Digital Transformation Monitor

The disruptive nature of 3D printing

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The disruptive nature of 3D printing: offering new opportunities for verticals

Significant advances in additive manufacturing (AM) technologies, commonly known as 3D printing, over the past decade have transformed the ways in which products are designed, developed, manufactured, and distributed. 3D printing’s ability and advantages over traditional manufacturing open plenty of opportunities for verticals, spanning from product design and development, customization service, to restructuring of supply chain for higher efficiency.

Democratisation of 3D printing is underway

Revolution in object creation

3D printing (3DP), included in the broader term of ‘Additive Manufacture’ (AM), refers to the various processes used in the manufacture of products, by depositing or fusing materials layer by layer. The 3D-printing process can, though, date back to the 1980s, when additive manufacturing (AM) was practised for rapid prototyping in industrial applications.

Disruptive nature

3D printing holds huge potential to disrupt the way in which a product could be designed, developed and manufactured.

Intricate product design

3D printed parts allows them to be designed with more complex architectures whereas with little additional costs, for example, the structure with hollowing holes, atypical shapes or rich interior details. In addition, some pieces that used to be molded separately and then assembled can now be produced as one piece in a single run, even for some precision components.

Flexibility and customisation

3D printing allows much more flexibility than standard manufacturing, because each unit is built independently, therefore modification or improvement can be made much easier and involving far fewer stages. For this reason 3D printing has been vastly used for fast prototyping and product customization.

Workflow optimisation

Workflow and process are expected to be streamlined, as a result of all the aforementioned advantages. Additive Manufacture processes are viewed as generating less scrap and using fewer tools than traditional manufacturing. Meanwhile, it is capable of reducing iterative process, assembly and possibly inventory. Consequently substantial operational cost benefits can be anticipated.

Cost-effective low volume production

3D printing also reduces the reliance on economies of scale, since it makes producing thousands items as cheap as producing single. 3D printing is thus viable for low to medium-volume production without higher initial investments for tooling and setup. Not being a replacement solution for the time being, 3D printing does provide an additional, financially responsible option for manufacturing.

3D printing applications

3D printing’s ability and advantages over traditional manufacturing make it a natural fit for many verticals for various purposes, with aerospace, automotive, medical and many other industrial products leading the adoption.

Rapid prototyping still dominates

A PwC survey of industrial manufacturers reveals that more than two-thirds were already using 3D printing. Most were using it for rapid prototyping or experimenting. Other applications include customised production in low volume, and product innovation that cannot be achieved using...
traditional methods. Using 3DP for final parts production was seen a significant increase, however, remains marginal, mainly due to relatively low throughput rate and printing quality.

**Demand for diversified usages**

Outside the industries, a survey of Sculpteo shows the full extent of the integration of 3DP in professional settings. Fast prototype (55%) remains the primary application while proof-of-concept (29%) follows its lead. Diversified applications also include hobbies, production, education and more. Production (24%) is among main purposes for 3D printing, confirming that demand is present but requires prior experience to leverage its full potential.

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**Radical transformation of verticals**

**A strong uptrend in market growth**

3D printing industry is growing rapidly. The previous three years saw a CAGR growth of 33.8% according to Wohlers Report. The total AM products and services worldwide grew at a Compound Annual Growth Rate (CAGR) of 25.9% to approximately 4.8 billion EUR in 2015. This was the second consecutive year that 3D printing industry grew by nearly one billion EUR.

Nearly half of market value is contributed by 3DP systems, and this trend seems to continue in the following 10 years (estimated 48.1% in 2023). The three system manufacturers - Stratasys, 3D Systems and EOS, account for nearly 70% of the total 3D systems market.

**3D printing in automotive industry**

Automakers have been using AM for over two decades, and today are progressing to a variety of applications, ranging from design, development, tooling and rapid manufacturing.

**Accelerated prototyping**

Automakers began the use of AM from rapid prototyping. It has been widely integrated into the product development cycle to speed up this process. It also allows the test-of-concept far less costly by creating multiple product iterations very quickly.

**Rapid manufacturing of functional parts**

Some functional parts of vehicles can be printed directly, without moulding and assembling procedures. The service is typically applied for high-end cars, for example, sport cars components.

BMW 3D-printed water pump wheel for its German Touring Car Masters racecars in 2015. BMW states, with 3DP, this high-precision part is available within only a few days, and the demand-oriented production becomes more cost-effective.

**Valued-added service: car customisation**

3DP is also being used to produce the personalized car components, such as car body with different materials and forms options, or car accessories.

Customers will benefit from decreased lead times. A Japanese automaker, Daihats allows buyer to order 3D-printed “skins” to customize the external car body. Daihats indicates, a customised car that might have taken two months under old production methods will be delivered in two weeks with the 3D-printed parts.

However, key spare parts with structural or safety properties have not been on the stage of customisations yet.

**3D printing in healthcare industry**

**Rapid production of implants and prosthetics**

3DP has been used successfully to make both standard and customised hearing aid shell, dental implants and prosthetic limbs, sometimes within 24 hours. Previously, implants had to be validated before being used clinically, which is very time-consuming. Today, 99% of hearing aids are manufactured with 3DP.

**Surgical planning and tools**

3DP has created applications that previous technologies are incapable to achieve - surgical planning and assistance. 3D printed anatomical models allow surgeons to properly understand organs’ internal structure.

In addition, surgical guides with a better visualisation assist surgeons to plan detailed surgical procedures. As a result, it increases the clinical efficacy, lowers the surgical risk from errors, and produces better outcomes for patients. More than 70,000 surgical guide units were produced in 2013 with AM.

**3D bio-printing**

Looking further, some 3D biomedical systems are already capable of printing cells, proteins and organs. Current research interest mainly resides in bio-printing of skins and organs, including the production of bone and cartilage scaffolds, ligament and tendon scaffolds.

Although still in its infancy, 3D bio-printing offers additional advantages over the traditional regenerative method, particularly in bone and scaffold regeneration, such as highly precise cell placement and high digital control of speed, resolution, cell concentration and drop volume. Various materials are available to build the scaffolds, depending on the desired strength, porosity and type of tissue.
3D printing in retail and consumer products

Product and service innovation

3D printing is being explored to design, develop and manufacture a variety of consumer products, spanning from clothes, jewellery and other fashion products, digital accessories, to home gadgets and decoration.

To begin with, 3DP is capable of creating intricate design or geometric free structure. In addition, 3D printing opens a door to offer mass customization at lower cost. On this basis, collective-design will become a reality since the exchange and coordination between designers and buyers cost much less than before.

Decentralised manufacturing of products

Additive manufacturing enables decentralized manufacturing of consumer goods. Multiple assembly processes and long-distance transportation will be eliminated. A number of benefits can be expected: costs and time saving, improved responsiveness and flexibility, management of demand uncertainty and reduction in required inventory.

As a result, the logistics costs will be significantly reduces for manufacturers. Meanwhile, logistics companies are looking for new value-added services for their manufacturer clients. UPS is reshaping its logistics business - turning its airport hub warehouses into mini-factories by using 3D printing technology. This is a forerunner to a time when distribution companies themselves become factories.

3D printing in manufacturing

Disrupting the value chain

Apart from the specific impact to particular verticals, 3DP also has influence across the value chain of manufacturing. New business is emerging along with service platforms.

- **Marketplace of 3D print files**

  The marketplace came into being since the file creation is a process where a strong design expertise is needed. In such marketplaces, designers upload files of required formats while users can download the files for free or pay some fees for later printing.

- **On-demand 3D printing service platform or hub**

  It can be brick-and-mortar locations or online services, where both individual and industrial customers can “outsource” the 3D printing service to desired manufacturers, and have the goods delivered at their desired location.

Both platforms are fueling decentralized manufacturing and impact the value chain on many aspects. For one thing, competitiveness will increase with the costs going down. For another, production bases are no more necessary since it can be outsourced to scattered local 3DP hubs, and only crucial value-added processes should be insourced. Flexible tariff for on-demand services will be another benefit, compared to standard manufacturing.

This area becomes crowded while retailers, 3DP system providers as well as internet providers are stepping in. Shapeways, Thingiverse, Staples, 3D Hub, Sculpteo, UPS and Amazon are among the active players.

43% of companies expect 3D printing to have a strong impact on the location of plants.

Reshaping of regional manufacturing competitiveness

In the future, 3D printing may impact the locations of plants. Given the ability to create highly customized products with fewer overheads and production steps, many companies perceive 3D printing as an opportunity to re-shore manufacturing back to Western countries.

Different regions are highly expecting the shift of plants location as well. According to a survey conducted by EY Research, UK leads the expectation with 66% anticipating this change, followed by China and South Korea (46%), as well as Germany (43%). For the US (37%) and the rest of Western Europe (35%).

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Taking steps forward

Price drop as a booster for adoption of 3D printing

A huge drop in price has been playing out since 2014, particularly for desktop-sized 3D printers, due to the expiration of key patents that year. A previous patent expiration in 2009 led to a significant drop of printer prices from EUR 13,000 to approximately EUR 275-375 during the past 5 years. The trend is expected to continue, allowing consumer to choose between higher speeds and more materials options (metal, ceramic).

Meanwhile, the proliferation of start-ups resulted from the patent expiration may bring more innovation to sweep out technical hurdles for adoption. The MakerBot Replicator 2X, for example, controlled by simplified 3D software, is priced at EUR 2,300 but is as reliable and as good as the Stratasys uPrint which sells for EUR 15,000.

Figure 6: Value chain of manufacturing enabled by 3D printing

Source: IDATE DigiWorld, 3D Printing, 2015

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Standardisation in additive manufacturing

The lack of European and international standards related to AM will be a impediment to the implementation on a large scale. Facing this challenge, EU project for Support Action for Standardisation in Additive Manufacturing (SASAM) delivered a roadmap for standardisation activities for AM in 2013.

A number of standards categories were distinguished including design, specific industrial needs, quality of manufactured parts, materials, data processing (safety (regulations) and education. This dedicated standardisation roadmap is expected to release an economical push towards the reliability of the processes, printers and their products.

DRM to protect intellectual properties

The rising of marketplaces of design files, where people can download printing contents for free, imposes an increasing threat to intellectual properties (IP). Garner\(^6\) reported that by 2018, 3D printing will result in the loss of at least 100 billion USD per year in intellectual property rights globally.

Following the same development trajectory as other digital content like music and films, the companies that provide DRM systems to secure and rule the digital files access, delivery and printing process are emerging in an iTunes-like mode. Authentise and SendShapes are at the forefront in providing DRM solutions to design model owners and marketplaces.

Roadblocks to move away

Quality of the printed products

Surface finish and mechanical properties are of great concern, particularly for the usage in final or functional parts manufacturing. For instance, those technologies working with metal powder, are often associated with property problems, such as strength, stress and voids resulting from heating and layer binding.

Further, the repeatability of production is an uncertain element. Many printed parts also need traditional finishing is a factor which limits any gains in production flexibility and lead time.

Trade-off between printing speed and quality

Speed, often a result of printing resolution and magnitude, is a factor that significantly impact the 3DP adoption. The usage of 3DP for direct manufacture is moving slowly; because the low speed (hours’ printing for several inches) does not have any advantage over traditional mass manufacturing. We do see some printer speeds are increasing, but mainly appeared in high-end industrial or enterprise systems.

Legal barriers

For decades that 3D printing has existed, however, jurisprudence remains unclear concerning many legal regimes including patents, copyrights and trademark. Apart from this, public security are challenged given the fact that advancement of 3DP may facilitate the manufacturing of illegal objects, such as firearms.

Lack of expertise

User and consumer unfamiliarity with 3DP is eroding somewhat their interest in acquiring both 3DP systems and printing services. A survey by EY\(^6\) implies that, even product engineer admits that they do not have enough in-house expertise to establish the processes driven by 3D printing. In this sense, education and learning to cover a wider range of the population is more than necessary to drive up the adoption.

References


About the Digital Transformation Monitor

The Digital Transformation Monitor aims to foster the knowledge base on the state of play and evolution of digital transformation in Europe. The site provides a monitoring mechanism to examine key trends in digital transformation. It offers a unique insight into statistics and initiatives to support digital transformation, as well as reports on key industrial and technological opportunities, challenges and policy initiatives related to digital transformation.


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