Direct Digital Manufacturing Industry Ascendant

XIA Bo-xiong, DU Jun, JIAO Hong-wei
Department of Mechanical Manufacturing Engineering,
Wuhan Vocational College of Software and Engineering, Wuhan 430205

Abstract: The paper introduces the origin of the word of Direct Digital Manufacturing and other forms of address, and the working principles of Direct Digital Manufacturing technology and major types of the technology, hardware and software development, use of materials, applications, market growth and its development prospects. Focused presentations of Direct Digital Manufacturing (additive manufacturing) compared to traditional mechanical manufacturing industry in the use of prices, processing speed, reliability and cost advantages and characteristics. Particularly the significant challenges and competitiveness of Direct Digital Manufacturing technology in the processing of any complexity created directly the number of objects, internal structure and channel function, as well as the shape of the chassis components and structure of the matching and optimization.

Key words: direct digital manufacturing; rapid prototyping; additive manufacturing; 3D printing; additive freeform fabrication

1 Introduction

Direct digital manufacturing (Direct Digital Manufacturing) is frequently a fast, real-time, or on-demand production of the manufacturing process, which uses a low cost device called "Desktop" or "personal manufacturing" small devices, the use of computer-controlled additive manufacturing technology (also known as three-dimensional printing or rapid prototyping), directly using 3D CAD files or data to create a number of physical components, without human intervention. The term first used as Direct Digital Manufacturing appeared around 2004. America's Digital Reality, Inc. Claims to have patents in an unfinished process of direct digital manufacturing process, they call custom orders registered a digital manufacturing enterprises. The company presented application of non-publication requirements in the patents.

Direct digital manufacturing is also known as Additive Manufacturing, Additive Freeform Fabrication, Rapid Prototyping[1], Layered Manufacturing or three-dimensional printing (3D printing). This technique began in the mid-1980s, was originally known as Rapid Prototyping Technology. Because it does not invest the time and resources without developing manufacturing tools or requiring the use of other traditional processing methods, we can produce prototype parts. The main differences between the term describing the use of additives manufacturing three-dimensional printing and other words describing the 3D printing, additive manufacturing technology is entirely used to describe parts of 3D printing as a minimal post-processing of the final product. As described in rapid prototyping, relative to the additive manufacturing, other words or other statements are just another word for the three-dimensional printing process itself.

Received 25 June 2013

2 Technology and principle

Direct digital manufacturing (additive manufacturing) is the one for the rapid expansion of the prototype of the solid parts of the final products, not just

the prototype itself. With the enhancement of technology and quality control, the additive manufacturing market has developed to the stage of production applications. Price, speed, reliability and cost compared to traditional manufacturing techniques already very competitive and challenging in 2010, the additive manufacturing, resulting in the rapidly expanding industrial applications. It has been explosive growth in terms of sales and the kind of hardware expansion. In order to more effectively use the additive manufacturing technology, there has been the emergence of a new industry targeting to develop software. A typical application of additive manufacturing technology customized products for consumers.

Figure 1 Example of metal sample produced by 3 dimensional printing

One of the main technical used is the additive manufacturing is Selective Laser Sintering [2], this process uses laser energy integration, to create a solid material object. Another technique is known as Fused Deposition Modeling, this is a common kind of technique used in rapid prototyping, and fused deposition modeling is also becoming more and more popular in direct digital manufacturing. The use and development of additive manufacturing technology is increasing. In 2007, there has been $ 4,000 machine. 3D printing companies have sprung up around the world. The RepRap machine is DIY rapid prototyping equipment, in addition to demonstration purposes, its use is limited. However, the machine is very cheap to manufacture, and is the one for the limited use of common materials, construction parts rapid prototyping machine.

According to incomplete statistics, at present there are about 25 kinds of 3D printing. The oldest is Layered Object Manufacturing. Time ancient is Stereolithography. The latest technology includs selective laser sintering, Direct Metal Laser Sintering, inkjet technology [3], Fused Deposition Modeling, Poly-Jet matrix and its many variants. All of these techniques require a 3D model, and calculate the cross-section of the model, then deposit from the top downward according to the geometrical cross section of the orders, until a final geometric entities formed. Aggregate upper cantilevered portion is supported by the second layer of powdered material or material, such as in the case of selective laser sintering.

The principle of three-dimensional visualization of printing, can be considered as a coffee cup. Imagine if you want a coffee cup cut into a very thin layer pieces, you will do as in a deli meat slicer and save each sliced meat and the meat then is stacked in sequence, which will re-create the original shape of the object. Dimensional printing is within a computer system from a CAD data or three-dimensional model from the slice starting at the top, followed sequentially by depositing a very thin layer of superimposed together, to form the original shape of the object.

3 Advantages and characteristics

With continuously improving of the speed of the hardware, reliability and accuracy, the additive manufacturing could replace or compensate for the shortcomings of traditional manufacturing in the creating final using product field, A frequently referenced classic advantage of additive manufacturing is

that it removes most of the traditional manufacturing labor. Another frequently cited example, the additive manufacturing technology can produce parts of any complex number at the same time, as long as these parts are matched in the construction of the machine shell. Relative to the traditional manufacturing, additive manufacturing technology has the following four advantages: [4]

3.1 High energy efficiency

Necessary energy expends only in forming parts, there is no waste of energy in additive manufacturing technique. In sharp contrast with the conventional machining, there is energy expenditure for smelting metal cast blank or heating metal forged into a blank, and then removing a lot of material in the processing of these billet material, making into the final parts in conventional machining process. Obviously this with respect to the additive manufacturing technique, the energy for metal smelting cast blank or heating metal forged into a rough blank is a waste.

3.2 Low material waste

Additive manufacturing technique process forming parts required compared to conventional machining, almost no waste generated. There is no waste so that the energy efficiency improves, because energy is not used for the transportation or disposal of waste in the additive manufacturing technology process.

3.3 Speed

Under normal circumstances, the actual three-dimensional printing process is much slower than the conventional technique, the conventional technique, however, often needs auxiliary step and preparations, in order to form the final product. 3D printing technique eliminates these steps. Products to the market directly, rather than using castings and forgings, so the total process is faster than the traditional process and sometimes even cheaper. No special tools, which can be a few hours or a few days to build in three-dimensional parts.

3.4 Complex geometries can be created

Additive manufacturing technology can make the design process more efficient, no other restrictions in the design process. The internal channels and functions of the parts can be created directly but it is impossible in the traditional way.

Additive manufacturing technique is insufficient place, changing layer thickness affects the surface roughness of the model and other mechanical property parameters, and sometimes not limited to mechanical properties. many measures has been taken to improve the surface roughness of the parts, of which usually decline the speed of the printing process.

4 Materials and their types

Modern machines can take advantage of the multitude of plastic and metal materials. Additive manufacturing industries as the amount of material used in the decade before 2007, has been greatly increased. Materials used in the additive manufacturing technique are divided into two categories:

4.1 Metal

Metals include various currently available 17-4 and 15-5 alloy, stainless steel, maraging steel, cobalt-chromium, Inconel 625 and 718, and titanium alloys Ti6AlV4. Once fully developed and validated, almost all of the metal alloys can be used for additive manufacturing process. These materials are not considered consistent with the ASME specification requirements of the metal grades, they are imitated as the ASME specification, generally considered "approximately similar" materials.

4.2 Polymers

The uses of non-metallic materials include acrylic resin, based on photopolymers, and various wax-like substances, even ABS plastic. Importantly, many of these materials are not considered the application to

production because they are brittle, lack of good mechanical properties, usually with short life. In addition, the exact composition of these materials is heavily guarded secrets of the manufacturers.

5 Application and market

Additive manufacturing technique can be applied to a variety of industries, including aerospace, automotive, dental, fashion, military, medical and other fields used in small to medium size direct complex parts. Mould Industry uses it to manufacture the direct insertion tools. Additive manufacturing techniques may also be used for small batch production or one particular component one-time assembly [5]. Usually a plurality of components of complex geometry can be optimized when the product being installed, thus the product being simplified into smaller subcomponents and joints. This is the one of main advantages of additive manufacturing technique. The processing volume of the parts in existing equipment has been growing, and with the increased demand for processing, hardware developments have been much faster and additive manufacturing technique will develop more viable new uses.

In 2006, there are about 50 examples of commercial printing three-dimensional visualization used in manufacturing tools or the middle parts. Additive manufacturing technique is still relatively ascending, the technique used is directly dependent on the engineering staff knowledge of the user part designed, and ability to effectively use printing equipment. However, all this does not affect the additive manufacturing technique development and promotion, market growth is very fast, annual growth rates estimated from 2006 have been up to more than 35% [6].

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Brief Biographies

XIA Bo-xiong is now a Professor, candidate in Wuhan Vocational College of Software and Engineering. His research interests include advanced manufacturing technology and mechanotronics. xiaboxiong_1@126.com.

DU Jun is now an associate professor, deputy director of machinery manufacturing engineering department in Wuhan Vocational College of Software and Engineering.

JIAO Hong-wei is now an associate professor of Machinery Manufacturing Engineering Department in Wuhan Vocational College of Software and Engineering.