Effects of 3D Printing Technology on Industry and Its Application

Anshuman Singh

SOMC, Sanskriti University, Mathura, Uttar Pradesh, India

Email Id-anshuman.me@sanskriti.edu.in

ABSTRACT: ***3D printing, also known as Advanced Manufacturing technology, has been branded the next big thing and is expected to be as widely used as the cellular telephone sector in the near future. 3D printers create objects by printing them from a computer template to a tangible, three-dimensional object in three dimensions. Plastic, metals, nylon, and more than a hundred other materials are used in the printing process, which is done layer by layer (also known as additive manufacturing). Three-dimensional printing (3D printing) has been found to be beneficial in a variety of industries including manufacturing and industrial design, jewelry and footwear, architecture and civil engineering, automotive and aerospace, comprehensive medical industries, schooling, geographic information systems, and civil engineering, among others. It has been proven to be a quick and cost-effective solution in a variety of fields of application. The number of uses for 3D printing is growing all the time, and it is proving to be a really fascinating technology to keep an eye on. In this paper, we will look at how 3D printing works, as well as the existing and future implications of this technology.***

KEYWORDS: 3D Printer, 3D Printing Technology, Digital Model, Manufacturing, Three-Dimensional Printing.

1. INTRODUCTION

Three-dimensional printing is a technique for creating three-dimensional solid objects of nearly any shape from a digital model. The material is placed down in layers, with each layer having a different shape. 3D printing differs from traditional machining processes in that it adds layers on top of layers rather than removing material as is done with procedures such as cutting or drilling. As a result, it employs a layering approach, in which an object is built up layer by layer until the entire object is completed and made. Thus, 3D printing shifts us away from the mass production line and toward a one-off, customized manufacturing process. Any object, from a home to a bar of chocolate, is literally within your grasp, to put it another way. The first 3D printers were employed in the 1980s, and they worked by tracing a pattern submerged in a liquid polymer with a computer. Because of the laser, the traced pattern solidified into a layer, which was then used to construct an object out of plastic. During the intervening period, great development has been achieved in additive manufacturing, to the point where material extrusion is currently being utilized. This process involves the construction of an item out of matter that is extruded from a mechanical head in the same manner that an inkjet printer extrudes ink onto paper. It's interesting to note that the cost of getting 3D printers has been reducing in tandem with technological improvement. The use of 3D printers in the home is increasing, and the typical cost, which starts at a few hundreds of dollars and goes up, is also increasing[1].

One significant disadvantage, however, is that printing 3D items necessitates the use of specialized equipment. In fact, it takes a skilled individual to create both the digital file and the final printed version of the document. There has also been an upsurge in the commercial use of 3D printers, particularly in industries like as the automotive industry and aerospace engineering. Parts for the automotive and aeronautical industries, for example, are being manufactured in large quantities, allowing for greater economies of scale. 3D printing is transforming the way manufacturing lines operate, prompting some observers to refer to the introduction of 3D printers as the second Industrial Revolution (second Industrial Revolution). 3D printing has also found widespread application in the realm of medicine, ranging from Bionics to Prosthetics to Digital Dentistry, among other fields. Naturally, this is having a positive impact on and transforming every element of medical practice. The majority of the work is still in the experimental stage, but experts expect that the incorporation of 3D printing as a tool will change medicine in the future[2].

1.1 Functioning Approach:

As illustrated in figure 1, 3D printing begins with the creation of a virtual model of the object you wish to construct. The virtual design is utilized to produce a template for the physical product that will be built from it. Virtual designs can be created using a 3D modelling application such as CAD (Computer Aided Design) to start from zero and then be modified and refined over time. A 3D scanner can also be used to create a

replica of an existing object. This scanner creates a three-dimensional digital replica of an object, which is then imported into a three-dimensional modelling tool[3].

Figure 1: Illustrates digital model of 3D objects [NOTTINGHAM].

In preparation for printing, the model is next split into hundreds or thousands of horizontal layers using a laser cutter. This created file is then uploaded into the 3D printer, which will result in the printer building the object layer by layer as illustrated in figure 2 below.

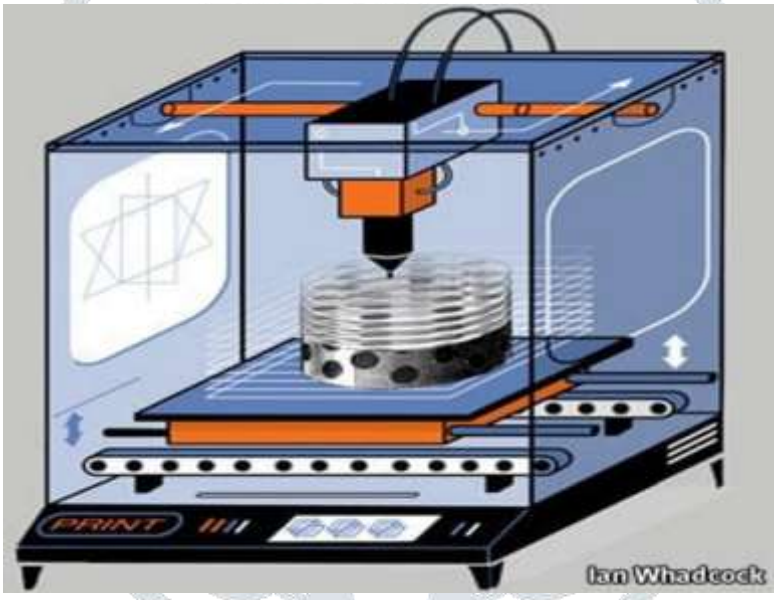

Figure 2: Illustrates layer by layer 3D printing process [ECONOMIST].

Every slice (2D picture) is read by the printer, which then proceeds to build the object layer by layer until there is no trace of the layering visible and the object has a three-dimensional structure rather than a two-dimensional structure[4].

1.2 3D Printing Applications:

In a wide range of industries, 3D printing technology has been successfully implemented. Figure 3 depicts the numerous types of applications for 3D printing, which include research, creative objects, visual aids, presentation models, device coverings, bespoke parts, functional models, and patterns, as well as series production and large-scale manufacturing.

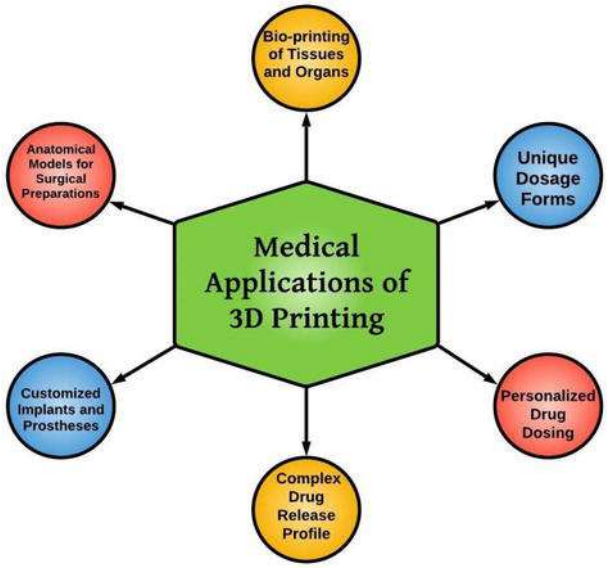

Figure 3: Illustrates the applications of 3D printing [INTECHOPEN].

1.3 Design:

Figure 4: Illustrates the 3D construction process [ARCHDAILY].

During one day, they were able to construct ten one-story dwellings, a process that would ordinarily take weeks or months to complete in the United States. As a result, 3D printing offers a more cost-effective, faster, and safer alternative to more traditional construction methods. Building of dwellings in Shanghai was made possible by WinSun Decoration Design Engineering, which employed four massive 3D printers to construct the walls layer by layer out of a mixture of cement and construction waste[5]. Approximately 10 meters wide and 6.6 meters high, each of these residences. Figure 4 shows the 3D construction process.

Due to the fact that each house costs less than $5000, it has shown to be both cost-effective and time efficient.

1.4 Medicine:

1.4.1 Bio-Printing Devices:

Organ printing or body part printing is now being carried out, with certain sections being used as implants for real-life body parts. It has been possible to print body components such as titanium pelvis, plastic tracheal splints, titanium jaws to name a few examples.

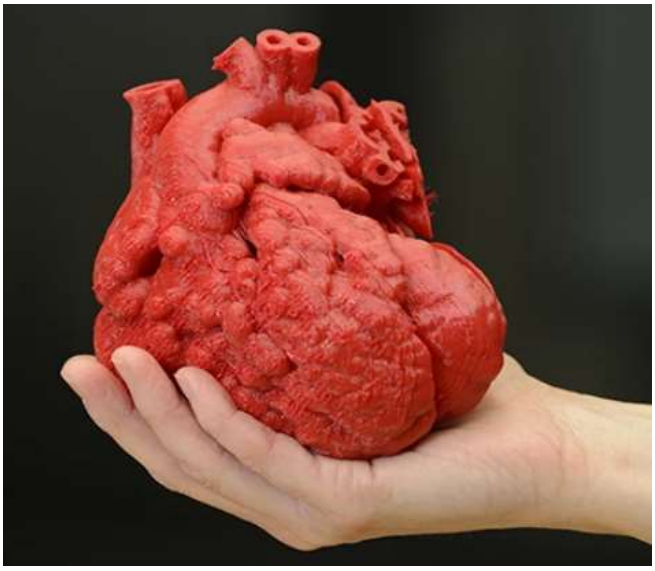

Figure 5: 3D printed heart [NEWATLAS].

Figure 5 depicts a human heart that has been 3D printed. New bio printers are capable of printing human tissue for use in pharmaceutical research and, potentially, the creation of whole organs and bones in the laboratory. Tissue engineering has advanced tremendously in recent years, with the ability to manufacture 3D blood arteries becoming a reality. Using breakthroughs in 3D bio-printing technology and biomaterials, the researchers were able to do this through the vascularization of hydrogel structures[6].

1.4.2 Digital Dentistry:

People are obtaining 3D printed teeth that are customized to their needs and preferences. Dental implants are now being manufactured on a commercial scale, which is speeding up and streamlining the entire procedure. Previously, false teeth were available in a one-size-fits-all configuration, regardless of age. People of the same age can now have various sized teeth, resulting in people experiencing discomfort when wearing prosthetic teeth that are ill-fitting. Customers can breathe a sigh of relief since they can now acquire teeth that are specifically tailored to their needs thanks to the introduction of personalized implants[7].

1.4.3 Prosthetics and Orthotics:

The need for surrogate body parts is wide-ranging, ranging from persons born without limbs to those who have been injured in accidents. A few years ago, the cost of obtaining surrogate body parts was prohibitively expensive; however, thanks to 3D printing, that cost has been greatly decreased. Prosthetics have made significant improvements in the lives of disabled persons, with Paralympic winner Oscar Pistorius being one of the most well-known examples. Oscar Pistorius had his legs amputated when he was a toddler, but that did not prevent him from participating in sports, much alone the Olympics[8].

1.4.4 Bionics:

Princeton and John Hopkins researchers were successful in creating a bionic ear that was 3D printed in their lab. The hearing is accomplished with the use of electronic devices. This development may make it easier for deaf people to hear.

1.4.5 Artificial Organs:

Aside from the potential for printing artificial organs, additive manufacturing of stem cells has also opened the door to a plethora of other possibilities, although most of the research is still in the experimental phase. Scientists at Heriot-Watt University, for example, were able to generate clusters of embryonic stem cells through the use of 3D printing technology. A seemingly unlimited world of possibilities awaits this world as a result of the possibility of printing actual functioning artificial organs on demand.

1.5 Manufacturing Process:

A new era of quick manufacturing has been ushered in thanks to 3D printing. It is now possible to skip the prototyping process entirely and proceed directly to the final product. 3D printing technology is being used to create parts for automobiles and airplanes. The printing of parts is accomplished in a timely and effective manner, thereby making a significant contribution to the value chain. The ability to make customized products is enabled by the ability for customers to update the digital design file and then send it to the

manufacturer for manufacturing. Using 3D design files of its casing, Nokia Company has taken the lead in manufacturing in this field by making them available to its customers so that they can personalize it to their specifications and have it 3D printed[9].

1.6 Home Usage:

The home can benefit from the use of 3D printers to create little goods such as ornamental objects such as necklaces and rings, among other things. Small plastic toys can also be printed in the comfort of one's own home. People will be able to print their own things at home in the future, rather than having to purchase them from a store.

1.6.1 Clothing:

The fashion sector has not been exempt from this trend. Clothing that has been 3D printed is now being produced. 3D-printed bikinis, shoes, and gowns are being experimented with by fashion designers today. With the use of a 3D prototype, Nike created the 2012 Vapor Laser Talon football shoe as well as the New Balance custom-fit sneakers for athletes. The manufacture was carried out on a large scale for commercial purposes.

1.6.2 Academia:

The use of 3D printing is currently being incorporated into educational curricula. With applications ranging from 3D-printed molecular models to plastic gears and everything in between. As a result, students are now able to print their prototype models in three dimensions, which aids in the learning process. Students are better able to comprehend things when they can see them demonstrated in a practical setting[10].

1.7 Advantages:

Three-dimensional printing has demonstrated the following advantages:

- Lower cost: In China, they were able to build ten one-story houses for less than $5000 per house, which was a significant savings. The cost of building a house similar to the one in question is significantly higher than the amount specified.
- Time: Unlike traditional manufacturing, where numerous components had to be assembled to make the final product, 3D printing allows you to print the 3D object directly. Businesses can now produce working models in hours rather than days or weeks, thanks to three-dimensional printing technology.
- Productivity: Using 3D printing technology, creating prototypes is considerably easier and faster than in the past.
- A variety of materials can be employed in the 3D models, which allows for greater flexibility in design. Because of this, it is relatively simple to generate construction models or prototypes for a wide range of projects across a wide range of sectors.
- Long-lasting items are created because the objects do not absorb moisture or distort with time, allowing them to last for a longer period of time.
- Product quality: Products with a great surface finish are manufactured.
- As an alternative to working with paper or digital models, real-time functional models can be created instead. Products that are more realistic in appearance are being developed.

CONCLUSION

In accordance with growth projections, the 3D printing industry is on the verge of experiencing explosive expansion. As more and more research is conducted into 3D printing, the number of uses for this technology grows. As indicated by Amazon's planned strategy, 3D printing would fundamentally alter the way people obtain items in the future. The field is unquestionably a game changer, and there are plenty of promising talents to keep an eye on. The 3D printing sector is expected to experience extraordinary growth in the next years, with market analysts projecting an 18 percent increase year on year. By 2025, it is estimated that the market for 3D printed parts would have grown to a size of $8.4 billion dollars, constituting a significant industry. Automobile parts and aerospace components would be the most successful segments in the parts sales forecast. In the future, the combination of stem cell research and 3D printing will result in the creation of transplantable body parts. Real-world functional body parts will be able to be 3D printed in the near future. Skin grafting is a surgical procedure in which healthy skin from a healthy region of the body is utilized to cover a damaged section of the body. A painful technique, as is well known, is involved in this operation. Researchers at the University of Toronto have developed a method of skin grafting that involves putting skin

cells and other polymers into a 3D printer to build layers of skin that are artificially created. Based on the experiences of war casualties, scientists at Wake Forest University's Institute of Regenerative Medicine in Winston-Salem, North Carolina, are working to print skin directly onto burn scars. They found that the majority of combat casualties were burn sufferers who were subjected to the painful procedure of skin grafting to survive. Hopefully, all of this research will come to fruition in the not-too-distant future. Amazon has opened a store dedicated to 3D printers. Customers would then print the product themselves, according to their idea. They would sell digital 3D design files to customers. Consumers will be able to print any things they want, which will completely transform the supply side of products in the near future.

REFERENCES:

[1] J. S. Mohammed, "Applications of 3D printing technologies in oceanography," *Methods in Oceanography*. 2016, doi: 10.1016/j.mio.2016.08.001.

[2] T. P. Mpofu, C. Mawere, and M. Mukosera, "The Impact and Application of 3D Printing Technology," *Int. J. Sci. Res.*, 2014.

[3] K. Ji *et al.*, "Application of 3D printing technology in bone tissue engineering," *Bio-Design Manuf.*, 2018, doi: 10.1007/s42242-018-0021-2.

[4] A. Vanderploeg, S. E. Lee, and M. Mamp, "The application of 3D printing technology in the fashion industry," *Int. J. Fash. Des. Technol. Educ.*, 2017, doi: 10.1080/17543266.2016.1223355.

[5] W. Zheng *et al.*, "Application of 3D-printing technology in the treatment of humeral intercondylar fractures," *Orthop. Traumatol. Surg. Res.*, 2018, doi: 10.1016/j.otsr.2017.11.012.

[6] Z. Ji, Y. Zhao, S. Yu, and H. Zhao, "The application progress of 3D printing technology in ophthalmology," *Chinese J. Ophthalmol.*, 2018, doi: 10.3760/cma.j.issn.0412-4081.2018.01.014.

[7] A. Ambrosi and M. Pumera, "3D-printing technologies for electrochemical applications," *Chemical Society Reviews*. 2016, doi: 10.1039/c5cs00714c.

[8] M. E. O. N. O. M. D. Mosoti, "Opportunities and Challenges of Application of 3D Printing Technology in Teaching and Learning in Developing Countries in Africa," *Int. J. Sci. Res.*, 2018.

[9] Q. Yan *et al.*, "A Review of 3D Printing Technology for Medical Applications," *Engineering*. 2018, doi: 10.1016/j.eng.2018.07.021.

[10] J. C. Ruiz-Morales *et al.*, "Three dimensional printing of components and functional devices for energy and environmental applications," *Energy and Environmental Science*. 2017, doi: 10.1039/c6ee03526d.