

3D Printing: A Manufacturing Revolution

Kondru Sharath Chandra¹, Kontheti Ajay Kumar², Mahesh³, Sainath⁴

¹²³MTECH, Department of mechanical Engineering, Sreyas Institute of Engineering and Technology

⁴Professor, Department of mechanical Engineering, Sreyas Institute of Engineering and Technology

Abstract - As the 3D technology is rapid, growing in the current market and making designers create flexible designs with the low cost even if the design is too complex to manufacture in traditional methods. This 3D printing technology can be called as Rapid Prototyping and Additive Manufacturing. In this paper, we will be discussing how the 3D printing technology replaced with traditional methods and the history of Additive Manufacturing starting from its roots. We will be covering the areas of Additive Manufacturing processes used in the current market and few statistics on the current market.

Key Words: Additive manufacturing, automotive industry, traditional methods, 3D printing, rapid manufacturing

1. INTRODUCTION

To be more precise, 3D printing is nothing but converting 2D image/dimensions into 3D physical solid models from a digital file. The evolution of 3D printing was introduced way back in 1970's during the time of inkjet printers. There is no much difference between ink jet printer and 3D printers; it just replaced ink with desired solid materials.

In the recent decades, multiple types of 3D technologies and applications were used by the industries on different platforms. Now the point to ponder here is how the 3D printing technologies reached the milestones.

1.1 History of Additive Manufacturing

Birth of 3D printing took place in the year of 1984 by Charles Hull, he is the one who introduced stereo lithography. It is a printing process, which converts data into meaningful objects, and it is pre-processing technology, which minimizes the cost and wastage. One can import the desired image into the CAD software with exact dimensions without any errors and then proceed with the final production.

Coming to 1990's using stereolithographic apparatus, which involves a UV laser solidifying photopolymer, they tried to make a 3D dimensional object, however, the objects are imperfect yet they are good to produce very complex models, which include mainly in the medical field.

Coming to Millennium 2000's a working 3D kidney was designed by using 3D printing by Dr. Adrian Bowyer at the University of Bath. There is a mass production in manufacturing units like automobile parts and medical fields like artificial metal leg, which includes bolts nuts and all the

movable parts. Overall, this technology moved to ground level for manufacturing toys and playing objects.

At present, we are able to print 3D printed robotic aircraft, 3D printed cars, and 3D printed ornaments using gold and silver.

We have to raise a question what if when industries opt 3D printing technology completely. Many manufacturing units helping forward-thinking players overcome the challenges and take advantage of powerful opportunities in this next generation of manufacturing.

“Latest fabrication will allow one to design and produce physical objects on the basis of need, wherever and whenever they require them. The revolution is not between additive and subtractive production; it is the ability to turn data into meaningful things and things into data.”

1.2 Materials used in 3D printing

3D Printing will be the Next Industrial Revolution, also it is known as additive manufacturing, and 3D printing creates tangible products from a digital design file by joining input substrate materials using a layer-upon-layer printing strategy.

There are few major printing technologies today, among them few of them are listed below:

Table -1: Materials use in printing

Sl No	Technology	Material Type
1	Photo polymerization	Plastics
		Ceramics and wax
2	Material extrusion	Plastics
		Sand
3	Sheet lamination	Plastics
		Metals
4	Binder jetting	Plastics
		Metals
		Glass

5	Material jetting	Plastics
		Metals
		Wax and biomaterial
6	Powder bed fusion	Plastics
		Metals
		Ceramics, sand, and carbon
7	Direct energy deposition	Metals

Waste reduction: unused material being reused for continuous printing, extremely less material is wasted.

3D printing technology allows us to create customized models based on the materials adopted.

3D printing allows buyers to create custom-made shoes or any other products.

3D printing is replacing some conventional manufacturing methods such as metal extrusion, computer-controlled machining, and manual modeling methods for prototype development production.

2. 3D Printing vs. Traditional Manufacturing

3D printing is not only the one solution for manufacturing products, in some points traditional manufacturing can give the best results.

Table -2: Comparing the both the technologies

	VOLUME	COST PER UNIT	TIME TO MARKET	COST OF COMPLEXITY
3D PRINTING	Small batch, Highly customized	High variable costs, No fixed costs	Very fast (≤ 1 day)	No higher than simple parts
TRADITIONAL	Large batch, Not customized	Low variable costs, High fixed costs	Very slow to moderately slow	Much higher than simple parts

Here are the top best reasons to pursue 3D printing:

3D printing can speed up the development process and delivery for customized products and bring increase flexibility through inventory process management. Other advantages include manufacturing advantages and cost advantages during production time. 3D printing can improve quality for lighter parts and it is very flexible to manufacture even for complex designs. It is critical to decide which the best is and flexible, every technology has its pros and cons.

3D printing offers various distinct benefits that traditional manufacturing cannot offer:

Volume customization: The technique to create custom designs opens doors to unlimited chances.

Capabilities: Complex products can be batch produced without high fixed-cost capital investments and at a lower variable cost than traditional methods.

Time and speed: Shorter design, process, and production cycles get products to market faster.

Supply chain: Production is closer to the point of demand with much less inventory.

2.1 Real-Life Examples of Automotive Companies Using 3D Printing

2.1.1 Present Applications: A few decades back automotive industry use 3D printing for commercial purpose, but now automotive industries use 3D printing for prototyping rather than parts manufacturing. This is because automotive production volume was too high and they cannot manage this by traditional methods.

3D printing users in the production industry have experienced measurable benefits. Small and medium sized industries use 3D printing to manufacture small-sized engines and when compared with traditional methods it is minimizing the time from 16 weeks to 1 week or less.

2.1.2 Future Applications

The key goal of the automotive industry is to Make parts cheaper, lighter and faster and create opportunities for 3D printing in parts manufacturing.

	LARGE AUTOMOTIVE CLIMATE CONTROL COMPANY	MEDIUM AUTOMOTIVE ENGINE CONTROL COMPANY
LEVEL	Early adopter	Recent adopter
PROTOTYPING USES	Product concept prototypes Pre-production prototypes Show models	3D printed sand cores for the casting of prototypes Plastic prototypes for other types of components
OTHER MANUFACTURING USES	Assembly fixture Test fixtures End of arm robotic tooling Misc. parts (screws, nuts, etc.)	Evaluate new tooling for assembly process improvements
OUTCOME	Improved product cycle times	Cut prototyping time by 94% Increased revenue by a factor of 10 3DP plastics led to reduced prototype turnaround time from 2 months to 2 days

3. Working procedure of 3D printing

1. Create an image using CAD software.
2. Send the image file to a 3D printer.

- The 3D printer then builds the product by applying layers one on another and produce a complete physical product.

3D printer works like ink jet printers; in place of inkjet, we use materials layer by layer to form a perfect physical model from digital file.

Laser source sends a laser beam to harden the material. The elevator moves the platform to make layer formation flexible.

Tub contains material, which is used in 3D object formation as shown in the figure.

The combination of the entire layer one upon the other forms a complete physical object.

For 3D printing, we can use one or more materials including plastics, iron, and gold or silver. It all depends on the desired model requirements.

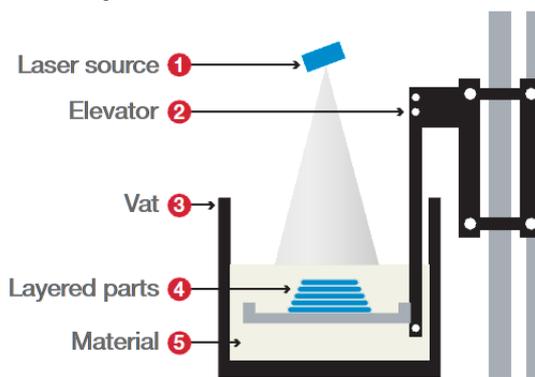


Fig -1: 3D manufacturing process

3.1 Areas of 3D Printing Technologies

- Automotive
- Aviation
- Manufacturing
- Medical
- Jewelry
- Custom made products

3.2 Areas of 3D Printing Technologies

Equipment Speed: The future of 3D printing technology is very intense across all the platforms and the production speed will be increased by 88% by 2020. If the working speed of the printer increase then the volume capacity tends to increase.

Enhanced Materials: The combination of different material using 3D printing, or improving the existing material will not only enable unprecedented 3D printing applications, but it also help us to reduce the price and time. There will be an importance in metals that is likely to grow over the next

three years. According to the statistical reports, it is observed the metals are widely used than the plastics.

3. CONCLUSIONS

If every individual uses this 3D technology, there will be a massive production in the industrial world and the important thing is that no one needs to visit the manufacturing units for the prototyping objects, one can create his/her own objects by just importing the model into the 3D printer and get the desired object. In the coming decades, there will be a chance of cloud 3D printing which will allow you to create objects for yourself and for your beloved once by sitting away from them. This Rapid prototyping technology will allow creating a massive production with less time and less capital.

However 3D is not a dream, it is already in the current market, few industries are using them for massive production, and that are building very complex models.

REFERENCES

- 3D Printing - The Future of Manufacturing (The Next Industrial Revolution) Dr.Ravi Shankar Kalva Professor, Department of Mechanical Engineering
- According to the US Department of Energy, 3D printing can significantly reduce energy and materials use compared with traditional manufacturing methods. www1.eere.energy.gov/manufacturing/pdfs/additive_manufacturing.pdf.
- McKinsey Global Institute Report, May 2013: Disruptive technologies: Advances that will transform life, business, and the global economy
- Savas Tasoglu and Utkan Demirci, "Bioprinting for stem cell research," Trends in Biotechnology, Volume 31, number 1, January 2013.
- Chris Anderson, The Long Tail: Why the Future of Business is Selling Less of More (New York, NY: Hyperion Press, 2008).
- Russ Banham. "Printing a Medical Revolution." Connections. T. Rowe Price (May 2012).
- Christophe Chaput and J. B. Lafon, "3-D Printing Methods: 3-D Printing Based On Laser Stereolithography Opens Up New Application Fields for Advanced Ceramics." Ceramic Industry (2011): 15-16.