DMH Stallard

REALISING THE BENEFITS OF 3D PRINTING

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THE MANUFACTURING INDUSTRY IN THE UK, AND INDEED THE WORLD, IS FACING CHALLENGES AND OPPORTUNITIES THAT COME ONCE IN A LIFETIME. THE 4TH INDUSTRIAL REVOLUTION (INDUSTRY 4.0) IS UPON US. THE EVOLUTION OF 3D PRINTING OVER THE PAST 30 YEARS IS NOW REACHING THE TIPPING POINT WHERE IT IS ENTERING THE MAINSTREAM.

However, while new technology allows innovation, it also brings threats which businesses must address. For every instance where companies save money and resources by reducing manufacturing waste or transport costs, there is the danger of intellectual property (IP) and competitive advantage being undermined.

This report looks at the driving forces behind the progression of 3D printing, the ways companies in the UK are using the technology, the risks posed to businesses by the technology and the steps they should take to protect their IP.

Our research was conducted through one-to-one interviews with R&D teams, CEOs and directors at eight companies which are driving the technology and using 3D printing to produce both prototype and finished parts.

We interviewed one company which produces machines at the some of the highest standards of resolution. And we also spoke to directors from four companies involved with the development of software relevant to 3D printing working in areas such as cloud based digital manufacturing, design protection, data logistics and developing the design software for creating 3D printable designs. We are grateful for their participation and a full list of these companies can be found at the back of the report.

To discuss any of the issues raised in the report, please get in touch. We hope you find it informative and useful.

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Global management consultancy McKinsey & Company define Industry 4.0 as the next phase in digitisation of the manufacturing sector. Additive manufacturing, or as we refer to it in this report, 3D printing, is an integral part of Industry 4.0.

THE MAJOR MOTIVATIONS BEHIND 3D PRINTING

SUPPLY CHAIN DISRUPTION

Many firms are using 3D printing to take back control of their supply chain. One company we spoke to was using 3D printing to create production parts for its products. Due to the low volume of parts required, their bespoke nature and them being used in a low stress environment, a 3D printed part could be made in-house in carbon fibre. In addition, the logo of the company and the customer's name could be printed on the part and it could be customised in terms of colour and the required dimensions of the matching part in the finished assembly. An alternative manufacturing option, injection moulding, would have been prohibitively expensive and used up valuable capital in tooling costs. The 3D printed parts were produced quickly and only when needed, avoiding building up costly inventory.

By using 3D printing, companies can reduce the amount of time it takes to create a prototype, as well as reduce risks in the design process by making working concepts before investing in machines. This was the most common current use we saw for 3D printing – the ability for rapid product development. The printing was often followed by a hybrid process that usually finished with traditional manufacturing techniques, but enabled the user to get the part to market quicker than before. In one example, members of an R&D team told us that they were able to design a part in the morning and have the first prototype printed in their office by the end of the day. Previously they had relied upon in-house machinists to create this type of part and it would take up to four weeks for the first iteration of a prototype part to be produced.

Early adopters of the technology mostly included high value manufacturing, particularly in the medical sectors, with parts such as hip joints, teeth and high-end consumer products. The aerospace sector is also at the forefront with high specification and high resolution production parts and widespread use of 3D printing for rapid prototyping of defence and aerospace components.

One business we interviewed had embraced 3D printing technology to the degree that it had developed specific raw materials to use in the process. It was at the stage of obtaining significant revenues from selling these materials, opening up a new capability within the company.

During our research we discovered that it is also possible to place 3D printing requirements onto web based platforms where 3D printing companies can bid to meet customer requirements. In terms of disrupting traditional supply chains, this could mean that in future companies could have a totally disaggregated supply chain.

One major automotive manufacturer has introduced the capability for its major service centres in the USA to 3D print over 30 polymer-based parts on the premises. This has removed the logistics requirement to ship finished parts to these service centres and the need to hold costly inventory there. There is also no expensive packaging required.

MASS CUSTOMISATION

A key advantage of 3D printing is that it can reduce the need for expensive and dedicated tools, enabling the creation of truly bespoke items which are totally focused on the needs of the end user. For example, one company, which is using 3D printing in a wide array of applications, is producing bespoke insoles for shoes created from a series of photographs of the end user's foot.

A company we interviewed had found itself with the unappealing prospect of having to buy an extremely expensive machine part, commonly used by competitors, which actually restricted the way they could create their own products. It also would not allow them to personalise the product for the end user. By 3D printing their own parts, the company could build prototypes that worked perfectly. They could then send the CAD file to an independent contractor who could make a finished part which was cheaper as well as being customised for the end user. This maximised their advantage against their competitors.

Running contrary to this however, we spoke to a company that used fused deposition modelling (FDM) 3D printing to create low resolution prototype parts, but didn't consider the technology appropriate for the very bespoke parts it created. Instead, a handmade model was used allowing manipulation and adaptation during the manufacturing process to create the necessary level of individuality required for this medical application.

Perhaps the most impressive example of mass customisation we witnessed was the production of individual replacement teeth in titanium and metal implants for surgical use. These were being produced to match individual patients' precise requirements.

REVERSE ENGINEERING

3D printing doesn't just allow for the design and creation of new and customised products. It also allows reverse engineering. One company that participated in our research scanned a complex metal part which would have been very expensive to manufacture. They created a 3D model and used their own technology to make it a one shot process. As well as being far cheaper to manufacture, with vastly reduced levels of waste material, the finished part was of better quality and far more reliable in service with the end customer. The part also used a bespoke formulation that they had created as the base material.

Reverse engineering allows the creation of parts for which tools and drawings no longer exist, for example replacement parts for classic cars. One interviewee was scanning and producing new parts using a variety of new materials (having them approved by the relevant regulatory bodies). The company was able to fulfil a need that would have been uneconomical to meet otherwise.

Other businesses purely saw 3D printing as a way of building high performance prototype parts. Although functionally capable, these parts would be replaced in production by pieces more suitable to high volume manufacturing and with less or no need for expensive post processing, which is often required for 3D printed parts.

MAKING THE IMPOSSIBLE POSSIBLE

Some companies we met with were using 3D printing technology to produce parts that could not possibly be made in any other way, such as complex lattice structures allowing unparalleled strength to weight ratios. The technique allows designs that previously would have been impossible using subtractive manufacturing techniques. Companies have also been achieving assemblies requiring fewer parts, that are lighter, have fewer joints and are more reliable.

Other benefits include the near net shape of the finished part; sometimes machining or subtractive manufacturing uses only 3% of the material used in the process, consequently the rest would be scrapped or recycled.

One company was using “full colour” printing of parts, removing the need for painting the product.

However, with nearly all of the parts we saw made, even those printed in colour, there was some requirement for post processing to improve surface finish and remove supports required in the manufacturing process from the finished part.

It was notable that some prototype parts were still expected to perform in quite aggressive environments. For example a plastic container was being tested to pressures in excess of 15 Bar. In this case, the optimal orientation of the part in the process was necessary to reduce the risk of splits occurring in between the 3D printed “layers” in the part.

The practice of designing parts which can only be manufactured using 3D printing is growing quickly and is naturally closely linked to the consistent improvement of the manufacturing technology itself.

THE RISKS TO BUSINESS POSED BY 3D PRINTING

One of the most attractive attributes of 3D printing is that a manufacturing business needs only to move data to the printer, wherever it's situated, to enable local manufacturing. This effectively eliminates the transport of goods and the need to have some degree of inventory in their distributed manufacturing locations. However, whoever holds the data also holds the key to the castle. We were interested in exploring with our research subjects how many had had data misappropriated and if it had been used against them, as well as the steps they were taking to protect their data.

One company we interviewed had experienced data for a commercially sensitive prototype part for a new product being moved to a third party without their permission. The CAD file for the part had been sent to a third party 3D printing company in the UK they had used before. Unbeknownst to them, the printing business was running at full capacity, so without permission they sent the file to a Chinese sub-contractor. The sub-contractor printed the part which was then posted back to the customer in the UK. The company only found out that this had happened when they were chasing up delivery of their part, which had been delayed, and the supplier let slip what had happened.

Bearing in mind that the UK company's biggest competitor is in China and the part was rich in IP – being part of a new product range – the company was not impressed. To prevent the situation from happening again, they decided to expand their own 3D printing capacity by buying a higher resolution machine. In fact, several of the companies we visited had gone through a number of different 3D printing machines and could see themselves investing in new machines on an ever more regular basis. Several had ended up not using their original purchase at all, as the resolution and product quality was so low, they were not fit for purpose.

It is clear that many companies want to keep their IP in-house and are investing in purchasing their own machines as a way of achieving this, with the added bonus of increased capabilities and faster processing times.

Most companies we interviewed did not see the risks of having their products and components scanned and re-manufactured using 3D printing. They thought that the process would probably be too expensive and the end parts would not be fit for purpose, needing work to be done on internal structures and supports. One had tried it themselves and said the part they had made was "useless". However, as mentioned earlier, 3D printing is advancing rapidly, making the possibility of higher quality counterfeiting a fast approaching threat.

In the B2C market file sharing sites such as Thingiverse, GrabCAD and TurboSquid invite comparisons to Napster and the early days of online music sharing. Potential users can download files and print products directly on their 3D printers at home or work. There are even some geometric search models which can find geometric similarity to locate copies of shapes. Some of these parts will be products that will inevitably have some degree of bespoke design or misappropriated IP.

It's possible to draw parallels between 3D printing and how the internet and the advent of MP3 files opened the floodgates to illegal digital music sharing and downloads. Comparatively speaking, we are with 3D printing and illegal digital design file sharing somewhere between the invention of the MP3 file in 1990 and the first lawsuit against Napster in 1998. Businesses cannot afford to be complacent.

Technology has now been developed where components that a customer may wish to 3D print are posted on a website but instead of downloading the file, the customer has a print instruction for a single part sent directly to their printer. Thus the customer never owns the file and is not able to print unlimited copies of the part. It also enables a degree of traceability as to who is using the process. This however is not straightforward, as there are a multitude of different types of printer software that need to allow communication from this facility.

We did not find anyone within our research who had effectively “digitally fingerprinted” their files to prevent copying. Of course, this has become a major weapon in the protection of IP and controlling illegal distribution in the music industry. Some “shared” their geometric models through browser based viewers so that the third party could see a visual representation of the part without it being vulnerable to copying and without it having to be transferred.

One risk of companies changing their processes from centralised manufacturing to remotely located 3D printers in satellite manufacturing operations or service support centres is that of maintaining consistent quality. In the early days of Computer Numeric Control (CNC) machining it wasn’t unknown for machine operators to “tweak” the process during manufacture to produce so-called improvements, which occasionally worked but sometimes didn’t. In manufacturing 3D printed parts for production purposes, it is essential that the process is followed exactly because as well as determining the final dimensions of the part, the 3D printing process is actually making the material itself. It cannot be the norm for the operator to change the settings and parameters in the process or indeed copy the design.

There are now some systems which can effectively control manufacturing of parts in-house at distributed manufacturing centres or even at subcontractor operations and remove variables. This can go some way to guaranteeing that the “recipe” is followed. These systems give traceability to the manufacturing process and enable the part to be certified and comply with regulatory requirements, even when it is made on different machines in different locations.

3D PRINTING AND INTELLECTUAL PROPERTY

While our research implies that 3D printing technology is currently not yet advanced enough to create significantly increased levels of counterfeiting and IP infringement, businesses rest on their laurels at their own risk. As mentioned in our earlier comparison between MP3 files and 3D printing, we are only at the start of the journey of possibilities in using 3D printing technology for large scale IP infringement.

Despite the fact that 3D printing technology has been around since the 1980s, it is only now that we are seeing a boom in the advancement of the technology and the accessibility and affordability of 3D printing machines. This point applies equally to industrially used technology, as to technologies aimed at consumers.

The ending of patent protection for FDM and selective laser sintering (SLS) 3D printing technology helped speed up recent advancements. While there is a concerted push to improve 3D print technology, there is still a long way to go. It is difficult to gauge how well the current system of IP law in England and Wales is equipped to deal with the challenges posed by 3D printing.

There are some potential challenges if our current system of IP protection remains the same. With the drive towards distributed manufacturing and 3D printing at home, it is important to note that items which are protected by patent and design rights will not infringe those rights if the person printing them uses the product for their own personal use and does not make any commercial gain. This will be more of an issue when the resolution and end product quality of cheaply available 3D printers has radically improved.

There is more of an issue when it comes to replacement parts because the law in England and Wales permits certain parts to be reproduced by anyone. With regard to designs, this exception relates to spare parts which must fit or must match another article. For example, spare parts for car engines which must fit the opposing part of the engine to which they attach. Other examples are the shape of a contact lens which must fit the shape of the human eyeball and a printer cartridge which must fit into the corresponding slot in the printer.

With patents, if a component of a patented product is not part of the inventive concept, then it is not protected by the patent. So articles which fall within the above exceptions can be freely reproduced.

The availability of 3D printing and the inevitable increase in the online sharing of 3D design files will undoubtedly see a significant increase in the production of replacement parts. Many rights holders will be concerned about this given the potential impact on their reputation when low quality replacement parts become more available.

However there is no personal use exception when it comes to copyright. So if an individual is printing items at home for their own non-commercial use, they will still be liable for copyright infringement. However protection will only apply to artistic works and not to functional objects, meaning that this protection is extremely limited.

Trade marks will afford protection if copied products incorporate a registered trade mark, such as a logo, and the products are produced in the course of business. Proprietors of 3D trade marks, which are famously difficult to obtain (the shape of a KitKat was recently not allowed, but the Lego man has 3D trade mark protection) will be able to take enforcement action where their protected shapes, such as the Lego man, are manufactured in the course of business.

A key factor working against mass infringement with 3D printing is that the economies of scale that exist for traditionally manufactured products do not exist for 3D printed parts. Products manufactured through 3D printing will cost roughly the same per item if one item is printed or if 1,000 items are printed. So for the foreseeable future it will be cheaper to use traditional manufacturing methods to counterfeit or copy goods.

The biggest risk to IP appears to be at the high specification end of the spectrum, where products are being produced at relatively low volumes with high levels of design complexity. In the same way that 3D printing has allowed for the drastic contraction of prototype development timescales, copiers can use the technology to more quickly get to market with their rip-off products. In short, as the designers can be more agile, so can the copiers.

The new level of agility facilitated by 3D printing and, more broadly, digital manufacturing, will work to the advantage of those seeking to adapt existing products. With traditional manufacturing processes it is common for opportunistic competitors to hang off the coat tails of successful businesses. As we saw in the Trunki litigation, a Hong Kong based company produced a ride on suitcase very similar to the design concept of the Trunki cases. However the design was adapted sufficiently by the Hong Kong based company for them to avoid infringing Trunki's registered designs. Where digital manufacturing is used, this adaption process will be much speedier and easier to conduct.

Hence it is important for 3D printing processes and materials to be protected with IP in order to set up barriers against unauthorised copying. In the same way it is wise to seek exclusivity to the use of various materials for the development of your products, particularly where you do not own the IP to those materials. This exclusivity should be formalised in clearly drafted contractual agreements.

At this stage it is clear that products should continue to be protected in themselves, with the relevant IP rights. But more careful thought should go into which specific parts of the product need protection and whether processes and materials can be protected too.

CONCLUSIONS

Understandably, most of the companies we spoke to were excited by the use and potential of 3D printing, seeing it as a great opportunity. They currently didn't see it posing much of a threat to their IP when working in business-to-business arrangements as long as sensible precautions were taken, although there is greater sensitivity at the low volume, high resolution end of the scale.

Using 3D printing to increase agility in design and manufacturing was seen as key to maximising competitive advantage. There is also a danger that as 3D print technology develops, the same agility afforded by this technology may well be exploited by copiers too.

In several instances we saw that the focus for intellectual property protection was on processes used and also in the bespoke formulations and material science of materials used in 3D printing.

It is clear that the business to consumer applications for 3D print technology opens up areas of potential intellectual property infringement, with vulnerabilities in the current law. However the state of domestic 3D print technology is not sufficiently advanced and accessible to facilitate this form of copying on a grand scale. We discovered that there are potential protection measures and processes that can be used to mitigate this form of copying.

3D printing is not a technology to be used in isolation, nor will it replace all subtractive manufacturing processes. However, as part of a suite of new technologies that can be harnessed together, it is truly revolutionising manufacturing.

TEN TOP TIPS FOR MAKING THE MOST OF 3D PRINTING

1. Evaluate the strategic benefits that 3D printing could bring to your business through increased agility and reduced product development time scales.
2. Secure your data both internally and externally. If you need to share designs with third parties, use geometrical models viewed through web based viewers. This means that you can avoid sending sensitive design files which can be rapidly disseminated and easily exploited through 3D printing.
3. For added security, invest in your own 3D printing capability to print prototype designs in-house.
4. Technology is constantly changing and advancements may overtake your current development and protection strategies. Keep up to date with changes in the industry to avoid this happening to you.
5. Set up as many barriers as possible to prevent the copying of your products. Remember to follow tried and trusted strategies to protect IP, such as design rights, patents and trade marks.
6. Place greater emphasis on determining which parts of your products may need their own individual protection.
7. If you are allowing customers or suppliers to 3D print finished parts of your own design, consider posting them on a site where distribution is controlled. You must have strict contractual terms agreed between you and the 3D printing bureau to give you added protection in case of any lost data, IP infringement or other legal liability.
8. If making production parts, ensure that you have appropriate control of processes within your organisation and with any sub-contractors you may use.
9. When making production parts, look to protect the process, not just the shape of the parts. Get advice to ensure the most important aspects of your products are properly protected. Don't forget to look at our earlier report on protecting intellectual property.
10. As well as protecting the process used to create products, think about protecting the materials being used and how important they are. This may be through IP or an exclusive contractual agreement with the supplier.

In order for your company to reap the benefits from a new market offering such as 3D printing, or to thoroughly manage the risk element, it's key that your suppliers work with you to fully understand the impact that this will have on the day-to-day running of your business.

DMH Stallard's experienced lawyers and account managers work with you to meet your needs. We will meet with you at your offices to discuss your core service requirements and agree together those that you are most likely to require, making sure that we can support your business in the most economical way, keeping costs down and reducing your exposure to legal risk. After our meeting, we will send you a clear, straightforward quote based on our discussions.

FOR MORE INFORMATION, AND FOR A FREE NO OBLIGATION CHAT WITH ONE OF OUR EXPERIENCED TECHNOLOGY LAWYERS, PLEASE CALL ROBERT GANPATSINGH ON **01273 744213** OR EMAIL **ROBERT.GANPATSINGH@DMHSTALLARD.COM**

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