

3D Creative Design of Cheetah Running Form

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ABSTRACT

In recent years, 3D printing technology has been developing rapidly, which not only helps the development of science and technology industry, but also promotes the progress of cultural and creative undertakings in China. Cultural and creative products are widely loved by people because of their unique cultural heritage, and hand-made model is one of the pillar industries in the field of cultural and creative industries. The emergence of 3D printing technology has greatly changed the design and manufacturing process of the original model, reducing the cost and shortening the cycle of the finished product. In this context, this paper puts forward the 3D creative design research of cheetah running form hand-made model. The core of this paper is to develop the cultural ideology of cheetah on the basis of 3D printing technology, and to make a hand-made model. This paper gives the design principle and the specific operation steps in detail. In addition, the printing material of this paper is ABS plus, which is a kind of 3D printing material with strong plasticity and high stability. The printing technology adopts the integrated manufacturing process, which reduces the development difficulty to the greatest extent, and is easy to operate and not easy to make mistakes. In order to further verify the actual effect of the design method in this paper, 500 samples of each were made by 3D printing method and traditional method respectively, and the user experience was investigated in groups. This study has carried out a number of comparative experiments including collection intention survey, single index satisfaction survey and use function survey. The survey data show that the cheetah model with 3D printing technology is more popular with users than that with traditional technology. This paper analyzes that this is due to the improvement of production technology, which greatly improves the quality of the model.

Keywords: 3D Printing Technology, Cultural Creativity, Creative Design, Model by Hand

1. INTRODUCTION

In recent years, we often hear about 3D printing from news reports and journalists, and are surprised by 3D printing. We live in the third industrial revolution, and 3D printing has taken us away from Henry Ford's mass production line and ushered in a new era of customizable, disposable production. For example, for washing machines, the current situation is that you place an order from a repairman, and the repairman picks up the goods from a dealer, and then the dealer delivers them from China. Then, with the help of very expensive injection molds, China can produce thousands of them at a time. In the future, from now on, all you have to do is download a CAD file, use 3D printing to get a washing machine at home. If you don't have a suitable printer, please print it in the local OEM. 3D printing is also known as additive manufacturing. Compared with traditional manufacturing, the manufacturing methods used in 3D printing are quite different in the direction of material use, such as cutting, reducing to stacking and adding. Therefore, 3D printing has great advantages over traditional manufacturing methods in the production of complex mechanical parts and personalized design of products. At present, 3D printing is widely used in medicine, aircraft manufacturing, art design, architectural design and other fields. The range

of products produced by it is not only used for conceptual verification in the initial stage of product design, but also directly used for product manufacturing. With the continuous improvement of follow-up materials, 3D printing will gradually change the face of modern manufacturing industry.

Manual model industry is a market with huge potential, which can bring huge economic benefits. However, the profit of manual model industry is unique. At present, tens of thousands of model product development manufacturers in China are doing the minimum processing for foreign cultural and creative companies. Most of their orders come from Europe, the United States and Japan. With the increase of domestic labor costs, the profit margin of hand-made product development enterprises is seriously squeezed. Especially in the 2008 financial crisis, 3D printing technology in the development of hand-made model products can meet the growing material, cultural and spiritual needs of people. Handmade model products are cultural and creative products, as well as spiritual and cultural leisure psychological products. With the great improvement of people's life quality and level, more and more personalized products are paid attention to. The demand for personalized products is increasing and the market demand is expanding rapidly. 3D printing

technology breaks the limitation of traditional hand-made product development model and maintains the revolutionary mode of hands. Product development provides a broad stage, especially for the hand-made model of product development and innovation. In this context, this paper puts forward a 3D creative design research on cheetah running shape model.

Firstly, this paper studies the core concepts and theoretical basis of 3D printing and creative design. Through the research, this paper believes that the emergence of 3D printing technology has greatly accelerated the development of industrial manufacturing industry, and has greatly improved the development environment of entrepreneurial industry. It shortens the product development cycle and increases the market competitiveness of enterprises. These favorable environments also affect the manual model industry. Then, based on the traditional cheetah running shape model, this paper carries out the transformation of 3D printing creative design. In the third chapter, the design principle and specific operation method are given in detail. The core of this method is based on 3D printing technology to make cultural and creative transformation of cheetah model, which integrates a variety of cultural elements to make the model more cultural. At the same time, with the help of 3D printing technology, the model is more solid, realistic and more realistic. Finally, in order to verify the actual effect of the transformation scheme, this paper establishes the corresponding comparative experiment. The experiment adopts the way of investigation and research, and compares the traditional model and the 3D printing model in user experience. In this paper, a number of comparative experiments including collection intention survey, single index satisfaction survey and use function survey were carried out. Through the analysis of the survey data, we can see that the cheetah running shape model designed by 3D printing is more popular with users than that made by traditional technology, and the indicators have been greatly improved [1-3].

2. CORE CONCEPTS AND BASIC THEORIES OF THIS PAPER

2.1. Overview of 3D Printing Technology

3D printing, also known as additive manufacturing, is a rapid prototyping technology. According to computer data instructions, 3D printers make objects by stacking plastic, resin or metal layer by layer on a variety of bindable raw materials. Traditional machining technology uses cutting materials or abrasives to make objects. In recent years, with the development of computing power, new design software, new materials, innovation driven and Internet development, 3D printing technology has developed rapidly. At present, it has been widely used in architecture, industrial design,

jewelry design, civil engineering, automobile manufacturing, aerospace, education, medical and other fields. The design phase of 3D printing is mainly realized by 3D modeling software or 3D scanning equipment. 3D printer prints objects from 3D design files. 3D modeling and visualization play an important role in the final printing effect. 3D scanner can directly generate 3D model by digitizing and modifying the object. Three-dimensional scanning, including optical, mechanical, electrical and computer technology, is mainly used to scan the spatial shape and structure of the object to obtain the spatial coordinates of the object surface, and the three-dimensional information of the object is converted into digital signals. It can be directly processed by computer, thus providing a convenient and fast method for digitizing objects.

The printing stage is mainly realized by 3D printing equipment. The 3D printing process is as follows. The 3D printer divides the 3D model design data according to the printing accuracy. The slicing data of each layer is constructed, and then the slices are printed from bottom to top. That is, the molten liquid material or powder is sprayed and solidified into a special flat thin layer. After the first layer of printing is completed, the nozzle returns, and the section information of the second layer reads, prints and solidifies to return. Read it again, and so on, until the layers are stacked together to form a three-dimensional solid. Compared with the traditional manufacturing technology, the biggest difference of 3D printing technology is that the 3D design model in the computer can be directly transformed into real objects without cutting, processing, grinding tools and other means. 3D printing technology for complex, accurate objects has a high degree of completion, can quickly print complex design. Most of the production time of 3D printing technology is used in 3D design software. There is no production and processing for grinding tools, which shortens the production time, improves the utilization rate of raw materials and reduces the waste [4, 5].

2.2. Classification of 3D Printing Technology

At present, many 3D printing technologies have been produced. The main difference between them lies in the deposition method and the materials used, mainly including the following categories.

2.2.1. Layered solid formation (LOM)

Lom is a rapid prototyping system developed by helisys. LOM uses paper, foil, plastic film and other materials. In the printing process, the adhesive tape, plastic film or metal laminate are glued together in turn, and then cut and molded by knife or laser cutting machine.

2.2.2. Melt deposition molding (FDM)

FDM uses additive manufacturing principle to construct 3D objects layer by layer. FDM mainly uses plastic fiber or metal wire as raw material. The raw material is heated to 1 degree above the melting point by electric heating, and then the melted material is coated on the worktable. After cooling, a layer of cross section is formed on the workpiece. The advantages of FDM are low pollution, reusable materials and simple operation.

2.2.3. Three dimensional stereolithography (SLA)

The working principle of SLA: focus on the specific wavelength and intensity of the UV curable material surface, make the solidification sequence from point to line, from line to surface, complete the first layer of drawing work, and then the lifting platform moves one layer in the vertical direction, then consolidates another layer, and repeats this operation to form a three-dimensional entity.

2.2.4. Selective laser sintering (SLS)

SLS selective laser sintering (SLS) uses laser to selectively layer the sintered solid powder and superimpose the solidified layer to form the required shape of the parts. The whole process includes the establishment of CAD model, data processing, powder spreading, sintering and post-processing [6-8].

2.3. Application Scope of 3D Printing Technology

Due to the advantages of excellent 3D printing technology, the application in architectural design, manufacturing, and protection of cultural relics, medical and health care industry, scientific research and product prototype, 3D printing technology in industrial upgrading and promoting efficiency can expand its broad space for further development. Figure 1 shows the more extensive areas of 3D printing applications.

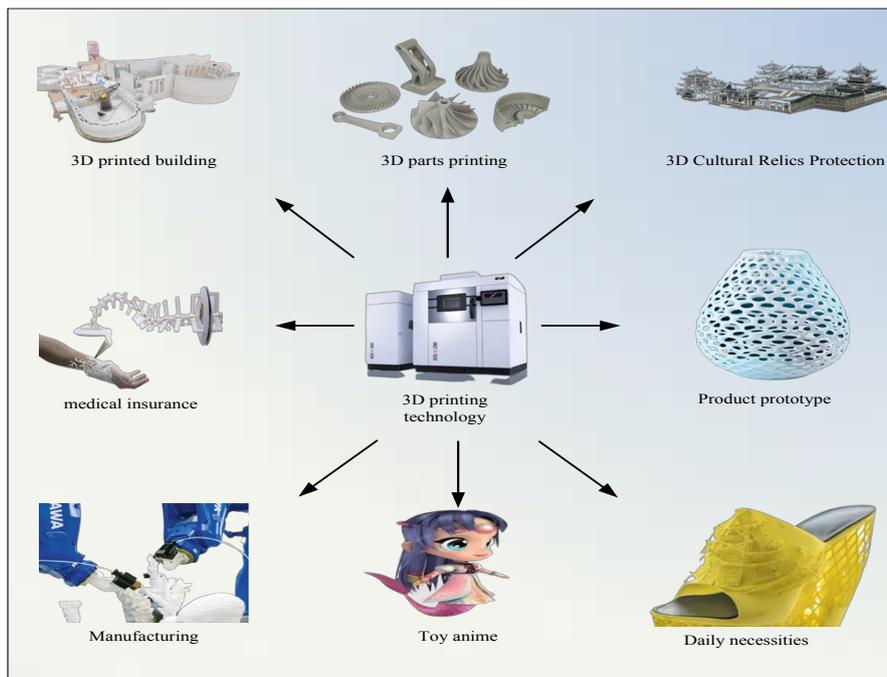


Figure 1. 3D printing application fields

When using 3D printing technology to develop animation derivatives, we should focus on the entity products of animation derivatives. In the animation derivative products, the publishing products generally focus on the broadcasting and publishing of animation works, and most of the people who contribute to the sales are animation fans. Therefore, it is impossible to support the investment of animation companies to a large extent by the return from the sales of publishing products. There are many kinds and wide range of physical products, which give full play to the flexible,

creative, entertainment and leisure products of lifestyle products. It also reflects the concept of interest, interest and practicality of animation derivative products. The physical products have a broad market, big consumption potential and high profit margin.

2.4. Concept of Creativity

Creativity is an abstract concept, which is often reflected in people's thinking activities, which needs to be realized through the innovation of consciousness and thinking. It's also what we call attention, thought, and so

on. Creative ability is embodied in creativity, that is, the need to create works that are both novel and in line with the purpose. Some scholars believe that creativity is a kind of struggle, which can help us find and liberate our hearts. Creative design is not a simple concept. In order to express the connotation of commemoration, creative design needs to mobilize all arts, materials and technical means to create an atmosphere. [9-11] resonate with visitors through the implementation of design ideas.

2.5. Application of 3D Printing in Creative Design

2.5.1. Adjust the design scheme

The application of 3D printing in the field of creative design is firstly reflected in the adjustment of design scheme. The design scheme itself is complex and changeable. In addition, it has to face the increasingly rich needs of customers, as well as the difference of personal aesthetics. Customized handicrafts need to be adjusted according to customers' preferences. The design scheme of modern arts and crafts cannot be reflected by simple drawings. On the contrary, it needs to be presented in a more specific way. In addition, the design itself also needs to be adjusted in kind, saving time and cost, which is of great help to the improvement of the design scheme. For example, in sculpture design, it is very risky to try to use the original stone directly, while 3D printer can simulate the product design well, show the design effect, and discover the mistakes and defects in the design process as soon as possible.

2.5.2. Shorten the time from design to molding

3D printing technology effectively shortens the whole cycle from personalized creative design to molding. With the continuous development of society, the taste of consumers is constantly changing. And 3D printing technology can effectively cope with the market, and designers who help manufacturers adapt to the changing consumer appreciation level can rely on the Internet as an open platform for product design. Increase "niche" product development and production, shorten the production cycle, product management era long tail. It should be pointed out that 3D printing is more suitable for small-scale manufacturing, especially for manufacturing high-end customized products such as individual special parts. At the same time, in the future development, metal materials will replace plastics for 3D printing, becoming an important technology for personalized creative design in the future, and support the use of new materials [12].

2.6. Introduction to Cheetah

Cheetah is an animal of the genus cheetah in Felidae family, and is the only one under cheetah. The cheetah

is covered with black spots, a black stripe extending from the corner of the mouth to the corner of the eye, and a circle of black around the end of the tail. The hair at the back of the neck is longer, like a very short mane. It has a slim body, long legs and a small head. The body length is about 1-1.6 meters, the tail length is 0.5-0.9 meters, and the weight is generally 33-75 kg. It is covered with black spots, from the corner of the mouth to the corner of the eye have a black stripe, which is a prominent feature of cheetahs and leopards. In order to identify "the fastest running animal in the world", cheetah, leopard, snow leopard, black leopard, zebra, giraffe and other animals, under the same conditions, cheetah runs the fastest under four conditions, and ranks first with greater advantages each time.

Cheetahs have a streamlined, slender body and long, fast legs, which earned them the title of land sprint champion. Cheetahs can approach and kill their prey in seconds. According to zoologists, it takes about 2.5 seconds to run 100 meters. The speed of a cheetah depends largely on the structure of its spine, and each part of the spine plays a different role in running. Among them, cervical vertebra and tailbone mainly play a role in regulating body balance, thoracic vertebrae, lumbar vertebrae and skeletal vertebrae are located between the anterior and posterior joints of the spinal cord. Its periodic up and down bending is the main factor affecting the running speed, among which the length of lumbar spine is the longest and the deformation is the largest. Cheetah's lumbar vertebrae is made up of rigid and elastic discs, which makes the structure of lumbar vertebrae deform and bend greatly. The bending of lumbar vertebrae is mainly contracted by upper and lower abdominal muscles and lumbar muscles. And elastic disc can store energy in the compression process, release the energy at a pace, improve the efficiency of energy utilization [13].

3. CREATIVE DESIGN CONCEPT AND METHOD OF CHEETAH MODEL 3D PRINTING

3.1. Design Research

The main value of cultural creative products lies in its cultural connotation, and its cultural connotation value depends on the producer's full understanding of the design theme. The core values and integrity of the theme, manufacturers must collect a lot of information related to the theme, fully grasp the basis, extract the core connotation of its culture, and use their own knowledge to find a suitable solution. Cultural and creative products in the market to achieve their own cultural value, of course, consumers, from their own point of view, mainly depends on the expression of its cultural connotation, and its ingenious design. But from the consumer's point of view, it is to check the scale of

the product market, the consumer's consumption ability, whether consumers have similar competitors to choose from. Therefore, it is necessary to carry out design research before design. The design research of this product mainly includes the following parts:

- (1) People's understanding of cheetah;
- (2) Ten reasons to like cheetahs;
- (3) Investigation of cheetah related products;
- (4) Collect a large number of elements related to cheetah related topics, and determine the type, size, price range, material, and applicable design elements of the model according to the survey data.

3.2. Design Originality

After sorting and analyzing the data, the following sales and design positioning are obtained from the design research. Cheetah's Handmade model aims at medium and high-end products, mainly through product highlights and creative shapes, to improve the commemorative attribute of handmade products and attract consumers to buy them at a lower price. The production cost of middle end products is set within 100 yuan and the price is 89 yuan. The design elements are not limited to the cheetah's main vision, but also integrate natural and wild elements.

3.3. 3D Printing Equipment and Materials

The maximum printing size of FDM 3D printer is $8 \times 8 \times 12$ inch, and the accuracy is 0.08mm. After printing, the supporting materials can be cleaned with specific solution, and the whole process of finished product printing does not need any manual processing, so as to better ensure the integrity of the molding model. The device adopts high strength ABS plus as the main manual structure, which is the patented 3D printing material of STRATASYS. Its strength is 140% of that of ordinary ABS material. 3D printing components have long-lasting mechanical strength and stability. ABS plus can also be used with soluble support materials, which can easily create complex shapes and deeper cavities without removing the supports manually.

The self-developed 3D printer for electronic printing includes high-voltage power supply, signal generator, 3D motion platform, pneumatic system and observation system. The printer adopts the principle of electro-hydraulic jet printing, and uses the electric field to drive the very thin jet on the top of the liquid cone. The printing resolution is not limited by the nozzle diameter, and it is not easy to block the nozzle. Electronic printing materials are unrestricted and widely used in conductive pastes with different viscosities. Electronic printing has the advantages of good compatibility, high resolution and low cost.

3.4. Design Process

Using 3D printing technology to make cheetah manual model, we need to collect cheetah to build the model. In order to ensure that the reproduction and recovery of finished products and real objects are 1-35 times of the original, there are two methods of information collection and modeling. First of all, photos with the same and different directions should be provided. Before printing, the data of the photo model needs to be collated and summarized. This method needs a lot of work, because the previous work is larger than the modeling work, requires more technical personnel and is more time-consuming. The second method is more convenient and faster. Only one 3D simulation scanning equipment is needed to obtain the data of cheetah model. The 3D data is imported into the computer to design the corresponding data parameters of the model, and the size, material and appearance of the model will be recorded. Then using the combination of manual processing and mechanical processing mold forming technology, accurate production of high proportion of simulation entity model.

The manual model made by 3D printing technology not only saves materials and production time, but also has high value of textual research, which can provide reference for future work.

3.5. Preparation in Advance

(1) Digital model making. According to the design scheme, the 3D Max software is used to convert the three model design sketches from plane to computer 3D model. The internal structure of the designed model is more complex, so special attention should be paid to the transition of cross-section when modeling. Finally, STL format file suitable for 3D printer is exported. 3D Max is a modeling software suitable for 3D printing. The model can be freely switched between polygon and surface with high printing accuracy.

(2) Selection of printing equipment and materials. According to the design characteristics of the model, on the premise of ensuring the printing quality and printing speed, the dimension elite 3D printer is selected as the model printing. The selected printing material is ABS plus, which is an excellent polymer extracted from plant starch, and is also a green printing material. It is stable in nature and not easy to deform, which is in line with the long-term display demand of art works. The finished product printed with this material has bright color and smooth surface, which can also enhance the color and appearance of the work. In addition, ABS plus is a renewable material made of corn, and its green environmental protection characteristics are particularly suitable for making furniture, which can be placed indoors for a long time.

(3) Import Cura software and set printing parameters. Import STL format model file into Cura software and set printer parameters. Pay attention to the setting of "layer height" in the software, which directly affects the printing quality of 3D printer. In the early stage of printing, it is necessary to adjust the shell thickness, printing speed, filling density, printing temperature and other important parameters according to the structure and shape of the model and considering the printing effect.

3.6. Integrated Manufacturing Process

(1) Drawing CAD 3D model according to design drawing, including basic shape and function structure. The CAD 3D model is converted into data, and the 3D model is approximately processed into data and STL format file.

(2) The STL format file is imported into FDM 3D printer, and ctalyse rapid prototyping software is used. After importing STL format file, the 3D model operation in the software, such as coordinate conversion, model layering, filling, inserting pause and so on, is carried out. Transform and layout the loaded 3D model, and carry out STL processing.

(3) After setting the parameters, click "process STL" to get the hierarchical model diagram. Set the pause position according to the model size, that is, insert the pause in the software settings where the pause is needed.

(4) Add the processed STL file to the model package. After you add the model file to the model package, you cannot change it. However, you can view the model view and layer view in the general view, and you can rotate the model file by selecting the reference plane and reference axis, and display the position of the model on the machine workbench on the software platform.

(5) Start printing the base structure of the model.

(6) When printing the pause layer model, FDM 3D printers pause printing, need to print in the printer tray, and then delete the infrastructure print tray. Remove the support from the removed infrastructure from the precisely positioned 3D printer on the 4 preset positioning block trays.

3.7. Post Print Processing

After the completion of 3D printing process, some follow-up treatment measures should be taken to

enhance the molding strength and prolong the storage time, including static, forced curing, powder removal, coating, etc.

The post-treatment of SLS includes high temperature sintering, hot isostatic pressing sintering, impregnation and impregnation. SLS method is used to print products, and the hardness after printing can meet the requirements. The surface powder can be removed by mechanical vibration, microwave vibration and wind blowing in different directions. A less commonly used method is to remove excess powder by soaking the product in a special solvent that dissolves the dispersed powder. This method has no effect on the cured products. In addition to eliminating the powder, it is necessary to consider the long-term preservation of the products, especially the mold materials which are easy to absorb water, such as gypsum and ceramic base [14, 15].

4. SURVEY RESULTS AND ANALYSIS

There were 500 participants in the survey, and 1000 cheetahs were made, including 500 with 3D printing design and 500 with traditional injection molding technology. One finished product of the two processes was distributed to the participants. A survey report form was attached. A total of 500 questionnaires were distributed and 489 were recovered, with a recovery rate of 97.8%.

4.1. Survey of Collection Intention

As a cultural and entertainment product, the most important function of hand-made model is collection value, and most model products can play a role of ornament. Therefore, to investigate the collection intention of cheetah models made by different technologies is of great significance to analyze the customer popularity between 3D technology and traditional technology.

According to the survey results in Figure 2, 95% of users think that the cheetah running model made by 3D technology has collection significance, and 85% of users are willing to collect it. For the model made by traditional technology, 67% of users think it is meaningful to collect, among which only 32% are willing to collect. The survey results show that the model with 3D printing creative design is more popular with customers.

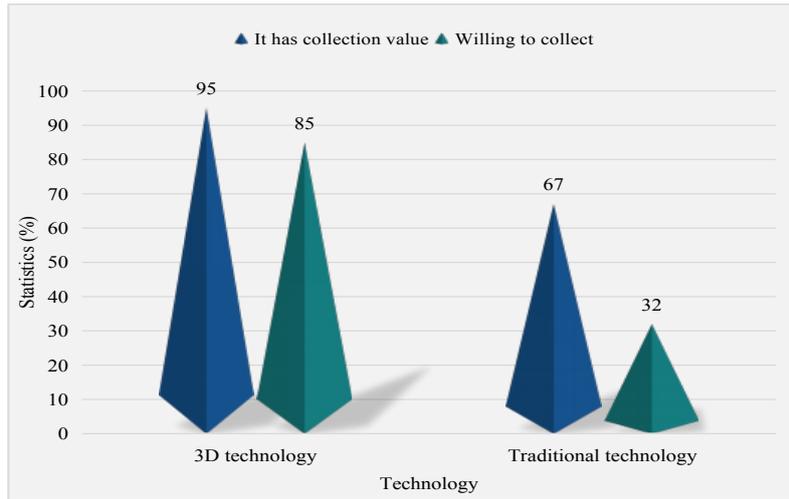


Figure 2. Survey results and analysis of user collection intention of two models

4.2. Satisfaction Survey of Single Index

The popularity of a product is often determined by many factors, including material, appearance, feel, color

matching and cultural significance. The single index satisfaction of this survey includes the above aspects, and the survey results of two kinds of technological products are statistically analyzed.

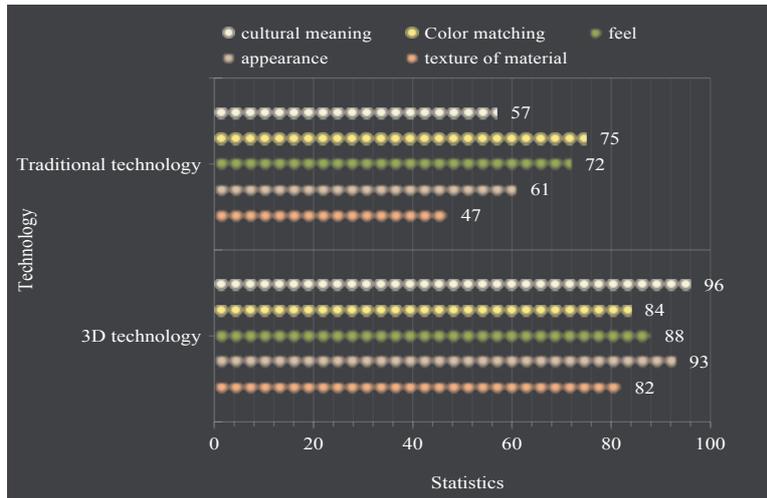


Figure 3. Survey results and analysis of single index satisfaction of two models

According to the statistical results in Figure 3, the cheetah model produced by the creative design of 3D printing in this paper has improved the production of traditional technology in various indicators, and the range is obvious. The improvement of appearance impact and cultural significance is more than 30%, which shows that 3D printing technology can make the model more realistic.

4.3. Usage Function Survey

This survey is only for cheetah hand-made model investigation, not specific production process differentiation. According to the survey and statistics in Figure 4, 65% of users use the model as collectibles, 15% as entertainment items, 12% as gifts for friends and relatives, and 8% as gifts for business activities. The results show that cheetahs' hand-made models lack of business function and tend to be collected by individuals. Therefore, this paper analyzes that cultural meaning should be integrated into the design. Only when the cultural connotation is deep enough, can the user's desire for collection be aroused more and more.

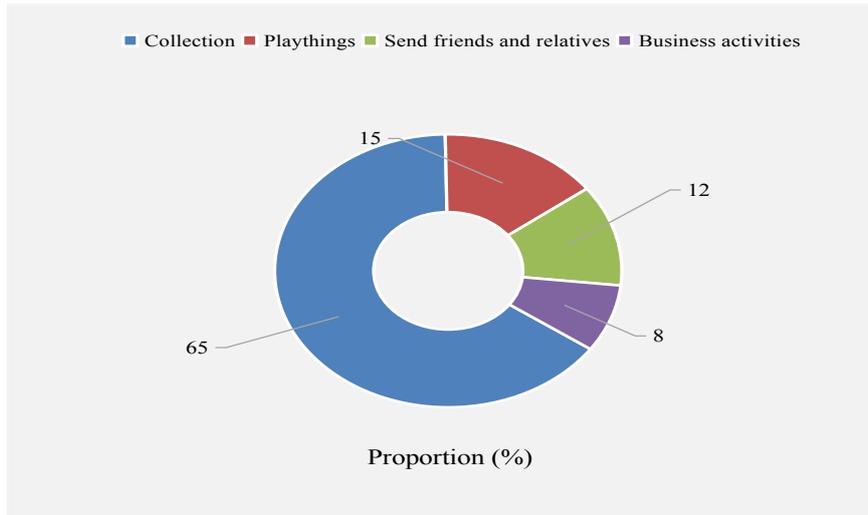


Figure 4. Survey results and analysis of model usage function

4.4. Attraction Factor Survey

According to the results of the previous surveys, the hand-made model with 3D printing creative design is popular with more users. In order to further analyze the specific factors that attract users' love, this paper makes a specific analysis of quality, quantity limit, price, cultural implication and production process in the following survey.

According to the analysis of the survey and statistics in Figure 5, for the new technology of cheetah running

shape model, the main attraction of users is that 3D production technology accounts for 42%, cultural connotation accounts for 27%, quality accounts for 8%, price accounts for 7%, and limit accounts for 6%. According to the results of the survey, this paper analyzes the main value of a product's manufacturing process and its cultural significance. In this paper, the 3D printing creative design of the new cheetah running form hand-made model, in the appearance and significance have been greatly improved, the user satisfaction, the effect is more ideal.

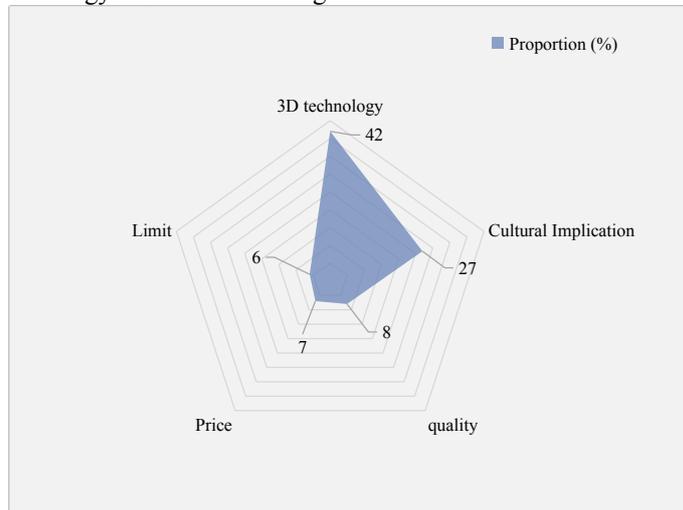


Figure 5. Survey results and analysis on the proportion of users' favorite factors of new cheetah model

5. CONCLUSIONS

Handmade model plays an important role in cultural and creative industries, and plays a key role in the development of related industries. However, due to the backward technology, most of the domestic model companies have become OEM factories of foreign brands, lacking their own core technology, and the industrial development has become very passive. Since the emergence of 3D printing technology, this pattern

has been greatly changed. 3D printing technology can make the idea quickly turn into finished product, which can shorten the product cycle and change our design concept. With the development of economy, people put forward higher requirements for cultural and creative products, and higher requirements for their quality and cultural heritage. However, the related research is still blank in China. Therefore, the 3D entrepreneurial Design Research on cheetah running form proposed in this paper has made up for the blank in this field to a

certain extent. The transformation and upgrading method in this paper completely abandons the traditional simple injection molding process, making the model no longer a simple plastic product, but a handicraft with cultural significance. About the design concept and production method, this paper has a detailed introduction. Finally, in the comparative analysis experiment of indifference survey, the cheetah hand-made model using the design method in this paper is more popular than the model made by traditional technology. Through the analysis of the data, this paper believes that the new model has been greatly improved in feel, appearance, and cultural heritage, and the comprehensive quality has increased to a level, which has more ornamental value and collection value than the traditional model.

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