Design and manufacture of customized products based on 3D printing technology

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Abstract—3D printing technology, as a new manufacturing technology, has attracted more and more people's attention, and the application field is more and more wide. 3D printing technology has broken the limitations of traditional manufacturing process and brought great advantages to the design and manufacture of customized products. This paper analyzes the current situation of private customized products, the principle and manufacturing process of 3D printing technology, the design method and manufacturing process of private customized products, and the application of 3D printing technology in the design and manufacturing of private customized products, and gives some opinions, hoping that 3D printing technology can better serve the design and manufacturing field of private customized products and promote it.

1. Introduction
In recent years, with the rapid development of information technology, a unified global market has been formed, and more and more enterprises have joined the ranks of competition, increasing the intensity of competition, customers can choose their own products in the global scope, and put forward higher requirements for product types, prices, quality and service. There are more and more types of products, smaller and smaller batches and shorter life cycle. Therefore, in the face of increasingly fierce market competition, enterprises are required to respond faster and faster to the market, adapt to the changes of product demand in the market, and create a private customized production mode for customers while taking into account mass production, so as to provide personalized products to meet customer needs. [6] The use of 3D printing technology can not only meet the different needs of customers and provide personalized services for customers, but also reduce production costs and shorten the cycle of product launch for enterprises, especially for products with more complex structure. 3D printing technology provides designers with material conditions for innovative product design. Designers can give full play to their imagination to design highly creative product structure or appearance without worrying about the manufacturing process and processing costs of products, and can actually provide customers with customized products. [3]

2. Analysis of the current situation of customized products
With the development of society and the improvement of living standards and economic ability, more and more people begin to pursue personalized, quality of life, especially for the 90 years, 00 years of this generation, the pursuit of personalized is a kind of character, an attitude to life. [3] Under this background, the rise of customized products has gradually become a trend. Whether in the traditional market or online platform, customized products can be seen everywhere: customized clothes, customized shoes, customized gifts..., making personal products, not only highlight the unique style,
but also make life full of fun! Customized products have existed for a long time in the economic and social development. The difference is that in today's era, the scope of customized products is expanding, which has quietly extended to all aspects of clothing, food, housing and transportation, from customized food, clothes, jewelry, 3D head pictures, to customized tourism, houses, cars, etc. I believe that with the improvement of living standards, popular and universal commodities can no longer meet people's needs, and personalized and quality products will be loved by people, and customized products that belong to their own unique will become a fashion.

3. 3d printing technology
3D printing technology is a kind of high and new technology developed in the mid-1980s. It is a leap of modeling technology and manufacturing technology. As soon as the technology appears, it has achieved rapid development and has been widely used in various fields. "The widespread use of 3D printers will trigger the third industrial revolution," an industry source said.

3.1. Principle of 3D printing technology
3D printing technology, also called additive manufacturing technology, is a kind of rapid prototyping, it is based on THREE-DIMENSIONAL CAD data files, using metal powder or plastic and other adhesive materials, through layer-by-layer printing, layer by layer cumulative curing method to build objects. It's about making our three-dimensional parts, and it makes it easier by reducing dimensions, by taking a three-dimensional shape, first turning it into two dimensions, then into one, and then into zero dimensions. In the manufacturing process, you start with a point, scan through a point into a line, turn the line into a face, cover the face, cover the second face, cover the third face, until the whole three-dimensional entity is formed. Compared with the traditional manufacturing process, it does not need tools, fixtures and molds, etc., while reducing the production cost and shorten the product manufacturing cycle.

3.2. 3D printing technology molding process method
Since the emergence of 3D printing technology, there have been more than a dozen different molding process methods, among which the more commonly used process methods are mainly four, namely, light curing stereotyping (SLA), melt deposition molding (FDM), selective laser sintering (SLS) and metal direct molding.

3.2.1. Light curing stereotyping (SLA).
Light curing stereoscopic forming (SLA) is the earliest developed 3D printing technology. It takes photosensitive resin as raw material and solidifies it through computer-controlled UV laser. This method can easily and automatically produce complex three-dimensional forms which are difficult to be produced by various processing methods, which is of epoch-making significance in the field of processing technology.

3.2.2. Fusion deposition molding (FDM).
Melt deposition molding technology (FDM) is to melt paraffin wax or engineering plastic through the computer numerical control of the fine nozzle according to CAD layered cross section data for two-dimensional filling, the eject wire after cooling, bonding and curing to generate a thin layer of cross section shape, layer upon layer superposition to form a three-dimensional entity.

3.2.3. Selective laser sintering (SLS).
Selective laser sintering (SLS) is the use of powder materials (metal powder or non-metal powder) under the principle of laser sintering, under the control of computer layer accumulation forming. The principle of SLS is very similar to SLA, with the main differences being the materials used and their shape.
3.2.4. Metal forming directly.
The relatively mature metal direct manufacturing technologies include selective laser melting manufacturing (SLM), laser solid forming manufacturing (LSF), electron beam selective melting manufacturing (EBSM) and electron beam fuse manufacturing (EBF3). Metal direct molding manufacturing technology is the use of high-power density laser beam directly melting metal powder, metallurgical combination, material compactness close to 100%, with certain dimensional accuracy and surface roughness of metal solid parts.

4. Design method and manufacturing process of customized products

4.1. Focus on customer needs
The design of customized product module is different from the traditional process method products, the traditional process product mode is mainly production, with stable market demand, large batch, low cost, stable quality, but the product is single, the development cycle is long, cannot meet the needs of many customers. The customized product mode mainly considers the needs of customers, and the product changes with the needs of customers. The product development cycle is short, which belongs to personalized customized production. In the design of customized products, it is not only necessary to design attractive products from the consideration of customer needs, but also to provide one-to-one services for customers, which provides a very large market prospect for customized products.

4.2. Customized product design method

4.2.1. Determine the design scheme.
According to customer demand, market research, conception of product function design scheme, compare the design scheme, put forward the design scheme to achieve the optimal function, from customer demand, technical and economic aspects such as evaluation and comparison of design scheme, determine the final design scheme. [5]

4.2.2. Output product diagram.
According to different kinds of products, can output two-dimensional CAD map or three-dimensional CAD map, the design scheme or the idea in the mind to expand and draw design drawings on the drawings. 2D CAD and the traditional manual drawing method is the same, just 2D CAD is computer aided design instead of manual drawing, 3D CAD is a dimension higher than 2D CAD, the designer to design 3D model directly, eliminating the two-dimensional patterns into three-dimensional model of the process, simplify the design process, reduce human resources input and software and hardware input, improved design efficiency and design quality. [4] This study is based on the design and manufacturing of customized products based on 3D printing technology, and three-dimensional CAD is the basis for the integration of design and manufacturing, so three-dimensional CAD software is used to output product drawings.

4.2.3. Types of 3D CAD software.
3D CAD software can be divided into two categories in terms of application objects. One category is 3D CAD software that is inclined to art product design, such as 3DMax, Maya, ZBrush. The other is the 3D CAD software which is inclined to engineering product design, such as Pro/E, UG, CATIA, Solidworks. In the product shape design, according to the structure and shape of the product to choose the appropriate 3D CAD software. [2]

4.3. The manufacturing process of customized products
Based on the 3D printing technology mode of product manufacturing, product manufacturing process is as follows: First, three-dimensional model design, according to product functions and customer needs to use three-dimensional CAD software for product modeling design; Second, 3D model surface
processing, that is, the model exported to STL format file; Third, 3D model slicing processing, using Cura slicing software to slice product STL file, set printing parameters, and generate G code required for printing; Fourth, check the state of the printing equipment, check whether the printing nozzle and hot bed plate can be heated normally, whether the nozzle is spinning smoothly, and adjust the level of the forming platform; Fifth, for product printing, insert the SD card with G code file into the printer card slot, open the operation interface, select the file and start printing; Sixth, the product post-treatment, after the completion of the printing of each part, remove the supporting part, and then face to the grinding treatment, and finally the parts are assembled to get the product.

5. Application of 3D printing technology in the design and manufacture of customized products

3D printing technology can be used in many fields from small to large in life. At present, 3D printing technology has been widely used in education, biomedical, automotive, aerospace, industrial design, cultural creativity, architecture and food and other fields. Because the technical principle of 3D printing technology is based on layer upon layer accumulation and superposition forming, the application of 3D printing technology has great advantages in some fields, especially in the design and manufacturing of customized products. The application of 3D printing technology in the design and manufacturing of customized products is increasing. Such as the Mid-Autumn festival in August 15 when using 3D printing technology to produce a belongs to own the moon light, to have friends to customize personalized birthday gift, and in the biomedical field, professor of Peking University third hospital orthopedic Liu Zhongjun for a 12-year-old patient changed the world's first successful application of 3D printing atlanto-axial cone of artificial custom. This paper lists several practical cases of the application of 3D printing technology in the design and manufacture of customized products.

5.1. Application of 3D printing technology in the design and manufacture of customized products

5.1. Design and manufacture of private customized intelligent table lamp

The intelligent desk lamp is designed and manufactured based on 3D printing technology. There are three ways to control the lamp on and off, which are switch button, sound and human body infrared. The appearance of the intelligent desk lamp is similar to that of the house, which is mainly composed of six parts: base, arm, roof, lamp post, lampshade and lampshade connecting block, as shown in Figure 1.

5.1.1. Modeling design of intelligent desk lamp

Creo2.0 three-dimensional design software is used to design the shape of the intelligent table lamp. Six parts are designed, including the base, arm, roof, lamp post, lampshade and lampshade connecting block, as shown in Figure 2.
5.1.2. Model data processing
Firstly, the model surface is processed, and each part is exported to STL file in turn; Secondly, the model is sliced. Cura slicing software is used to slice STL files, set printing parameters and generate G code for printing; Finally, the xj3dp format file is exported, and the G code format file is transformed into the xj3dp format file that can be recognized by 240A 3D printing by using click software. Printing parameter setting: printing parameters are very important for the printing quality of each part of desk lamp, so it is necessary to set appropriate printing parameters. Because FDM 3D printer is selected and the printing material is PLA plastic wire, the important printing parameters are set as follows: ① layer height: 0.1 ~ 0.2mm, if the layer height is doubled, the printing surface quality will be greatly improved, but the printing time will be doubled, the appropriate layer height shall be selected according to the shape of the product. For example, when the forming direction is curved or inclined, the layer height shall be as small as possible to ensure the printing surface quality; ② Shell thickness: 1 mm; ③ Bottom / top thickness: 1 mm; ④ Filling density: 60-100%; ⑤ The printing speed is 40mm / s; ⑥ Nozzle temperature: 210 °C; ⑦ Hot bed temperature: 60 °C.

5.1.3. Check printer status
Molding process: melting deposition molding. Printer manufacturer: Shaanxi Hengtong Intelligent Machine Co., Ltd. printer model: FDM 240A. Check whether the printing nozzle and hot bed can be heated normally, whether the nozzle can spin smoothly, and adjust the level and zero point of the forming platform.

5.1.4. Product printing
Insert the SD card with G code file into the printer card slot, open the operation interface, select the file and print each part of the intelligent desk lamp one by one.

5.1.5. Product aftertreatment
After the printing of each part, the supporting part is removed, and then the surface of each part is polished. Finally, the parts are assembled to get the intelligent table lamp.

5.2. Design and manufacture of customized lunar lamp
3D printed moon lamp is an exquisite personalized custom gift. The exquisite details and vivid effects of the lunar lamp under light projection come from the light transmittance difference caused by different wall thickness of 3D printing relief. Its production process is basically the same as that of other customized products. In terms of equipment, only an entry-level FDM desktop 3D printer is needed. The most difficult part in the production process of lunar lamp is the design of lunar lamp model.
5.2.1. Design of lunar lamp model
The three-dimensional model design of lunar lamp needs lunar mapping materials, and the modeling software includes PS software, ZBrush software, and FlashPrint software. Firstly, PS software is used to modify the brightness and contrast of the moon map, and text and pictures are added to make the black-and-white image contrast of the moon map more obvious; Secondly, use ZBrush software to design the three-dimensional model of the lunar lamp, set the outer diameter and inner diameter of the lunar lamp, and export the STL format file, as shown in Figure 3; Finally, FlashPrint software is used to divide the lunar lamp model into two parts: the upper cover and the lower cover, and the STL format file is exported, as shown in Figure 4.

![Figure 3 Three-dimensional model design of the Moon Light](image1)

![Figure 4 Lunar lamp model segmentation](image2)

5.2.2. Formation of finished products
Complete the slicing of lunar lamp model, check the status of printer, print lunar lamp model and polish lunar lamp model in turn. The finished product of lunar lamp is shown in Fig. 5 and Fig. 6.

![Figure 5 Lunar moon lamp](image3)
5.3. Design and manufacture of switch button for private customized electric rice cooker

The switch button of an electric cooker is damaged due to long-time use, but the switch button of the same model can't be bought in the market, and the electric cooker can't work normally. At this time, we can play the role of 3D printing technology in the design and manufacture of private customized products, and make the private customized switch button to replace the original switch button, so that the electric cooker can work normally, as shown in Figure 7.

6. Conclusion

As a new high-tech manufacturing technology, 3D printing technology has been widely used in various fields. The introduction of 3D printing technology in the design, manufacture and development of private customized products can greatly promote the technological innovation of private customized products, and solve the shortcomings of single product type, long manufacturing cycle, high cost and insufficient personalization. [1] Of course, 3D printing technology, like other emerging technologies, also has some disadvantages. The application of 3D printing technology requires computer modeling and application skills of 3D printers as the basis. The types of materials of 3D printers are also limited and the molding efficiency is low. Therefore, we need to pay more attention to the application and development of 3D printing technology in the field of private customized products to meet the different needs of customers, so that private customized products can be well promoted in the market.

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