

3D Printing

How it's being used and what's next

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Introduction

Whilst 3D printing has been touted as tomorrow's technology for around a decade, and been around since the 80's, it now encompasses seven key techniques and there are signs that it is seeping into the mainstream to the extent that major change is on the horizon.

Chinese company Wilsun has demonstrated the construction of a two-story villa in less than three hours, using the techniqueⁱ. This novelty value is to crystalize into solid business opportunities, with research suggesting there could be a number of viable 3D-construction businesses within five to ten yearsⁱⁱ. Indeed, the UAE is aiming for 25 percent of its buildings to be 3D printed by 2030ⁱⁱⁱ, no doubt in since 3D printed construction can save 80 percent in overall building costs^{iv}. Whilst the impact on anyone using real estate could in itself be profound, the 3D printing revolution will impact a variety of product and even service oriented industries in ways that may surprise the casual observer.

Capabilities are rapidly evolving thanks to improvements in both digital technologies and the machines themselves^v, which are already moving beyond plastic to become material agnostic. In addition, a new printer has been developed that is ten times faster than commercial counterparts^{vi}. Carbon Inc.'s M1 3D printers can now produce complex objects in minutes, compared with the hours needed by traditional, layer-by-layer 3D printers^{vii}.

As such, we are, after a long period of over hype and under performance, on the cusp '...of creating a new generation of devices that could vastly expand the practical applications for 3D and 4D printing^{viii}.' One breakthrough has allowed scientists to edit 3D printed object after completion^{ix}. Other current research could allow future 3D printers to operate at the molecular level, potentially transforming the nature of personalised medicines, energy generation.

It is currently forecast that by 2030, 3D printing could represent a \$400 billion market^x. The bigger transformation however, will likely be found with how industries are reconfigured, downstream opportunities and challenges arise, and how it intertwines with other emerging technologies. After A.I and perhaps quantum computing, there is reason enough to suggest that 3D printing could become one of the key sources of innovation and disruption to products, services, business models and beyond in the first half of the 21st century.

Retail

Current consumption habits and accepted obsolescence are fundamentally problematic for the environment and as several studies suggest, our humanity itself. The Economist Intelligence Unit has noted that 80 percent of customers demand new consumption models including subscribing, leasing and sharing^{xi}.

3D fabricating a broad array of products will likely not just create new consumption models, but new industries. Repair components for goods or even the goods themselves in the case of clothing could 'exist,' only in cyberspace until required. Some 71 percent of the top 100 manufacturers already use 3D printing, some for rapid prototyping and others for production or custom parts. This is likely to expand in range and could ultimately blend some industries together and alter models as high-end design becomes mass market. Researchers have calculated major cost savings of 3D printing household items – from between 93 and 98.6 percent^{xii}.

Uses in the sector

- Ministry of Supply are experimenting with in-store automated manufacturing. In 2017, they installed a machine in its Boston store that can make a

garment on demand in 90 minutes^{xiii}.

- Staples offers 3D printing services in a select number of stores and an online service in which users can upload a design and ship 3D prints directly to their home or office^{xiv}.
- Adidas aims to sell 100,000 of trainers with 3D printed soles by the end of 2018^{xv}.

Possible future consequences

- Open source 3D knitting machinery could profoundly reshape the \$3 Trillion global apparel market. Open source designs are likely to be free or extremely cheap and the speed at which copies or originals produced, unrivalled^{xvi}.
- Build-to-order production strategies could fundamentally challenge the dynamics between manufacturers, wholesalers and retailers^{xvii}. New supplier relationships essential.
- Customers could become involved in product design and perhaps even finished goods manufacturing^{xviii}. White label could prosper.
- 'Value will shift from finished goods to the digital representations of goods^{xix},' notes MIT Sloan.
- Direct-to-consumer models will likely thrive, necessitating a new form of marketing and consumer relationship. Data use, and mis-use, will be central to defining such relationships.

Financial Services

As of 2017, only 0.01% of all manufacturing output was 3D printed^{xx}. Given the low utilisation rates, stating that 3D printing could redraw financial services as we know them might seem far-fetched. Whilst artificial intelligence and data science are perhaps more obvious vectors of change, 3D printing could shift the environment in which financial services providers operate in profound ways.

Digital Rights Management is likely to receive a significant boost from the introduction of 3D printing across manufacturing sectors as assets increasingly become digital. Digital Assets owners and producers will have an enormous stake and 'Know Your Customer' (KYC) shared utilities will probably continue to experiment and grow.

Thanks to PSD2 rules in Europe, blockchain and FinTech, the payment landscape is already changing. Banking customers will likely soon require a unique Digital Identity for many aspects of their life^{xxi}. 3D printing could further fuel this as more value is digitally stored. The WEF has already proposed the concept of a data bank account. A person's data, it suggested, should '...reside in an account where it would be controlled, managed, exchanged and accounted for^{xxii}'.

Uses in the sector

- Banks are ideally-placed to capitalise on the identity opportunity that 3D printing further fuels. Banks already verify identities for commercial and regulatory purposes.
- Digital identity, as part of a wider initiative, could enable banks to reposition themselves as trusted advisers. BBVA, for example, has launched Veridas along with the start-up Das-Nano. It '...specializes in biometry that helps develop customer identification and authenticity systems that are securer and easier to use^{xxiii}'.

Possible future consequences

- The digitisation inherent in 3D printing presents many new revenue streams. For example, in '...offering identity-as-a-service, acting as a 'broker of trust' in previously trustless transactions, disrupting the credit bureau model, or engaging in new public-sector partnerships^{xxiv}'.
- Previously fringe ideas will gain currency as the automated economy takes hold. The Commonwealth Bank of Australia, for example, is reportedly considering the implications of a future in which '...machines have their own bank accounts and pay for replacement parts and engineers to service them^{xxv}'.

Insurance

The digital revolution is rewriting the rules of business, and with it, redesigning organizational and business model structures. However, only 11 percent admit feeling ready to craft more 'future-proof' organizations^{xxvi}. Many industry orthodoxies are increasingly irrelevant yet most insurers have been reluctant to reinvent themselves^{xxvii}. 3D printing represents one more compelling reason why change for insurers is no longer optional, but rather a core part of future business strategy.

The shift from purchasing a finished product to copy rights could well shift product liability, perhaps to the manufacturers of the printers or product designers. Although the legal implications – and thus the insurance implications – remain vague, especially relating to personal sue of 3D printers, there is likely to be an array of challenges and opportunities that arise.

In a way, insurers are already mentally adjusting to some of the possible implications of a 3D printed world. Some 83 percent of insurers believe that digital is powering the shift from selling products to selling outcomes^{xxviii}.

Uses in the sector

- SBS Insurance in the UK uses 3D printing technology and a first-of-its-kind insurance claim service to provide identical, high value, 3D printed jewelry models that replace the previously irreplaceable^{xxix}.
- In Belgium, DVV rolled out a new service called "Key Save". Customers scan their keys and save the data on a secure server. Whenever they lose their keys in the following they can import the data on a 3D printer and create a new one^{xxx}.

Possible future consequences

- Insurance business models could continue to shift from indemnify to replacement.
- 3D printing could create fundamentally new liability vectors and scenarios for companies in many sectors^{xxxi}.
- Since customer needs are becoming more fluid and often '...combine expectations encompassing multiple needs^{xxxii}', there is an increasing call for some sort of 'halo' coverage. With liability difficult to assess with some uses of 3D printing technology, the development of all-in-one outcome based coverage could rise.

Legal Services

The suite of digital technologies set to boost the global economy to \$120 Tn by 2025 (from \$78 Tn now)^{xxxiii} will also transform its very nature. It is estimated that 50 percent of the additional growth 2025 will be generated by start-ups and as yet launched companies and even business sectors. Quite simply, a swathe of new business for legal services will emerge.

The transition will not be without its issues however; the boundaries between manufacturer and end-user will likely be blurred by 3D printing, for example. End-users, in some cases, will be able to participate in the design and production processes, printing partial or even complete products by themselves. As a result, product liability is set to become a key issue.

SwissRe notes that ‘...application of 3D printing might cause uncertainties in apportioning liabilities, (and notes that) accountability and traceability issues can also arise^{xxxiv}.’ This could be an issue for a larger chunk of the value chain than just the end manufacturer, whoever that may be.

Professional indemnity covers will need reviewing – anybody involved in the creation of a given design, from designers to engineers and even architects may need to assess whether 3D printing shifts liability in new ways.

Furthermore, IP rights and cyber issues may require assessing in the case of manipulation or misappropriation - or simply with design being open source and shareable.

Impacts on the sector

- It has been predicted that by as soon as the end of 2018, 3D printing could start to induce intellectual property losses of around \$100 billion per year globally^{xxxv}.
- Digital transformation for legal services goes well beyond a new consumer facing interface or integration of A.I. Although important, issues such as 3D printing should also be front and centre of future strategies and current discussions.

Possible future consequences

- For those with the digital capability and understanding, there is likely to be a market for preventative or pre-emptive legal services (perhaps integrated into products and/or services in conjunction with the IoT)
- An increasingly digital existence, including for IP, will generate a market for those wishing to protect themselves from cyber-risk.
- 3D printing could challenge how I.P is protected^{xxxvi}

Health and Pharma

Perhaps only the aviation and automotive industries can claim to have used 3D printing more successfully and over a wider range of areas than healthcare.

3D printing promises to not only further change both the delivery systems of treatment, but also their price dynamics. Deloitte notes, for example, that '...the first 3D implant made for children - airway splints that grow with babies being treated for tracheobronchomalacia - can be produced in a matter of hours at a cost of about \$10 per unit^{xxxvii}.'

The wide range of 3D printed products – from dental implants and organs to skin replacement and even bone repair suggests a promising avenue for helping curtail rising healthcare costs in the United States and the United Kingdom^{xxxviii}. Especially so, when these savings are combined with new techniques for manufacturing pharmaceuticals. 3D printing drugs is expected to form a \$522 million market by 2030^{xxxix}, and also raising the possibility of personalised medicine.

Uses in the sector

- Using 3D printing and a person's own cells, Chinese scientists have grown five human ears for transplant^{xl}.

- Scientists have developed a ceramic 3D printed implant that holds broken bones together before turning into natural bone during the healing process^{xli}.
- Modular 3D printed prosthetics have been created with equivalent functionality as existing models, but at as little as half the cost^{xlii}.
- Israeli bioprinting company CollPlant is edging closer to creating the first, much anticipated bioprinted organs^{xliii}.
- Players such as Stratasys and 3D Systems are 'certifying an end-to-end process for producing medical parts with newly developed materials, using their own printing technology and offering printing services to customers such as hospitals, which formerly purchased from OEMs^{xliv}'.

Possible future consequences

- Supply chains for pharma will radically alter. Healthcare burdens could shift from hospitals and towards other settings.
- Harvard Business Review reports that '...scientists have used 3D-printing tools to create a bionic ear that can hear radio frequencies far beyond the range of normal human capability, in a project to explore the feasibility of combining electronics with tissue^{xlv}'.

Marketing

Since 3D printing has, at the very least, the potential to change how business is done, then it follows that it will change how marketers interact with consumers. For a start, 3D printed products rely on the sale of a license rather than a physical copy of the product. This is a new business model that could rewrite the role of the 'brand,' introduce new direct-to-consumer models and redefine consumer behaviour in quite profound ways. If high-end design becomes mass-market, dynamics could alter quite appreciably. The extent to which 3D printing could change consumer behaviour, expectations and norms should not be underestimated; ING estimates that 3D printing will create over \$6 trillion of goods within forty years^{xlvi}.

Whilst the overall strategic direction of marketing would appear uncertain, the near-term benefits of 3D printing would appear more certain. Some 83 percent of consumers like receiving a promotional product with an advertising message, whilst some 85 percent of promotional product recipients subsequently do business with the advertiser^{xlvii}. 3D printing could not only customise messages but do so with an expanding array of materials, techniques and output.

Uses in the sector

- An increasing number of brands are including 3D printing as part of their campaigns. Marketers from companies such as Coca-Cola, VW, and Belvita, have experimented with 3D printing for their creative campaigns^{xlviii}.
- Volkswagen promoted its Polo with the help of 3D printing in Denmark. Members of the public were allowed to '...take control of the 3D printer used to create the original car model via a website. Then, the consumers could create their very own versions. 40 ideas were finally 3D-printed and displayed in Copenhagen. Afterwards the designers had the chance to take their mini-car home – one of the ideas was even turned into a real-life Polo^{xlix}.'

Possible future consequences

- There is a possibility of disintermediation of messaging in a world awash with non-branded third-party suppliers.
- Design will likely emerge as a key differentiator in an expanding array of products and goods.
- An increase in competition is likely given the democratising nature of 3D printers. An increase in platform sue is likely to ensue to help consumers avoid drowning in choice.
- New marketing business and operating models will be needed.

Education

Learning and education would appear to be ideally set to benefit from 3D printing, since the technology encompasses a wide range of subjects -from design to technology- and can be used for model buildings across the sciences and geology^l. Perhaps most notably in its impact is the use of 3D-printed models for rapid prototyping within architectural design and engineering.

Many technologies, such as virtual or mixed reality can help bring abstract ideas to life, and 3D printing is no different. MIT Sloan states that ‘...the addition of 3D printing to educational experiences is having a powerful impact on learning effectiveness and will support the development of new experiential pedagogical approaches^{li}.’ Building the standards and frameworks from which to extract this value will be a key task in the next half a decade or so.

Uses in the sector

- ‘2017 saw plenty of innovative 3D printed educational aids and projects for the classroom – even 3D printed educational models for visually impaired students^{lii}.’
- In addition, America Makes, Pinshape, and 3Dexter all held contests in 2017, with the goal of

developing creative 3D printing lesson plans^{liii}.

- 3D printing offers hands on learning for medical students and others studying complex systems.

Possible future consequences

- This has led to the Department for Education concluding that ‘...3D printers have significant potential as a teaching resource^{liv}.’
- In the UK, the recently published UK Additive Manufacturing National Strategy identified development of 3D printing skills in current and future workforce as a core recommendation^{lv}.
- The 3D printing effort, entrenched in higher education, will further blur the line between school and commerce^{lvi} and potentially provide a significant start-up stimulus.
- The links between universities and companies could further strengthen.
- 3D print designer training centres could appear as ‘micro-colleges^{lvii}.’
- Education and tech companies could develop new synergies. GE Additive has announced that over 400 schools around the world will receive 3D printers as part of its GE Additive Education Program^{lviii}.

Automotive

Together with aerospace, companies in the automotive industry ecosystem have been at the forefront of 3D printing adoption^{lix}. Its popularity lies in its' ability to help streamline development, reduce stock, increase quality of parts and cutting time and costs significantly.

At Ford, for example, as of 2017 five 3D prototyping centres produced more than 100,000 prototype parts annually. In the future, Ford states that additive manufacturing will likely be used to construct a least a portion of production parts on vehicles^{lx}.

3D printing will also prompt a paradigm change in design. With instant feedback from prototypes (or even with 4D printing, changes in the printed form itself) the extent to which feedback is incorporated into R&D will be enhanced. Design itself is likely to see significant innovation as the capabilities and materials of 3D printing grows.

Uses in the sector

- 71 percent of the top 100 manufacturers are using 3D printing, some for rapid prototyping and others for production or custom parts^{lxi}.
- Within 5 years, 85 percent of spare parts suppliers could incorporate 3D printing into their business model^{lxii}.
- Local Motors can develop new designs for its 3D printed cars at one thousandth of the cost of a typical competitor and manufacture each car 5-22 times faster^{lxiii}.
- Michelin's Vision is both a wheel and airless tire in one. The 3D printed tire is taking aim at the driverless car market^{lxiv}.

Possible future consequences

- 3D printing could reduce '...the cost of developing an entirely new vehicle from \$600 million today to just \$60 million^{lxv}'.
- Trade flows could be heavily impacted by 3D printing. Large scale importers of cars, such as the U.S, could see increases in local production, for example^{lxvi}.
- ING suggests that up to 50 percent of manufactured goods (some \$6 trillion) could be printed by 2060^{lxvii}.
- Under some scenarios in which investment doubles every five years even show this threshold reached by 2040.
- The result could be a reduction of world trade by one quarter by 2060, or even two fifths by 2040 under the accelerated scenario^{lxviii}.
- Digital presence of IP rights, designs and blueprints will need to be considered; is it possible that anything we produce digitally will likely no longer be transferrable to the next file format^{lxix}.

Tech

If data is the foot-soldier in breaking down industry barriers – allowing Amazon to muscle in on banking for example, then for some industries 3D printing could be the killer app. Data allied with 3D printing could redraw a host of industries – from construction to food to manufacturing. The ability to use any material is central to 3D printing's central role in Epson's \$14.9 billion 2025 revenue strategy^{lxx} (50 percent growth from than 2016). The range of sectors tech companies could partner with or else provide competition to, will grow significantly.

At the same time, how things are done will change almost as much as what is done. Ideas can progress from concept to prototype at ever shorter intervals^{lxxi}. This shortening lead time is one of the reasons why, although still at an early stage, the applications for 3D-printed electronics seem promising.

Uses in the sector

- A new 4D printer can create electrical wiring that can be printed directly onto an antenna, sensor or other electrical device^{lxxii}.
- Researchers at the University of Nottingham have '...pioneered a breakthrough method to rapidly 3D print fully functional electronic circuits. The circuits contain

electrically-conductive metallic inks and insulating polymeric inks^{lxxiii}.

- The University of Nottingham project has led to several collaborations, variously aimed at developing medical devices and boosting the harvesting of solar energy.
- Engineers are experimenting with stretchable electronics that can be embedded in fitness trackers, smart apparel, and skin patches. They could also be applied to on-demand manufacturing and mass customisation processes^{lxxiv}.
- In the near term, '...developments such as printing electronics in nanoscale and using newer materials such as graphene could lead to additional possibilities in product design^{lxxv}.'
- NASA is building densely populated assemblies using 3D printing for electronic devices^{lxxvi}.

Possible future consequences

- Some analysts expect 3D-printed electronics to be the next high-growth application for product innovation in the next five years^{lxxvii}.
- Companies could potentially print their own parts.
- PwC notes that '...companies like Amazon and Google are looking into business models based on platforms for 3D printing design files and blueprints^{lxxviii}.'

Conclusion

People have always tended to overestimate the short-term impact of technologies whilst significantly underestimated the long-term impact. This still holds true. The long-term impact on traditional value chains, business models and even industry boundaries remains uncertain, yet it is likely that an expanding range of companies beyond manufacturing will be impacted. ‘The elements for creating a “cradle-to-cradle” economy are here (one where there is no ‘grave’ or throw-away of items – ed). It is the killer app for 3D printing^{lxxxix},’ says Dr Gregory Unruh in MIT Sloan Management Review.

The ways of serving markets will change, with consumer-centric propositions flowing from the synergy of many technologies, including 3D printing. The combination of 3D printing, the emerging bio-economy and A.I could presage a new economy.

Nevertheless, a number of barriers need overcoming. The first is the plethora of standards and regulations likely to emerge as relating to individual industries’ need. Deloitte correctly notes that ‘...consensus and coherence will require some measure of time—as stakeholders in other emerging technologies such as the Internet of Things have come to understand^{lxxx}.’ In addition, to realise the potential of 3D printing, there is a need to address the following social and technical issues^{lxxxi}:

- Lack of design knowledge.
- High (although falling) production costs.
- Limited production scale.
- Limited cybersecurity and IP protection.

Nevertheless, with a combination of 3D and 4D technologies we could be on the cusp of an ‘instant anything,’ era. Size and material no longer reflect the boundaries previously seen in 3D plastic printers. Anything is now plausible, from a block of flats to a new ring. Organisations will need to consider what propositions this could afford, what they could achieve with wider and revamped networks (for making and distribution) and how they could help influence consumer behaviour with new forms of consumption. Cocreation and engagement, via new mediums will be essential for such a future to come into fruition as processes such as real-time co-design and printing democratise processes previously requiring input from professionals.

About David Smith

David is recognised as a leading strategic futurist who combines the experience gained from a 35 year IT, marketing and business career with strategic visioning to help organisations better prepare for the future. His career has spanned European and US corporations. He is a much sought after keynote speaker and is the author of many works on embracing change and the drivers of change. Before establishing Global Futures and Foresight, an independent futures research firm, he created and ran the Unisys internal Think Tank, The Global Future Forum. Prior to this he was head of strategic marketing for their \$2bn global financial services business.



David and his organisation has been engaged by some of the largest and most prestigious firms from around the world including: The European Commission, NATO, BBC and financial services firms including HSBC, Lloyds/TSB, Atom Bank, RBS, Lloyds, More Than, e-sure, Travelers, Allianz, QBE and Lloyds syndicates along with many other prestigious firms including CSC, Unisys, Cisco, Microsoft, Siemens, Deloitte, Ernst & Young, PWC, Bausch & Lomb, Linpac, Kraft, Heinz, John Lewis, Roche, Philips, Ogilvy etc. He is a regular lecturer at business schools across Europe.



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About Global Futures and Foresight

Global Futures and Foresight is a research and consulting organisation that helps organisations be better prepared to embrace change, innovate and develop new strategies and solutions and helps clients to avoid the risk of being blindsided by external disruptive change.

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About Marcela Lopez, Artist

Front cover by Marcela.



Marcela Lopez, Colombian artist with European influences based in UK. Commissions and artwork for sale. My subject matter is landscape. Using my hands I choose plaster to capture the movement of water and trees on wooden boards. Through my artwork I intend to invite viewers to a peaceful moment of reflection. I see my artworks gently brightening up any space and being a source point of serenity and comfort.

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