



A Study on Advancement and Application of 3D Printing in various Industries

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Date of Submission: 20-03-2023

Date of Acceptance: 04-04-2023

ABSTRACT

A 3D printer is a type of manufacturing device that creates three-dimensional objects by building up layers of material, typically plastic or metal. These printers use a process called additive manufacturing, which involves adding layers of material on top of each other until the final object is complete.

The process starts with a 3D model, which is created using computer-aided design (CAD) software. The 3D printer then reads the digital model and uses it as a blueprint to create the physical object. The printer deposits layers of material onto a build platform, with each layer being a cross-section of the final object.

3D printing technology has come a long way since its inception and is now being used in a variety of industries, including aerospace, automotive, healthcare, and education. This technology has revolutionized the way prototypes are created, and it has opened up new possibilities in design and manufacturing.

I. INTRODUCTION

3D printing, also known as additive manufacturing, is a process of creating three-dimensional objects from a digital model. This technology involves adding layers of material, such as plastic, metal, or ceramic, to create a physical object.

The process of 3D printing begins with a digital model, which can be created using a 3D

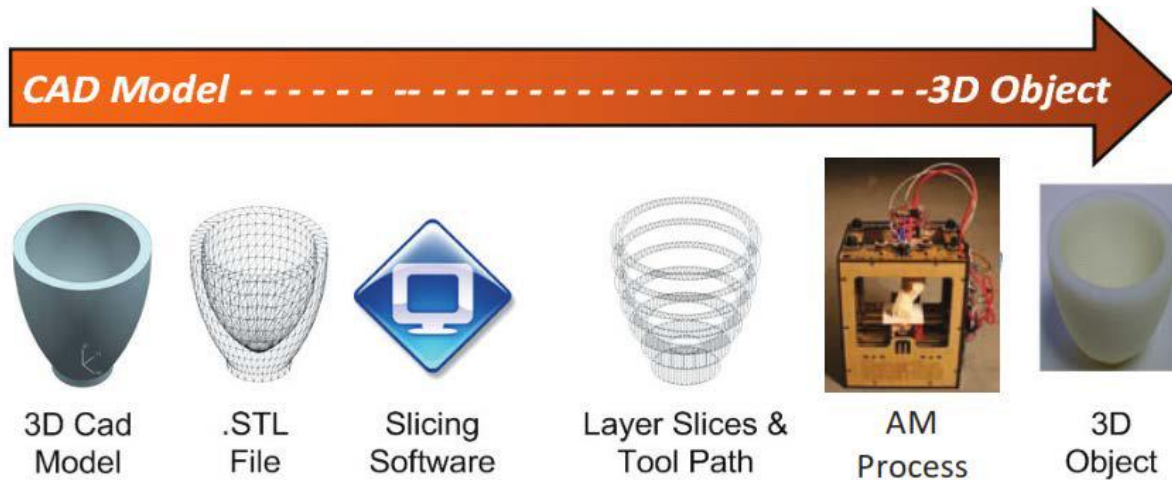
scanner, computer-aided design (CAD) software, or downloaded from an online repository. The 3D printer reads the digital model and uses it as a blueprint to create the physical object by depositing material layer by layer.

3D printing has become increasingly popular in recent years and is now used in a variety of industries, including healthcare, aerospace, automotive, and fashion. This technology has revolutionized the way prototypes and products are created, allowing for faster production times, reduced waste, and increased design flexibility.

Overall, 3D printing has the potential to transform the manufacturing industry and change the way we approach design and production.

Existing 3D printing Technology

Recently, 3D printing has attracted significant attention and captured the imagination of everyone from entrepreneurs to at-home hobbyists. 3D printing is an additive manufacturing process that adds many layers of the materials upon layers until the product is built. 3D printing uses a computer-aided design (CAD) or laser scan to create a 3D object (Birtchnell and Hoyle 2014). The design model is sliced into several plans, which direct the 3D printer in depositing the successive thin layers of material upon each other to construct a final product. Figure 3 illustrates the essential steps of the 3D printing process.



The 3D printing technique produces an assembled unit and reduces the number of separate components, thereby involving fewer suppliers of raw material. AM process offers the ultimate geometric freedom in engineering design to create complex shapes that cannot be produced by any other means. For example, curved internal cooling channels can be integrated into components (Khajavi, Partanen, and Holmström 2014).

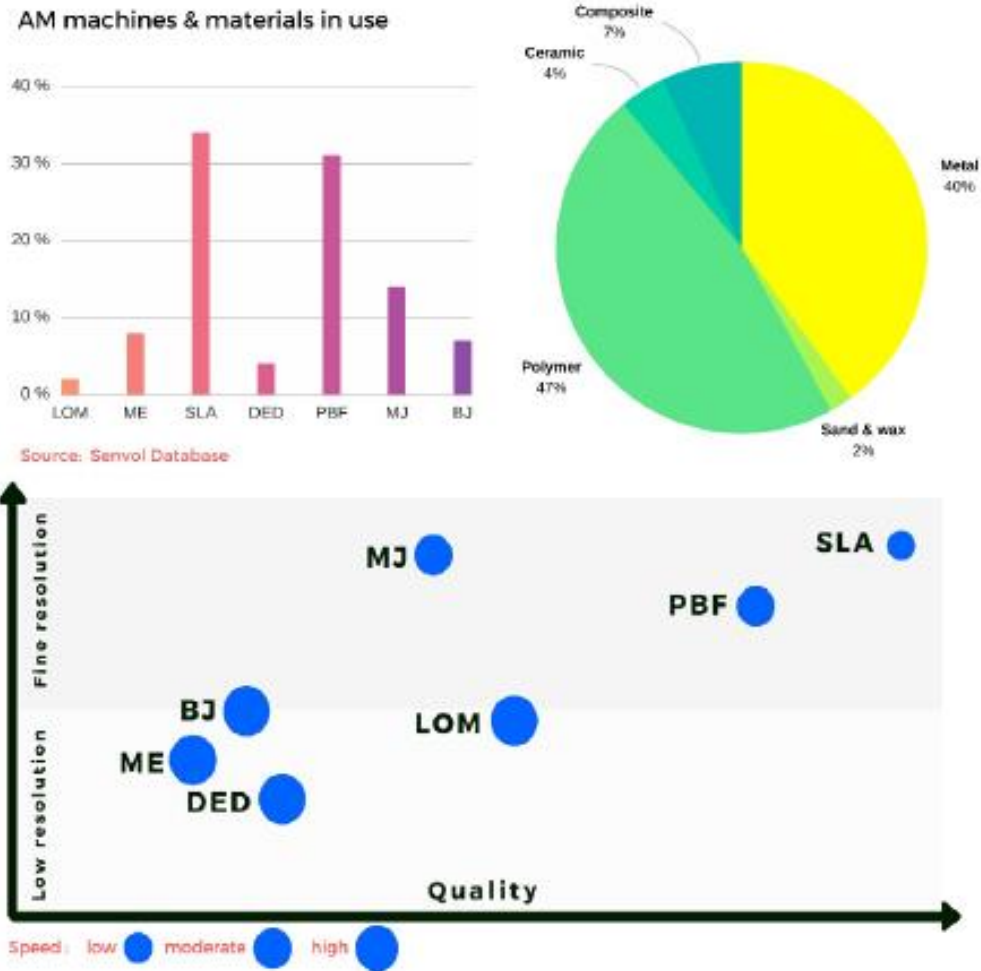
AM process creates the object from bottom-up by adding layers. So, it is more efficient of the environment because there is very little waste material compared to traditional manufacturing (Ankner and James 2017). Conventional manufacturing processes such as casting and forming create the object from bulk raw materials, while subtractive machining such as milling, and turning create the objects from the top-down by subtracting and removing materials until getting the final product. Figure 4 presents a list of common subtractive and additive manufacturing methods

Method of Additive manufacturing

Most common methods of AM have been developed to meet the demand for production of a large complex structure with fine resolutions using a wide range of materials. AM technology includes many methods such as stereolithography apparatus (SLA), powder bed fusion (PBF), fused deposition modeling (FDM), binder jetting (3D Printing), directed energy deposition (DMD), laminated object manufacturing (LOM), and hybrid manufacturing technologies. These methods are introduced briefly in Appendix I along with their descriptions, applications, suitable materials, advantages, and drawbacks. More details and comprehensive review are found elsewhere (Bhushan and Caspers 2017, Sandeep and Chhabra 2017, and Gibson, Rosen, and Stucker 2015). Today, there are many different 3D printing processes. However, a 2016 survey of Sculpteo revealed that powder bed fusion (PBF), fused deposition modeling (FDM), material jetting (MJ), and stereolithography (SLA) are the 3D technology most used by the respondents



A BRIEF REVIEW OF COMMON AM TECHNIQUES



Application of 3d Printer

3D printing has a wide range of applications across different industries. Some of the most common applications of 3D printing include:

1. **Prototyping:** 3D printing is commonly used to create prototypes and models of new products. This allows designers and engineers to test their designs and make improvements before moving to mass production.
2. **Manufacturing:** 3D printing can be used for small-scale manufacturing, especially for custom or low-volume products. This technology enables faster production times and reduces the need for expensive tooling.
3. **Healthcare:** 3D printing is being used in healthcare to create custom prosthetics, dental implants, and surgical tools. It is also used for

medical research and creating models for surgical planning.

4. **Education:** 3D printing is increasingly being used in education to teach design, engineering, and other STEM-related skills. It allows students to bring their designs to life and provides hands-on learning opportunities.

5. **Architecture and construction:** 3D printing can be used to create complex architectural models and prototypes. It can also be used to create custom building components such as concrete forms or prefabricated panels.

6. **Art and design:** 3D printing has opened up new possibilities for artists and designers, allowing them to create complex and intricate structures that would be difficult or impossible to make by hand.



Overall, 3D printing has numerous applications across various industries, and its potential for innovation and creativity is only growing.

Advantages

1. **Faster prototyping:** 3D printing allows for the quick and efficient creation of prototypes and models, reducing the time and cost associated with traditional manufacturing methods.
2. **Customization:** 3D printing enables the creation of highly customized products, as it can produce unique and complex shapes that would be difficult to make using traditional manufacturing techniques.
3. **Reduced waste:** 3D printing produces less waste compared to traditional manufacturing processes, as it only uses the required amount of material to create the object.
4. **Design flexibility:** 3D printing provides greater design flexibility, allowing for the creation of intricate and complex designs that are difficult or impossible to produce with traditional manufacturing methods.
5. **Lower cost:** 3D printing can be cost-effective for low-volume production runs, as it eliminates the need for expensive molds or tooling.
6. **On-demand production:** 3D printing enables on-demand production, allowing businesses to produce products as and when needed, reducing the need for large inventory.
7. **Accessibility:** 3D printing has become more accessible to small businesses, hobbyists, and individuals, enabling them to create their products and prototypes.

Overall, 3D printing has the potential to revolutionize manufacturing and design by offering greater flexibility, customization, and cost-effectiveness.

REFERENCE

There are many 3D printers available on the market today. Here are some of the most popular brands and models:

1. **Ultimaker 3:** This is a popular FDM 3D printer that is known for its ease of use and reliability.
2. **Formlabs Form 3:** This is a resin-based 3D printer that produces high-quality prints with great accuracy.
3. **Prusa i3 MK3S+:** This is an affordable FDM 3D printer that has a large community of users who share knowledge and modifications.
4. **MakerBot Replicator+:** This is a high-end FDM 3D printer that is known for its speed and reliability.

5. **LulzBot Mini 2:** This is a versatile FDM 3D printer that is compatible with a wide range of materials and has a large build volume. These are just a few examples of 3D printers that are available on the market. It's important to do your research and find a printer that suits your needs and budget.

Conclusion 3D printing has revolutionized the way we approach manufacturing and design. With the ability to create complex shapes and designs quickly and affordably, 3D printing has opened up new possibilities in fields such as medicine, aerospace, automotive, and architecture.

3D printing has also become more accessible to the general public, with the availability of affordable desktop 3D printers. This has allowed individuals and small businesses to create prototypes, custom parts, and even finished products without the need for expensive manufacturing equipment.

However, 3D printing still has some limitations, such as the types of materials that can be used and the time it takes to print larger and more complex objects. As technology continues to advance, it's likely that these limitations will be overcome and 3D printing will become even more versatile and efficient.

Overall, 3D printing is a promising technology with a wide range of applications and potential for further development.