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Application and Trend Research of 3D Printing Technology in Marathon Running Shoes

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Abstract: This paper discusses the application and development trend of 3D printing technology in marathon running shoes. 3D printing technology provides a new way for personalized customization, functional optimization and intelligent integration of marathon running shoes through precise control of structure and materials. Currently, the technology has been applied to sole structure, upper materials and customized services, significantly improving the performance and comfort of running shoes. In the future, with technological innovation and changes in market demand, 3D printed running shoes will make more breakthroughs in materials, design and market applications, bringing runners a more comfortable, personalized and intelligent running experience.

Keywords: 3D printing technology; Marathon running shoes; Personalized customization; Technological innovation; Design innovation

Introduction

With the rapid development of science and technology, 3D printing technology has become one of the hot technologies in the manufacturing field with its unique manufacturing methods and wide application prospects. Especially in the field of sporting goods, especially in the design and manufacturing of marathon running shoes, the application of 3D printing technology has attracted increasing attention. Marathon running shoes, as an important equipment for athletes in the race, its performance directly affects the athletes' performance and results. Therefore, how to improve the performance of marathon running shoes, achieve personalized customization and meet the specific needs of athletes, has become the focus of manufacturers and designers. 3D printing technology, with its high precision, high flexibility and high degree of freedom, provides a new idea and method for the design and manufacture of marathon running shoes. Through 3D printing technology, designers can more accurately control the structure and materials of running shoes, achieve personalized customization and functional optimization, thereby improving the performance and comfort of running shoes. Therefore, this paper aims to deeply discuss the application status, innovation points and future development trends of 3D printing technology in marathon running shoes, in order to provide reference and reference for research and practice in related fields.

1. 3D printing technology overview

1.1 The basic principles of 3D printing technology

The basic principle of 3D printing technology is the technology of transforming digital models into physical objects. Its operating principle is similar to that of the traditional inkjet printer, but under the 3D digital model drive, the forming material is sprayed out by a device similar to the printer nozzle or the binder is sprayed on the material layer to build the interlayer accumulation, accumulate layer by layer, and "print" out the entity consistent with the shape and size of the 3D digital model. Specifically, the basic process of 3D printing consists of the following steps: First, digital modeling, using computer-aided design software (CAD) or other technologies to transform objects that need to be printed into three-dimensional models that computers can recognize and process. The second is the slicing process, which cuts the three-dimensional model into layers of thin sheets, known as "slices, " which will guide the printer to add material layer by layer. The third is the print control, which converts the information of the slice into the instructions that the actual printer can recognize and execute, and controls the printer to add materials layer by layer in accordance with the set path and order. Fourth, the material is added. The printer melts or bonds the printing material by heating or other means, then jets it onto the printing platform or the previous layer of printing material, and accumulates layer by layer until the entire model is completed [1].

1.2 Advantages of 3D printing technology

The first advantage of 3D printing technology is the ability to achieve personalized customization, personalized customization according to customer needs, whether it is product design, size adjustment or material selection, can achieve a high degree of customization. 3D printing

technology can quickly transform digital models into physical models, greatly shortening product development cycles, reducing manufacturing costs, reducing material waste, and having less negative impact on the environment, contributing to environmental protection and sustainable development. 3D printing technology provides designers with more room for innovation. Designers can use 3D printing technology to explore new shapes, structures and materials to create products that have never been available before [2].

2. Application status of 3D printing technology in marathon running shoes

The specific application examples of 3D printing technology in marathon running shoes can be reflected in a number of well-known sports brands. The first is the FUTURE ULTRA LIGHT series of running shoes launched by domestic brand Peak, which is China's first competitive marathon running shoe with 3D printed upper technology. The layout of the upper surface lines comes from the distribution of foot pressure during marathon exercise. Through the 3D printing upper technology manufactured by melting deposition, the TPU fiber is woven in layers and cured to form a more lightweight and breathable upper. Taking the US9(42.5) size 3D printed upper running shoes as an example, its single gram weight is only 197 grams, which effectively reduces the energy consumption during long-distance running. Peak's 3D printing technology also allows a full range of 3D customized solutions from the middle sole to the upper based on the runner's foot shape data to achieve personalized and high-performance products [3].

Figure 1: FUTURE ULTRA LIGHT running shoes from Peak

Adidas' 4DFWD technology, developed in collaboration with Carbon, 3D prints midsoles using digital light synthesis technology. The technology uses an innovative bow-shaped grid structure that converts vertical pressure into horizontal force to bring forward propulsion to the runner, demonstrating the application of 3D printing technology in midsole design and manufacturing, bringing unique performance and comfort to the midsole. The brand focuses on using 3D printing technology to improve product functionality and performance to meet the needs of runners [4]. Patagonia In the choice of materials, Patagonia uses a large number of recyclable or biodegradable materials. For example, some of their product ranges use recycled polyester, a material derived from discarded plastic bottles that is specially treated and converted into high-performance fibers for clothing and equipment.

Figure 2: 4DFWD lace-up running shoes developed by Adidas

3. Development trend of 3D printing technology in marathon running shoes

3.1 Technological innovation

The emergence of new 3D printing materials, such as carbon fiber composite materials, bio-based plastics, etc., these materials are not

only light in weight, but also have good mechanical properties and durability. This multi-material combination printing method can customize more suitable running shoes according to the specific needs of runners and foot characteristics, providing better sports performance [5]. By optimizing the printing parameters, selecting the right printing equipment and materials, and adopting parallel printing technology, the speed of 3D printing can be significantly improved. The active use of environmentally friendly materials in 3D printed running shoes not only reduces the impact on the environment, but also promotes the sustainable development of the industry [6].

3.2 Design innovation

In terms of design innovation in marathon running shoes, modular and detachable design, through 3D printing technology, each part of the running shoe can be designed as an independent module. This modular design makes the replacement and repair of running shoes more convenient, and users can replace a module according to their own needs or damage, rather than buying a whole new pair of shoes. Users can choose different module combinations according to different sports scenarios and climatic conditions. The design method of multi-material combination can customize more suitable running shoes and provide better sports performance [7].

3.3 Market application trend

According to industry reports and consumer surveys, more and more runners are pursuing running shoes that perfectly match their foot type and running needs. Through 3D scanning and printing technology, consumers' foot shape data can be accurately obtained and running shoes that meet their individual needs can be quickly produced. In the future, customized services will become the mainstream trend of the marathon running shoes market. With the continuous progress of technology and the reduction of costs, more brands and manufacturers will launch customized services to meet the individual needs of consumers [8]. The market demand will be more diversified and personalized.

4. Conclusion and prospect

The application of 3D printing technology in marathon running shoes has made remarkable progress, bringing revolutionary changes to the running shoe industry. At present, the technology has been widely used in the customized production of running shoes, multi-material combination and biomimetic design, modular and detachable design and other aspects. Although 3D printing technology has made remarkable progress in marathon running shoes, there are still some problems and challenges. First, the technology costs are relatively high, and second, consumer awareness of 3D printing technology is limited. In terms of application prospects, 3D printing technology will promote the personalized, high-performance and environmentally sustainable development of marathon running shoes, and expand to more fields, such as smart wearable devices, medical rehabilitation and so on. In the future, with the integration and development of 3D printing technology and emerging technologies such as artificial intelligence, big data and cloud computing, 3D printed running shoes will make more breakthroughs, providing runners with a more comfortable, personalized and intelligent running experience.

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