

# Differences Before and After Application of Additive Manufacturing in Production

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**Abstract.** With the popularity and development of additive manufacturing, more and more industries are using different types of additive manufacturing in the production process to improve their production efficiency. This article will analyze the impact of additive manufacturing on the production process before and after the application of additive manufacturing based on actual cases. Influence and analyze the technological status and development direction of additive manufacturing based on the conclusions.

**Keywords:** Additive manufacturing; subtractive manufacturing; 3D printing; Production design.

## 1. Introduction

Traditional manufacturing, mostly cutting engraving-based reduction manufacturing method, through the removal of materials to achieve the final molding, this traditional technology has the disadvantage of consuming more materials, consumables are difficult to recover, and it takes a long time. Additive manufacturing, as a new production technology, makes three-dimensional objects by adding materials layer by layer, which is the opposite of additive manufacturing. Additive manufacturing includes Powder bed fusion; Directional energy deposition; Stereo lithography; Adhesive injection; Material extrusion; Material injection; and thin material lamination. By stacking materials forming, additive manufacturing as a new technology in the production process, not only can save costs, and reduce consumables waste, but also bring higher work efficiency, so it has been widely used in many production links, such as the production of abrasive manufacturing, metal casting, and custom parts production and so on. Thanks to the continuous progress of technology in recent years, precision is getting higher and higher, and the popularity of more and more industries, including medical, aerospace, construction, automotive, industrial manufacturing, and additive manufacturing has also promoted the development of various industries to a certain extent. Therefore, in the production process of many industries, additive manufacturing technology has gradually replaced the original reduction manufacturing technology, which appears in the production links including metal parts manufacturing and product testing. This phenomenon of replacing material reduction technology with additive technology is a universal trend, and it is also worth analyzing and summarizing. This paper will focus on additive manufacturing before and after replacing the traditional process, we will compare and make a summary and analysis through quality, time consumption, material consumption and production accuracy. By analyzing changes in production design, we can intuitively and effectively understand the role and advantages of additive manufacturing in production

## 2. Principles and differences of processing technology

Subtractive manufacturing is a processing method in the form of removing the remaining material from a large part. Additive manufacturing, also known as 3D printing. It is a manufacturing technology that stacks materials in layers to create physical items, which is different from traditional manufacturing methods. It is based on a digital model and is manufactured in layers step by step. This is considered a "top-down" technique [1]. The following sections will explain and introduce each of the two technologies and compare the differences between them.

## **2.1. Subtractive manufacturing**

Subtractive manufacturing is a technology that gradually removes excess parts from larger blocks of material and finally forms them, mainly including the following processing methods, which are described in detail below:

### **2.1.1. Milling**

Milling is the rotation of different cutting tools and the relative movement of the workpiece to remove material with sharp edges. It is a processing method in which excess material is removed.

### **2.1.2. Turning**

Turning is the method of removing excess material by rotating the workpiece and meeting a fixed prop, mainly on round, symmetrical parts.

### **2.1.3. Grinding**

This is a processing technology that uses grinding tools to perform fine machining to make the surface smoother and the size more refined.

### **2.1.4. Laser cutting**

Laser-cutting materials are used to separate the parts that are needed.

## **2.2. Additive Manufacturing**

### **2.2.1. Model Building**

To be able to print the ideal part or physical object on the machine, the maker needs to build a 3D model with computer-aided design software (CAD) such as Solid Works AutoCAD. Designers generally consider the printability of additive manufacturing design, support structure, and fault-tolerant design to build a 3D model appropriately to ensure that there are no excessive overhangs and particularly small features during the printing process, and to reduce the support structure to reduce the difficulty of subsequent processing.

### **2.2.2. Layered slicing**

As mentioned above, additive manufacturing, as a manufacturing technique for stacking materials in layers, requires the decomposition of the 3D model into multiple 2D layers. Designers generally convert the 3D model into 2D layers through slicing software and generate the corresponding print paths and instructions. Ensure the printing effect by adjusting the printing parameters, including layer thickness, printing speed, and filling density.

### **2.2.3. Material Deposition**

After the above steps, the material is deposited by different methods depending on the additive manufacturing technology chosen. There are 7 technologies to take advantage of, including Fused Deposition Modeling (FDM), Stereo lithography (SLA), Selective Laser Melting (SLM), Selective Laser Sintering (SLS), Digital Light Processing (DLP), Binder Jetting, Molten metal jetting. The author will introduce their principles separately.

### **2.2.4. Modeling of fused deposition**

Fused deposition modelling (FDM) is an additive manufacturing process used to produce prototypes at a low cost, mainly made of plastics such as ABS, PEI, or PC. The basis of FDM 3D printing is the so-called filament, where plastic fibers are rolled into a roll. In the fused deposition modelling process, the filament is printed through a nozzle, also known as an extruder. The filament is melted inside the extruder so that the slender material can be deposited on the construction platform. Once the extruder has successfully extruded a filament layer, the build platform lowers the thickness by one layer and a new filament layer can be applied. This process is repeated until the required part or item is completed.

### **2.2.5. Stereolithography**

Stereo lithography (SLA) is a reductive photo polymerization technique that allows the creation of 3D objects by selectively exposing liquid polymer resins to ultraviolet (UV) light. When irradiated with ultraviolet light, the photo reactive molecules of the resin are linked together and become solid during the photo polymerization process.

### **2.2.6. Selective Laser Melting**

By selectively scanning the metal powder layer by layer on the machine tool with a laser, the scanned powder will be sintered to achieve the effect of metallurgical bonding.

### **2.2.7. Selective laser sintering**

SLS is a technology like SLM, but SLM is formed by sintering, while SLS technology uses laser selectivity to scan metals, plastics, and ceramics to melt and re-solidify them in layers, reducing the thickness of each layer of powder bed and adding new layers of material.

### **2.2.8. Digital Light Processing**

Digital light processing uses a laser or digital light to irradiate a photopolymer material to form a cohesive material [2].

### **2.2.9. Binder Jetting**

This is a type of part that is made by spraying an adhesive on a powder with a nozzle or inkjet device to make the powders bond to each other.

### **2.2.10. Material Jetting**

Molten metal jetting is a process in which an alloy solution is atomized into fine molten droplets, which fly and cool under high-velocity airflow to deposit the formed part before it has fully solidified.

## **2.3. The difference between the two manufacturing methods**

The principles of the two technologies have been introduced above. The differences between the two will be explained from different perspectives later. In terms of processing principle, additive manufacturing is to build an object by adding material layer by layer, while subtractive manufacturing is to remove material to form the desired part shape. In terms of material utilization, additive manufacturing has a high utilization rate, because using the deposition method, this processing method only needs to use the required materials and does not need to produce too much waste of waste. Subtractive manufacturing, on the other hand, generates a lot of material waste through methods such as cutting, and recycling materials will also increase costs. However, additive manufacturing, as an emerging technology, is still not fully popularized, and there are still considerable quantitative differences with traditional manufacturing methods. In addition, additive manufacturing has a higher demand for equipment, requires professional printing equipment, and has more material restrictions than traditional manufacturing, such as many photo molding technologies that require photopolymer resins to produce parts, which are more restrictive than traditional industries.

With the popularization of additive manufacturing, more and more production types are now applied to 3D printing technology in production design, so what role does additive manufacturing play in the actual production process, and what changes have occurred in production before and after application, which is a question worth summarizing, which will be described in combination with cases below.

After the author's query and retrieval of the documents, two cases were obtained: they are the application of additive manufacturing in the footwear industry and the application of this technology in the aerospace industry. As a case study of civilian products and the demand for more refined parts, they will illustrate the role of additive manufacturing in production and reflect the future development direction and improvement space of 3D printing to a certain extent. The following is a summary of the two cases and a comparison of the two industries before and after the use of 3D printing [3].

### 3. Case Study

#### 3.1. Application

A variety of flexible and durable rubber materials used in footwear: rubber materials including thermoplastic elastomers and TPU thermoplastic silicone greases. These materials are generally made by fused deposition modelling or selective laser sintering, which can replace the traditional manufacturing mode, eliminate the impact of seams and seams on design and production, and limit the development of shoe art design. The application also specifically mentions the use of different brands, and manufacturers mainly apply additive manufacturing technology to the manufacture of customized products and the production of product prototypes. Among them, Adidas and related companies cooperated to use digital light projection technology to make customized shoe outsoles using liquid resin; Nike, on the other hand, uses 3D printing to prototype its products, which can bring it higher cost efficiency and the possibility of using additive technology to achieve mass production. In addition, the literature also lists the application methods of additive technology by manufacturers of other brands [4].

The problem of 3D printing is also pointed out, because of its low efficiency and limited materials, 3D printing cannot be used in large-scale production, but it can bring higher efficiency to researchers in the development stage. In addition, the effective materials used in 3D printing are also inferior to those used in traditional production techniques.

Opportunities and Challenges for Additive Manufacturing in Space Applications explores the use of additive manufacturing in the aerospace industry. They made the parts of the Ariane 5 rocket by powder spraying, which was able to perform well in tolerances, surface finish, complex assemblage shapes, etc., thanks to powder spraying technology, and increased functional performance with geometries that could not be achieved by traditional methods. This enables the application of additive manufacturing to lead to higher quality and shorter lead times for parts in the aerospace industry, as well as eliminating the need for expensive castings and reducing production costs [5].

#### 3.2. Analysis

Both applications strongly elaborate on the positive impact of additive manufacturing on R&D efficiency and production efficiency. Because additive manufacturing has better performance of shape details, and can also avoid problems such as suture lines when multiple parts are combined, it can improve efficiency and quality in customized items or demonstration models during development. On the contrary, the use of traditional techniques such as casting, cutting and splicing has the shortcomings of limited artistic design and low efficiency.

To sum up, in the production process, additive manufacturing replaces the position of traditional technology in the field of customization and product research and development, the application of 3D printing makes the production of fine parts in production more efficient and low-cost way, and additive manufacturing in the research and development process provides more space for designers, optimizes the research and development process and research and development efficiency, reduces research and development costs, increases the accuracy of prototype models, and lays a more solid foundation for subsequent large-scale production.

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Because additive manufacturing limits the materials and equipment it can be produced, and because it is not manufactured fast enough, additive manufacturing does not play a significant role in large-scale production these reasons. As can be seen from the above, the main manufacturing products of additive manufacturing are focused on high-precision customized products and R&D products.

Both are different from large-scale production, they are more refined and functional, and the pursuit of efficiency and speed is not as high as the pursuit of large-scale production, so they do not require the production speed of additive manufacturing. Mass production, on the other hand, requires more quality products in a short period, which is a challenge for additive manufacturing technology.

#### 4. Future development and prospects

Although additive manufacturing has the unsurpassed advantages of less waste and more refinement, due to its limited materials and equipment, as well as the low efficiency caused by precision manufacturing, the application of additive manufacturing technology in large-scale production is not long. How additive manufacturing can assist large-scale production has become a challenging development direction: it needs to reduce the complexity and cost of ownership of equipment and add more additive technology production methods for different materials. Increase production speed and focus on efficiency and do this through more flexibility to handle faster programs or more inkjet parts.

#### 5. Conclusion

Additive manufacturing, as a production technology opposite to traditional subtractive manufacturing, has many advantages such as finer and fewer consumables, based on these advantages, additive manufacturing is gradually replacing traditional processes in R&D and customization and has brought more convenience and improvement to different industries. Based on the literature, we analyze the performance of additive manufacturing in two distinct fields, shoe manufacturing and aerospace, and compare the impact of the use of additive manufacturing on industrial production. In addition, based on the relevant information, we also look forward to the future development prospects and trends of additive manufacturing.

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