Formative Arts Based on 3D Printing Technology

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Abstract. Through the analysis of the basic concepts and application status of 3D printing technology, combined with the design development trend of creative formative arts, some cases of 3D printing creative home products were analyzed. The design development trends of 3D printing creative home products are proposed.

Keywords: 3D Printing, Formative Art, Design

1. Introduction

1.1. Basic concepts of 3D printing

3D printing technology is also referred to as rapid prototyping technology or additive manufacturing technology. Based on three-dimensional models, 3D printing applies linear, powder, and liquid materials that can be melted by heating and bonded for product forming and manufacturing by layer stacking [1]. However, modern society is more and more in pursuit of personalized customization, which complies with the advantages of short 3D printing production cycles, small batch production, and convenient product shape changes, providing opportunities for 3D printing development.

1.2. Basic types of 3D printing

1) Fused deposition modeling (FDM)

The printing type of FDM is according to the slices of the three-dimensional model, it has accumulated through multiple layers and finally completed the modeling of the solid model [2]. The overall process is like squeezing toothpaste, so the technology does not have high requirements on the printing environment and consumables. It is relatively easy to get started and control. It is generally used as an introduction to 3D printing and for teaching.

2) Selective laser sintering (SLS)

The printing type of SLS mainly applies powder (metal, ceramic, wax powder, formative powder, etc.) as the material and is formed by calcination and bonding. The SLS method is mainly used in the foundry industry and can be used directly to manufacture rapid molds [3].
3) Stereolithography (SLA)

SLA printing type is mainly the use of liquid photosensitive resin, cured by light curing. Light curing molding has the most extensive applications due to its high degree of automation of the molding process, the good surface quality of the prototype, high dimensional accuracy, and the ability to achieve relatively fine dimensional molding \cite{4}.

1.3. Application status of 3D printing technology

3D printing technology has been applied in various fields, and in recent years, it has continued to develop and expand. In the medical field, 3D printing can accurately print human organ replacements, such as auricles, prosthetics, etc. By scanning, modeling, and printing, organ replacements for patients can be more suitable, and the time for making and waiting can be shortened. In the field of aerospace, 3D printing can print precise parts faster, easier, and cheaper. It has made up for the insufficiency that the traditional manufacturing process is challenging to achieve the accuracy. In the archeological field, through accurate 3D scanning and model establishment, the restoration of cultural relics can be more accurate. In the manufacturing industry, 3D printing technology improves the manufacturing cycle, simplifies the manufacturing process, and makes personalized manufacturing possible. The appearance of products is no longer limited by the process \cite{5-6}. At the same time, 3D printing technology has gradually spread to the field of education, and its application in cultural and creative industries has increased.

2. Creative formative art design

2.1. The concept of creative formative arts

Creative formative art is a relatively broad concept. Taking the household industry as an example, it includes original home furnishings, personalized layouts, personalized home accessories, and home culture. The difference between innovative home furnishing products and traditional products is that in addition to the functional properties of classic home furnishings, original home furnishings also have specific spiritual features. In the process of use, users can enjoy material functions and have spiritual pleasure. Articles are more a reflection of the director's culture, ideas, tastes, and hobbies.

2.2. Current status of the creative formative art design

In recent years, whenever the traditional home furnishing industry is connected with new ideas such as “creative”, “design”, and “culture”, great achievements have been continuously made. In life, people pay more and more attention to creativity, full of humor, fun, innocence, convenient and versatile products (Figure 1).
In a modern society with better material life, when people buy home products, the practical value is no longer the dominant factor. More and more choices are based on the style, cultural background, and taste of the product. The purchase of products is to satisfy psychological pleasure and pursue a style. Art seeks specific artistic conception for a certain identity. In such an environment, creative home furnishing products are continually emerging, especially the formative art is prominent. More and more styles of the same commodity emerge to meet the aesthetics and needs of different users.

2.3. Development trend of creative home products

1) Trend ①: Emphasize personality

As people's living standards are continuously improved, consumers in the home market are not only confined to prices and quality when buying home products but also consider the added value brought by product brands. Creativity will become the biggest selling point for product sales. Hence, many home furnishing brands have begun to refine and integrate elements such as “personality and self-expression” into furniture. Furniture with a single style has become increasingly challenging to meet the needs of modern people for home space. This type of consumer group refuses to be dull and monotonous and desires the flexibility of design. The ingenious fusion of personality and overall space makes young people more fascinated.

2) Trend ②: Home culture

As people are more and more in pursuit of high-quality life, cultural elements are gradually infiltrating into the corners of citizens' lives. Where cultural elements are incorporated into home decoration, it will no longer be merely an “ordinary” home, and its connotation goes far beyond “fashion and personality”. A home with culture and stories can reflect the owner's preferences, temperament, and cultural qualities from the side. Therefore, the mainstream of home consumption in
the future may be the integration of culturally rich goods, combining furniture, lighting, fabrics, cabinets, bathrooms, crafts and other related products in a harmonious manner.

3. Application of creative home formative art design based on 3d printing technology

3.1. Diversified shapes

3D printing technology only requires the consideration of material issues in product design. The shape of the product can be made and modified arbitrarily through the 3D model file. As long as the model can be produced, product shape is easy to implement, and there is no need to consider the production process and technical restrictions. This greatly expands the creative thinking, making the creative home products more diversified, and even achieves the same style and unique effect. For example, Figure 2 shows that in the design of this coffee table, the parts between the tabletop and table legs are 3D printing to make a variety of styles, so that a product has many different shapes.

Figure 2. 3D printing coffee table components

The principle of 3D printing is as follows. It is assumed that P is a unit vector in the selected molding direction, as shown in equation (1):

\[ P = [\sin \theta_1 \cos \theta_2, \sin \theta_1 \theta_2, \cos \theta_2] \]  

(1)

Where \( \theta_1 \in [0, \pi] \), \( \theta_2 \in [0, 2\pi] \)
Figure 3. Modeling coordinate system

In addition, the 3D printing molding time is used to evaluate the efficiency of 3D printing, as shown in formula (2).

\[ Q = x \sin \theta_1 \cos \theta_2 + y \sin \theta_1 \cos \theta_2 + z \cos \theta_1 \] (2)

The mathematical model of forming efficiency can be expressed in equation (3):

\[ T = \frac{1}{h} \{ \max(Q) - \min(Q) \} \] (3)

Where T is the number of forming layers/layer

3.2. Personalized customization

In 3D printing, the advantages of rapid prototyping are used to achieve small-volume production of products and fulfill the public's demand for customization. In the traditional manufacturing industry, customized products are only luxury products, and customized products can only be implemented by pure hand-made method, which can only be consumed by a small number of people. With the advent of 3D printing, customization has become simpler, product sizes can become more arbitrary, and products can better meet individual needs.

3.3. R&D efficiency

The application of 3D printing technology can greatly shorten the cycle of product sample production, adjustment, and re-production. In the early stage of product development, accurate dimensions are calculated in 3D software, and the intuitive style of the product can be displayed, which can avoid many sample adjustments caused by size and style problems. After product design, the process of making samples will be faster and more convenient than the traditional hand-made process. The shortened product research and development cycle makes the innovation of product styles no longer limited by time and production technology.

4. Conclusions

As a new manufacturing technology, 3D printing technology has a broad development prospect. The application of 3D printing technology to the design and production of creative home formative art products can endow customized and personalized products with more plain folk features to meet
people’s increasingly urgent personalized needs. However, so far, 3D printing is restricted by some factors in the design and production of creative home products. Nowadays, in the pursuit of customized and personalized products, the potential of 3D printing technology in the design and production of creative home products is enormous.

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