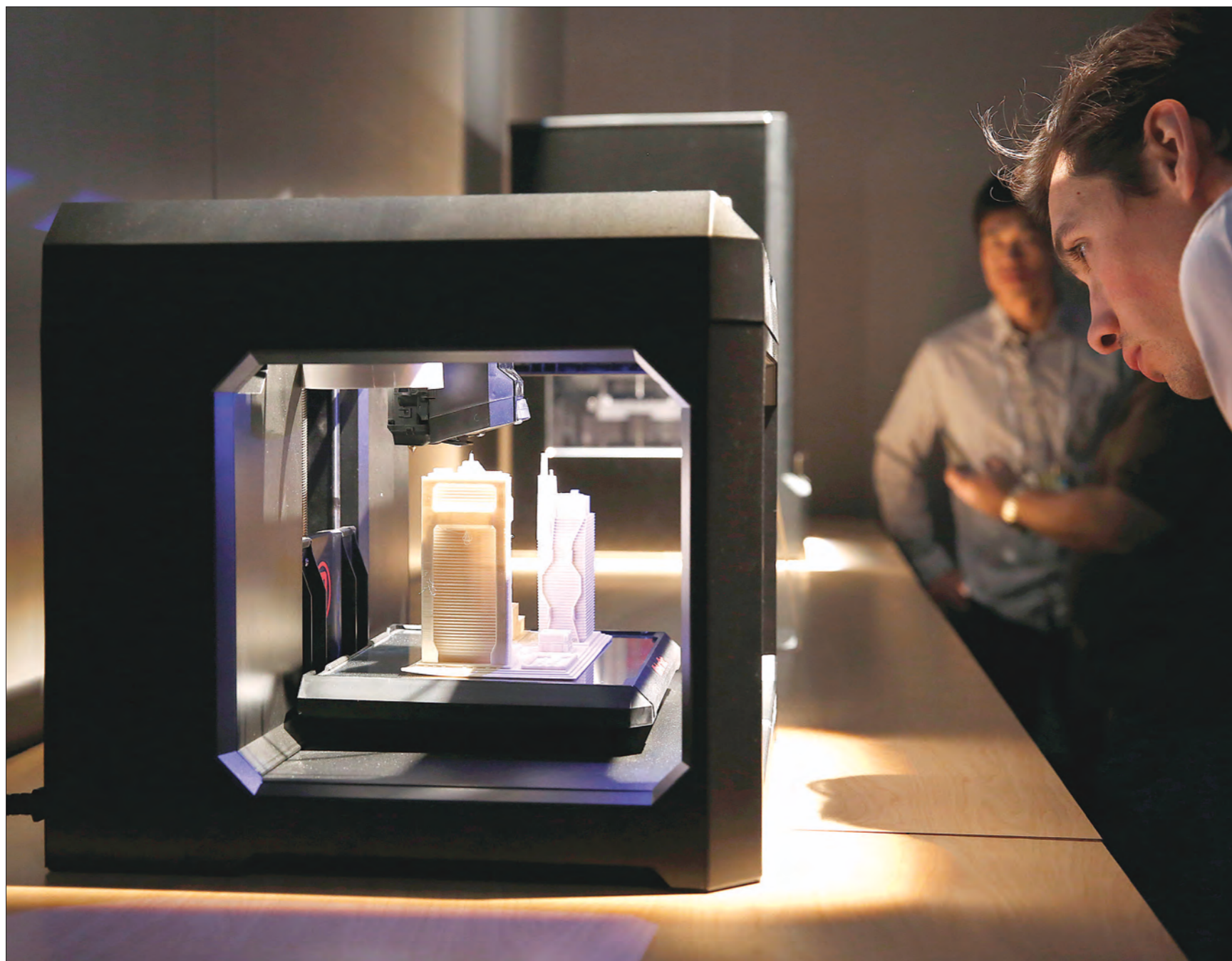
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The Connected Business



Layer player: a Makerbot 3D printer on display at this year's Consumer Electronics Show in Las Vegas

Bloomberg

Additive process lays it on thick

3D printing The market is growing fast and broadening – even into food, writes *Paul Solman*

Imagine a structure to suspend street lighting – a complex web of metal struts and high-tension cables, linked by steel joints.

It was an innovative design but the problem for Arup, the engineering group that developed it, was the joints, or nodes. Each had to be slightly different, making manufacture time-consuming and costly.

Then the company hit upon the idea of using a 3D printer.

The process – also known as additive manufacturing – has been around for a quarter of a century, but only in the past few years has it become widely used by both industrial manufacturers and consumers.

This expansion has been boosted in part by the availability of cheaper printers and by the possibilities offered by new materials.

The global market for 3D printing grew last year by about 35 per cent, or more than \$3bn, the highest compound annual growth rate in 17 years, according to Wohlers Associates, a 3D printing consultancy.

Where once the popular image of 3D printing was plastic guns, the technology can now create anything from jewellery and furniture to dental products and parts for nuclear facilities. The future is likely to see 3D printing of food and artificial body organs.

Printing in metal is one area that seems to have captured industrial groups' imagination, and users of the process include Siemens, General Electric and BAE Systems.

"In some ways, metal printing has developed further in the past 10 years than plastics have in the past 25," says Terry Wohlers, president of Wohlers Associates. "Metal printing is still too expensive for the automobile industry, but it's very affordable for

industries such as aerospace, and many types of metals can be used."

For Arup, even 3D printing did not present a simple answer to producing the nodes for the street lighting project.

"The 3D printing industry is not used to working with the building industry, so we needed to find out how to implement the design freedom and production restrictions in our design," says Salomé Galjaard, the senior designer at Arup who led the company's 3D printing project. "We still have much to learn about how to use 3D printing for building in terms of design and production and the structural behaviour of printed products."

Nevertheless, Arup was able to create nodes in a light-weight and complex design printed in maraging steel, which is strong but also has good machinability.

"I doubt that all building projects would benefit from 3D printing in the future," says Ms Galjaard, "but it has big advantages in design freedom, where form can follow function, bringing weight reductions that can also reduce costs."

Another area raising expectations is the use of 3D printing in medicine to create, for example, organs for transplant surgery. The possibilities are enormous, but experts caution there is still much work before it becomes a reality.

"It's still very much in R&D," says Mr Wohlers. "The idea of printing hard and soft tissue has been around for some time, but we are still quite a way from commercial viability."

"There are still a lot of problems to be solved with printing skin and tissue for hearts, livers and lungs. Even [leading medical experts] wouldn't

commit to that happening in our lifetime."

Closer to fruition may be the 3D printing of food. The additive manufacturing technology can be used along with other processes to mimic existing products or create something new.

"There are a lot of possibilities in food structures," says Wil Schoenmakers, global head of consumer products at PA Consulting, which is printing food at its Cambridge Technology Centre in the UK.

"We can put together ingredients that would normally be incompatible with conventional techniques. It also allows us to use air to create textures and create a different experience."

There is also huge potential in creating customised products, tailored to the consumer, he says. Mr Schoenmakers thinks the food industry is three or four years away from printing commercial food products on a large scale. PA has been working on 3D printed chocolates, and has made edible prototypes.

He adds: "Many food companies are looking to

3D printing to do it all, but it's not a single solution; it will need to be used with other technologies rather than on its own to produce food."

However, the growing number of industries that are finding a use for 3D printing suggests the process is moving closer to being an important tool for manufacturers.

McKinsey Global Institute, research arm of the management consultancy, believes 3D printing could proliferate rapidly over the coming decade and could generate economic impact of \$230bn-\$550bn a year by 2025.

"I don't think there is any material that couldn't be printed eventually," says Jon Cobb, executive vice-president of corporate affairs at Stratasys, which makes 3D printers.

Stratasys specialises in plastics-based printing, and Mr Cobb says manufacturers are constantly challenging the industry to find ways of printing in more materials.

"Manufacturing companies want us to print using materials they are familiar with to meet their specific needs, so there is a growth in nylon and polycarbonate materials, some of them containing partials such as metal or glass," he adds.

Most exciting, says Mr Wohlers, is the boom in interest and investment in 3D printing.

"It takes a lot of money to make things happen, and governments and leading corporations are spending hundreds of millions of dollars on 3D printing," he says.

"That could accelerate development radically, and rather than waiting decades we could be waiting years."

For more on 3D printing, an opinion column by Eric Openshaw and Mark Cotteeler of Deloitte is published online today at www.ft.com/connected

Lawyers focus on short cut to riches for counterfeiters

Intellectual property issues

3D printing is a threat to rights holders but they can learn from the music industry, says *Jane Bird*

Additive manufacturing, or 3D printing, makes it easy for almost anyone to produce items from Barbie dolls to rifles – and evade intellectual property laws.

Large-scale 3D printing will enable counterfeiters to produce goods in their home market, reducing shipping costs and avoiding customs seizures where products are imported, says Lorna Caddy, senior associate at Taylor Wessing, a law firm.

But smaller scale activity, too, with people copying protected items at home could add up to as serious a problem as illegal music downloads.

The technology can bypass traditional retail models, potentially depriving rights holders of a stream of revenue derived from their intellectual property, Ms Caddy says.

IP laws include patents, design rights, trade marks and copyright. They differ considerably globally, although Commonwealth countries have similar laws to those in the UK, and copyright and trademark law is largely harmonised across the EU, as are parts of design law.

In the UK, IP law has several weaknesses with regard to 3D printing.

It can be used only for commercial purposes, and not against an individual who is producing something for personal use. It is unlikely to be much use preventing home copying, Ms Caddy says.

Nor is copyright law much help, as it is mainly intended to protect "artistic" work and has so far been largely unsuccessful in protecting functional objects or mass-produced artistic goods.

Rights holders are more likely to succeed in using IP laws against companies that provide 3D printing services, says Ms Caddy. They are also more likely to take action against websites offering people pirated computer aided design (Cad) files used in 3D printing, as the music and film industry did with file-sharing sites.

Kim Walker, partner in technology law at UK-based Thomas Eggar, a law firm, says that changes introduced with the UK's Intellectual Property Act 2014 have been timely in relation to 3D printing.

They have clarified questions of IP ownership and what can happen if it is breached, Ms Walker says. "The IP rights now belong to the designer rather than the business that commissions the design; any business that uses third-party designers should be aware of this."

Other innovations include big fines and the ability to confiscate equipment used to manufacture products that infringe design rights. These "draconian remedies" will not be particularly relevant to home users, says Ms Walker. But they would have an impact on companies using high specification 3D printers to make complex items such as prosthetics, she says.

"Manufacturers that want to avoid costly fines or having their equipment

seized will need to ensure their customers produce proof that they own the rights themselves or have licences."

Copyright law has also recently been changed to provide extra protection to 2D images, including those applied to a 3D design. Previously, they were covered for only 25 years where they were used as decorations on mass-produced items such as mobile phone covers, which are popular with additive manufacturers. Now, 2D images used this way are safeguarded for the creator's life.

This hugely reduces the library of images that can be used, with a whole catalogue from the late 1980s and earlier no longer available, Ms Walker says. "Manufacturers and those asking for print services need to be clear on the ownership of any artwork being applied to the surface."

So how can rights holders protect themselves? One sensible precaution is to stamp goods with a logo that shows they are protected, like the copyright declaration in the front of a book. This might cause people to hesitate before printing, says Ms Caddy.

Rights holders should also learn from the music industry, she says, and provide legitimate sources for the Cad files used for 3D printing along with usage instructions and information about materials. "Consumers will turn to unauthorised sources if they want something and there is no alternative," Ms Caddy says.

"Companies need to provide consumers with what they want in a way that can be downloaded quickly at a reasonable cost. For example, customers wanting to replace vacuum

One sensible precaution is to stamp goods with a logo that shows they are protected

cleaner parts might in future log on to the manufacturer's website and download the Cad file to print the part themselves."

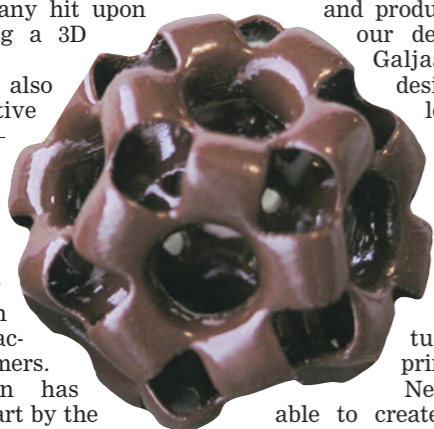
Making files available in this way lets businesses provide safety warnings and printing tips while monetising their rights, Ms Caddy says.

There have been few, if any, cases involving 3D printing and IP rights so far. But Ms Caddy believes that rights holders are likely to use copyright law, as the music and film industries have done against sites such as The Pirate Bay and Newzbin.

She says: "EMI Records' recent action against the six leading retail internet service providers demonstrates the relatively streamlined process that copyright owners can now use when their material is being shared online without their consent."

"The English High Court ordered the ISPs to block access to three file sharing websites without the claimants needing to involve the website operator or its users."

But although copyright works well for dealing with piracy, in most cases, rights holders will need to rely on design and patent law, neither of which make it easy for courts to order ISPs to block access to infringing websites.



Success is sweet: 3D-printed chocolates from PA Consulting

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Virtual reality lab helps helicopter maker land shorter timeline

Project management

Sikorsky designers donned 3D goggles and gloves to avoid costly delays, writes *Michael Dempsey*

To the untrained eye, the Sikorsky CH-53K military helicopter looks just like a type that has been flying for 50 years. But the prototype unveiled in Florida this year was a completely new beast. And it was designed entirely using virtual reality (VR) tools in a digital 3D lab.

The aerospace industry has an unenviable record of new designs falling badly behind schedule. But Sikorsky has harnessed IT to

overcome the obstacles that dog any complex engineering process where multiple suppliers are involved.

James Andrews, deputy chief engineer, says VR was not on the agenda when the project began in 2006.

"We planned on some digital design using computer-aided modelling and assumed this would be more efficient. But as we got going, we realised there were other tools we could use."

The first step was a digital mock-up of sections such as the cockpit. It was then that Mr Andrews had his lightbulb moment: "What if we could build it using digital tools before we bend metal?"

The traditional approach to aircraft design sees digital plans translated into a physical test article. This means that problems with

internal fittings emerge only when the airframe is constructed. Altering parts after metal has been cut on the assembly line is very expensive and time-consuming. It creates a ripple of delays and cost along the supply chain.

With 70 per cent of the CH-53K coming from external suppliers this threatened to derail a tight development schedule needed to replace ageing helicopters in service.

Sikorsky set up the VR lab for \$2m. It comprised a room with one large screen linked to a set of high-powered PCs running design software from France's Dassault Systems.

Mr Andrews is keen to distance his work from the image of virtual reality popularised by games and cinema. "You have to avoid

getting hung up on Hollywood and focus on where it really adds value," he says.

In the centre of the room was a terminal controlling goggles and gloves worn by members of the design team and linked to cameras and sensors in the ceiling.

One person would don the VR gear and as their movements were translated into the digital environment, they could shift parts inside a virtual fuselage.

"It immerses you in a 3D environment. It allows you to understand the look and feel of things. For example, you know what you will find if you push a fuel-line into the aircraft," says Mr Andrews.

Getting fuel lines right is a sore spot in aerospace. The looping of flexible components cannot be properly assessed on a PC screen.

But if the space for the lines proves to have been designed even slightly wrongly, it can require extensive re-engineering. So Sikorsky brought assembly-line mechanics into the lab to shove and pull the lines.

There are more than 100 elements to a fuel line in the CH-53K and letting mechanics feel their precise path involved 20 essential redesigns.

Improving the maintenance and reliability of the helicopter was a priority. Space on an assault ship is tight, limiting the number of helicopters and the spares inventory carried.

And downtime because of maintenance can seriously erode military effectiveness. The VR lab allowed maintenance personnel from the customer, the US Marine Corps, to experience the



Built on computer: the Sikorsky-53K military helicopter

task of keeping the CH-53K flying and give their perspective on how big jobs such as engine changes would proceed in reality.

None of these tasks was accomplished overnight. Mr Andrews calculates that building in a virtual world before a single physical component is manufactured does stretch out the design phase. But it slashes the time taken to make a real machine.

"We had a target of

cutting the assembly hours spent on the actual flying prototype by 35 per cent. You sacrifice time up front and gain it later on because you flush out problems that you would otherwise find out only when it flies."

He estimates that the number of changes needed between the first static test model and the flying prototype were halved thanks to the virtual reality lab.

Casper Ryborg, a senior

partner at PA Consulting, identifies the strength of the Sikorsky approach as "getting everything in the same room at the same time, so you unlock things that would create complications when you move to full production."

Subcontractors joined the lab so they could see and feel how their components were integrated with the airframe, eliminating potential snags.

The lab has more than paid for itself, says Sikorsky, and the \$4bn initial development programme is on track.

In time, it should deliver 196 CH-53Ks to the Marines on top of four prototypes. What the helicopter maker calls "build before you build" is now firmly embedded in its plans for all future models.

The Connected Business

Social media and big data come into play

Supply chain Techniques such as improved predictive maintenance can lead to big savings for manufacturers, writes *Maija Palmer*

Can social media reduce the price that a retailer pays for bread? Can big data help a manufacturer reduce hundreds of thousands of dollars worth of waste? These much-hyped tech buzzwords may not seem the obvious answers to supply chain management issues, but they are producing results at a number of companies.

Take Asda and the price of bread. The UK supermarket group was keen to make its network of 34 bakery suppliers more efficient, reducing the prices it paid for products as well as improving its environmental and sustainability credentials. Simply telling suppliers to improve seemed heavy-handed, however. So Asda turned to a social network, 2degrees, to help “nudge” suppliers into taking action.

2degrees is an independently run network where retailers and their suppliers can exchange information about energy-saving and environmental initiatives. Companies might, for example, post questions about energy-saving lightbulbs, or waste management best practice and receive answers from other suppliers on the network – in much the same way that an individual might post a question to friends over social media.

Asda’s bakers were all encouraged to join the network and to take part in a confidential survey asking them what percentage of their costs were related to energy.

Martin Chilcott, founder and chief executive of 2degrees, says: “When we asked bakers where they thought they would stand as regards energy efficiency, they all said they would be in the top 50 per cent of their peer group. They all believed they had

been making incremental improvements over the years and assumed they were doing well.”

In reality energy consumption as a percentage of costs ranged from 0.5 per cent to 12 per cent – and the distribution surprised many of the worst performers. Asda did not see the results, but the networking platform plotted the answers on a chart to show each company where they were compared with the rest. 2degrees then asked the best performers about what they were doing to save energy, shared a list of best practice and put suppliers in touch with each other to share tips.

“There was something close to £60m worth of savings to be made from getting the worst performers to behave like the top end,” Mr Chilcott says.

At no stage did 2degrees reveal to Asda any of the individual performance ratings – or details about the cost savings suppliers were making.

“It has to be a blind collaboration and the golden rule is that any savings you make, you keep,” says Mr Chilcott. “Suppliers were not keen for Asda to know about their savings, because they did not want the buyers to put pressure on them to pass those savings on in prices.”

Nevertheless, over time, with all its 34 bread suppliers more efficient, and with normal market competition at work, Asda expects to see prices fall.

Other companies with large supply chains – from Tesco to RBS and GlaxoSmithKline – are using the 2degrees network for similar projects, and Mr Chilcott estimates it has helped save suppliers £1.6m in 18 months.

At the same time, big data is starting to change the dynamics of



Wired for sound: a Rolls-Royce Trent 1000 engine

the supply chain. Companies such as Nestlé and Kraft, for example, are linking to supermarkets’ point of sale data, and analysing them to predict consumption trends.

Ford is doing something similar so that it can recommend what stock its dealers should carry in different areas.

While this kind of stock control exercise is similar to what companies have done in the past, big data allows it to be done in a matter of minutes, a speed simply not possible before.

Some of the clearest savings come from using big data for predictive maintenance and statistical process control. Suppliers can fit sensors on to more bits of machinery, which can report back when anything abnormal is detected, for example, a turbine engine beginning to consume more oil than usual.

Most of the world became familiar with this concept this year, when it emerged that the Rolls-Royce engines on Malaysia Airlines flight MH370 transmitted data for hours after the flight disappeared off radar systems.

Rolls-Royce’s Trent engines, such as those on the lost aircraft, can be fitted with between a dozen and 25 sensors monitoring aspects such as vibration, pressure, temperature and speed. Knowing exactly the moment an engine needs maintenance helps keep

downtime to a minimum as well as improving safety.

“The potential savings from predictive maintenance of big machinery operations are huge,” says Lorenzo Veronesi, senior research analyst for IDC Manufacturing Insights, the IT market research company.

Statistical process control – where big data allows companies to monitor the manufacturing process more precisely than before – is also helping save money.

Coty, the beauty and perfume company, for example, saved more than \$250,000 by avoiding overfilling its perfume bottles. The company spent \$47,000 on a system from manufacturing intelligence company InfinityQS and in two years saved \$270,000 simply by being more exact about the amount of liquid in each bottle.

These technologies are only just beginning to become popular, however. Mr Veronesi says only about 30 per cent of manufacturers in western Europe are considering using big data to analyse their operations. And even fewer – about 20 per cent – are using the technology at its full potential to analyse online customer behaviour.

These numbers could double over the next two to three years, says Mr Veronesi, but there is still plenty of scope for companies to gain an advantage from being pioneers in this area.

Power to people on product design

Continued from Page 1

these ventures is “authenticity”, says Quirky co-founder Ben Kaufman, as this is vital to getting outsiders to engage with new products. They have to feel they are part of a genuine community of interest, not simply taking part in some elaborate corporate marketing exercise.

A sense of personal connection is key, he adds, before people will develop the level of trust needed truly to engage: “If we want them to give us their best idea, they need to have seen us or met us.”

Quirky uses live product evaluations once a week and other events to bring a more personal touch.

The question for companies such as these will be whether they can still engender the same passionate engagement as the number of people contributing to them gets bigger and individual members feel less of a sense that their own contribution is making a difference.

As Mr Kaufman puts it: “As the community grows, how do people think it’s not just a lottery?”

The second common feature behind hardware start-ups of this type involves the process of taking a product idea through to the point of manufacture. This involves the use of advances such as 3D printing to help with rapid prototyping, greatly streamlining the process.

Full production also draws on new manufacturing models that were not available to start-ups until recently. In the case of Quirky, that means tapping into a base of low-cost manufacturers in Asia, who can turn out its consumer products in volume.

Local Motors, on the other hand, has relied on innovations in machine tooling to develop its own small-scale production base.

“We needed to bring down the cost of tools to make hardware development more like software development,” says Mr Rogers.

A wave of innovations in computer-assisted machine tools is bringing down costs and making it possible to produce in much lower volumes, according to Jordan Brandt, technology futurist at Autodesk, the big US maker of design software.

These include combining 3D printing with older techniques, he says: a product made from a highly expensive material can be built up in a 3D printer before being fine-tuned in a milling machine.

Breakthroughs like this are also opening the way to producing better parts for older machines, making them more efficient. Printing a mould

100

Break-even for sales of Local Motors’ Rally Fighter

with thin air channels inside it, making it quicker to cool the part after each use, could raise the efficiency of an injection moulding machine by 30 per cent, says Mr Brandt.

In Local Motors’ case, new manufacturing techniques have made it possible to produce in what it calls “micro-factories” employing a maximum of 50 people, and as few as a dozen if they are not involved in product development. The company is working on opening its first overseas plant, in Berlin, and hopes one day to support a wide network of facilities serving highly local markets and interests.

“If you have a market for a few thousand items, you can serve it now,” says Mr Rogers.

Additional reporting by Andrew Baxter

Cloud is new platform for supply chain partners to get together

Collaboration Common venue has benefits, says *Jessica Twentyman*

At many manufacturers, supply chain collaboration is stuck in the dark ages.

When it comes to ordering materials and components, managing inventory levels, or organising the delivery of finished goods to customers, companies are forced continually to chase business partners – mostly suppliers, logistics companies and retailers – via a messy stream of emails, phone calls and even faxes.

Worse still, much of the data that could give manufacturers a complete, end-to-end view of their supply chains already resides on the back-end IT systems of these partners: as much as 80 per cent of it, according to some industry estimates.

In other words, when a manufacturer receives an order, it has little idea if its partners can provide the materials needed to fulfil it on schedule, the transport capacity required to deliver it, or the shelf space to display it to customers.

What is needed is a healthy dose of cloud technologies, according to Nader Mikhail, chief executive of Elementum, a software-as-a-service (SaaS) company that was spun out of contract manufacturing company Flextronics this year.

With its cloud-based supply chain collaboration platform, Elementum proposes to transform supply chain collaboration in the same way that other SaaS companies such as Salesforce.com and Workday have transformed sales and marketing and human capital management, respectively.

“Our aim is to bring supply chain collaboration into the 21st century and make it simpler,” says Mr Mikhail. “To a large extent, that’s about eliminating the many blind spots in the process.”

The cloud, he argues, is the perfect place for supply-chain partners to collaborate for better visibility.

Globalisation has meant that supply chains today

are longer, more dynamic and riskier than ever before – but the cloud provides a common venue, easily accessible from any internet browser, where partners can get together to exchange information in real time.

That makes it easier to detect potential sources of disruption and formulate better contingency plans in response. And a service such as Elementum, he adds, gives them a common language in which to describe bills of materials, replenishment orders, planned lead times and the status of orders.

It is still early days for Elementum, but the company has already attracted a \$44m round of funding from investors including the co-founders of Workday and Box, another SaaS company, as well as Jerry Yang, a co-founder of Yahoo.

And it is targeting a real need among manufacturers and their supply chain partners.

Christian Titze, an analyst at Gartner, the IT market research firm, says: “We’re seeing a very definite move to the cloud and a widespread recognition that old ways of working

are no longer good enough in today’s world.”

Supply chain traceability is a huge issue for many manufacturers, he adds, but it is no longer enough for them simply to be able to answer basic questions, such as “Where are my materials?” and “Where is my order?”

“Now, what they’re looking for is a broader view. They want to know if their supply chain is following

‘One of the main things for us was the low-cost barrier for bringing partners on board’

the plan they’ve set out for fulfilling customer needs. And they want to operate their supply chain networks as profitably as possible, to lower costs and to respond faster to new opportunities, as they emerge.”

This, he says, is prompting great interest in cloud-based supply chain collaboration platforms from companies such as GT Nexus and E2open, among others.

Stock control can be done in a matter of minutes, a speed that was simply not possible before

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What does the future hold for IT in design and manufacturing? Andrew Baxter interviews Rahman Jamal, National Instrument’s technical and marketing director for Europe; Matt Davies, director of product marketing at Splunk; and David Stonehouse, technology and innovation expert at PA Consulting, to shed light on current smart manufacturing buzzwords such as “industry 4.0”, “cyber-physical systems” and the “industrial internet of things”. Read more at: www.ft.com/connected



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Farmers take flight into the future

Drones at work Agriculture and construction are growing markets, writes *Hannah Kuchler*

By the end of walking round and round his fields in Illinois seven times, hunting for pests, fungi and sickly plants, Aaron Sheller wanted to give himself the sack.

Instead, he turned to drones. The farmer teamed up with a drone hobbyist about three years ago to see if the small unmanned aircraft could scout the crops more easily and efficiently, saving farmers money.

Starting with a basic model, they piled on features: GPS controls, stabilisers so the drone can fly in high winds and a live camera feed so the farmer on the ground can inspect his fields in real time.

Now, Mr Sheller owns Precision Drone, which has dealers across 20 US states and Canada.

"You can use technology to be better farmers and provide more food for a growing world," he says. "The larger farmers, higher-end crop farmers are the most interested because they have the most in the game."

Big technology companies such as Amazon, Facebook and Google may have made headlines for their recent forays into drones – with the e-commerce company working on delivery by drone and the latter two looking at how to beam internet from the sky.

But drones are already being used in agriculture, construction and mapping. These industries are likely to be able to expand their use of unmanned aircraft the fastest, because it mainly involves flying over unpopulated areas, while regulation, particularly in the US, is focused on restricting flight in more built-up locations. This enables farmers to use drones on their own land.

AeroVironment, a California-based drone maker, has gained the trust of the regulators by providing 85 per cent of the military drones bought by the Pentagon, as well as selling to 30 allied countries.

The company was granted the first licence to fly over land by the US aerospace regulator this month, but is restricted to an oilfield in Alaska. Its low-flying, slow drones – which look more like a giant paper aircraft – will survey the ground for BP, alerting the oil company to when the roadways need fixing and guiding drivers of drill rigs in low visibility conditions.



Game of drones: one of Precision Drone's unmanned aircraft at work

Steven Gitlin, vice-president of AeroVironment, compares the drones with having "night goggles". "They offer super human vision; you can see beyond obstacles and collect information to make better decisions," he says.

AeroVironment, which was founded in 1971 and came up with the idea for the portable hand-launched plane in the late 1980s, first began to get contracts with the oil industry in the mid-2000s. But it could not execute them because of regulations.

"As we developed the technology

further and proved it out further in the military space, we developed a long record of successful operations which was very helpful for the FAA [Federal Aviation Administration]," says Mr Gitlin. He adds the drones were subject to a certification process similar to that used for commercial aviation. "The more success we can demonstrate, the more confidence there will be," he says.

AeroVironment also sells drones to a couple of law enforcement agencies, which use them to search for suspects as well as to monitor car accidents

from above to collect forensic evidence.

Chris Anderson, co-founder of drone maker 3D Robotics, thinks it will be the "alpha farmers" and "alpha architects" who will use their knowledge of their industries to expand what drones can do by working with technology companies.

Mr Anderson, a former editor of Wired magazine, started tinkering with drones seven years ago, as a way to get his five children engaged with science and technology. Sitting at his dining room table, he built both drones and a drone-loving online community at DIY Drones. He started his business three years ago.

"I contacted this guy in the community, who turned out to be a teenager from Tijuana, though I didn't know that at the time. He agreed to make them and I gave him \$500 to get started," he says. "Now we're America's leading drone company, selling more drones than any other."

3D Robotics sells drones to hobbyists, who can fly them on private land, and do everything from developing new programmes for them on an open platform to taking the "ultimate selfie, or dronie".

But Mr Anderson dismisses as "media stunts" many of the uses of drones that hit the headlines, from bottle service in Vegas to Amazon's plan to deliver packages by unmanned aircraft.

"Drone delivery is a difficult problem, the hardest technology, as they need to see their surroundings and avoid trees and birds and telephone lines and small children and dogs," he says.

Peter Lee, a lawyer specialising in drones at Taylor Vinters, says public acceptance and regulatory approval would be even more difficult to achieve than the technology. "The big concern about that type of use is around safety. If the equipment failed, you could have some pretty horrific injuries," he says.

For Mr Sheller, the real opportunity lies in using drones to spray crops, but as he's not even able to rent them out yet, he thinks this is far off.

"We, as an industry, have a long way to go before we're able to take up and fly 100 drones in one county to do all the spraying."

Drone legislation Regulators search for a balance between safety concerns and commercial priorities

In March this year, a gas explosion destroyed two buildings in East Harlem, New York, with tragic consequences. Three people died at the scene, and the death toll later rose to eight people, writes **Stephen Pritchard**.

The incident dominated local news bulletins. However, some of the most striking footage came not from New York's myriad news organisations but from an amateur.

IT expert Brian Wilson used a camera-equipped DJI Phantom 2 "quadcopter", a type of drone, to record about 30 minutes of video footage, some of which later made it on to the news.

News organisations are, currently, banned from using the technology deployed by Mr Wilson. Under US Federal Aviation Authority rules, commercial use of drone aircraft is not allowed, although "commercial" may be open to interpretation. As an amateur, Mr Wilson was not covered by the ban, although he did seek the permission of police on the ground before launching his drone.

Since then, there have been numerous other incidents in the US and elsewhere of amateurs capturing footage of breaking news using devices such as Mr Wilson's Phantom.

Depending on the model, these quadcopters cost about \$1,000 (£700) and produce high-definition video footage, making them appealing to hobbyists and professional photographers.

But such devices operate in a legal grey area. In the US, the Federal Aviation Authority is reviewing the rules on commercial use of drone aircraft, officially known as unmanned aerial systems (UASs).

The intention is, between now and 2020, to integrate UASs into civilian airspace and provide a regulated framework for commercial use, including training and pilot licensing.

This will mirror – and eventually go beyond – arrangements in the UK, where owners of the smallest drones, up to 20kg, can use them commercially, provided the owner has operating permission.

Drones between 20kg and 150kg, need operating permission, an airworthiness certificate, and a qualified pilot.

Above 150kg, drone operators also need an EASA (European Aviation Safety Agency) Permit to Fly or UK Permit to Fly.

The UK is widely regarded as at the forefront of regulations, striking a balance between safety, and allowing for the development of the commercial, unmanned vehicle market. This is in contrast to countries such as South Africa, which recently banned the use of camera-equipped drones.

But in the UK and mainland Europe, there is still a range of rules that UAS owners and operators must obey.

In countries where unmanned vehicles can be used commercially, their owners operate under a set of rules that ensure safety – but for now, may limit their usefulness.

In the UK, aircraft weighing between 7kg and 20kg can be flown only up to 400ft, and without permission cannot fly within 50m of any person "not under the control of the person in charge of the aircraft". The operator also needs to maintain a visual line of sight, which the Civil Aviation Authority interprets as 500m horizontally. Additional restrictions apply to drones used for monitoring or surveillance.

Nor, as it stands, can UAS operate in commercial airspace. This is part of the FAA's road map for the US, and the FAA has already set up six testing grounds for manufacturers and operators.

Allowing "interoperability" will require drones to meet standards for safety – especially collision avoidance and airworthiness – that currently apply to crewed aircraft.

Manufacturers of drones will need to develop technology to give pilots of unmanned vehicles levels of situational awareness that are equivalent to those of pilots in conventional aircraft – although, crucially, drone makers will not be required to provide a higher level of safety.

But businesses operating drones, or bringing in specialists to do so on their behalf, will also need to consider privacy, data protection and public liability laws. Even a small drone going rogue is capable of real physical damage – but the reputational damage could be greater still.

Brian Wilson used a drone to capture shots of a New York gas blast AP



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