The Current Application Situation and Development Bottlenecks of 3D Printing Technology in the Field of Sculpture*

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Abstract—3D printing technology has been widely applied to the field of sculpture creation. This technology enhances the predictability of sculpture art creation, greatly enhances the creative efficiency of sculpture art workers, changes the way of sculpture art production, and enriches the means of sculpture art creation. However, 3D printing technology still has certain limitations in the application of sculpture. Many factors such as print size and materials affect its deep integration with sculpture art.

Keywords—way of creation; technology; materials

I. INTRODUCTION

3D printing technology is known as the third industrial revolution. It is a rapid prototyping technology. It digitizes the model data through 3D design software, and then solidifies it by layer-by-layer printing using related materials such as wire, resin, and metal powder. Since 2012, there has been a wave of 3D printing in China. Especially in the past two years, with the localization of some 3D printing equipment, printing costs have been rapidly reduced, and 3D printing technology has ushered in the spring of its development. Nowadays, 3D printing technology has been introduced into many production fields. More and more sculptors are paying attention to this new technology that leads the times, and actively participate in the artistic practice of 3D-printed sculpture.

II. THE NATURAL COMMONALITIES BETWEEN SCULPTURE ART AND 3D PRINTING

First, 3D printing technology is also called additive manufacturing technology in the international academic community. It is based on computer 3D design model. By the software of layered discrete and numerical control molding system, it uses methods such as laser beam and hotmelt nozzle to stack and bond special adhesive materials such as powdered metal, plastic, ceramics, powder, cell tissue, and things like these layer-by-layer, eventually superposing to form a solid product [1]. In brief, print materials such as special powders and liquids will be printed by computer by superposing the three-dimensional shape or product layer by layer.

Second, sculpture is different from many other art categories. It is a three-dimensional form of plastic art. It can be appreciated in multiple angles and in multiple directions, and it can also be in close contact with. It can be touched or played. The form presented by sculpture art is the form of conglomeration in space, and the materials are the basis of sculpture art. The characteristics of the sculpture materials also play a vital role in the sculpture itself. The artistic effects brought by the sculptures of different materials also have great differences, which directly affect the expression of the artists' aesthetic emotions.

Both 3D printing and sculpture have strong threedimensional characteristics, and they need diverse materials. 3D printed materials are the representative materials commonly used in modern sculptures as well. Sculpture art creation is usually a kind of additive manufacturing in a certain sense. It is also a form of molding through addition, which makes the sculpture art and 3D printing technology have great similarities and commonalities.

III. DEEP INTEGRATION OF 3D PRINTING TECHNOLOGY AND SCULPTURE ART

A. Powerful Replication Capacity

In the traditional sculptural creation, usually it is to conceive the approximate form of the sculpture on the manuscript paper first, then to mould the details of the threedimensional shape according to the form and creates a small draft of the creation, and after that to enlarge the model according to the small draft, turn out the outer mold and the inner film, and trim the details. The whole process is very cumbersome, and the manpower and material resources consumed are also very large. Since there has been the mature 3D printing technology, the whole process has become very simple. The scanner can be used to scan the created small mud in all directions. After the 3D data of the whole shape being acquired, the related software can be used to make the simple art processing and perfection, and then

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the sculpture can be formed by 3D printing through 3D printer. This creation method saves a lot of time.

B. Innovation in Shaping Methods

The application of 3D software to create sculptures is also a development trend of sculpture creation in recent years. Many of the characters in the film and television are made with 3D software, such as 3DMAX, MAYA, LIGHTWAVE, SOFTIMAG, etc. 3DMAX and MAYA are well-known. Especially 3DMAX, this is a very mature and powerful 3D sculpture making software. However, this software is mainly aimed at film and television animation, environmental art design and other fields. Although it can also be used for sculpture modeling, its production efficiency is still insufficient for the modeling of complex sculptures. With the emergence of three-dimensional software called ZBrush. because of its continuous upgrade and especially improvement in recent years, it has become a sharp tool for sculptors to make three-dimensional sculptures. More and more sculptors are convinced by its powerful sculptural production ability, and amazed by its fast and efficient sculptural production ability and sculptural surface texture performance. When the sculpture is produced by ZBrush and other sculpture production software, it can be imported into the 3D printing software to set the size of the sculpture and then printed out. This 3D printing sculpture production method by three-dimensional technology has greatly improved the efficiency of sculpture creation, and the sculpture creation has become more free and handy.

C. Digitalization of Reproduction and Communication

Today in the 21st century, the world has entered the digital age. The reproduction of sculpture artworks has also been digitalized. Just twenty years ago, the reproduction of Chinese sculpture art artifacts was realized by traditional turnover forms, and the accuracy of reproduction was also general. Nowadays, through the perfect combination of 3D scanning technology and digital 3D printing technology, the reproduction of cultural relics has reached a near perfect level. Nowadays, all kinds of exquisite three-dimensional sculpture modeling data on the Internet are also dazzling. Such as the data of various realistic sculptures, abstract sculptures, classical sculptures, and modern sculptures, they are all available. The rapid development of modern technology is surprising people. Clicking on the keyboard, an identical 3D printed sculpture will be copied.

IV. THE BOTTLENECKS OF 3D PRINTING TECHNOLOGY IN THE FIELD OF SCULPTURE

A. Limitations of the Size

Although desktop-level 3D printers have become very popular, a cheap Chinese desktop-level FDM-formed 3D printer is probably worth a few thousand yuan. However, the size of the printer is generally below 30-40 cm, which is far from the requirement of a few meters high for the sculptor. Although the sculpture can be segmented and then stitched, too much fragmentation will lead to great inconvenience to the sculptor, and it may also cause deformation and aliasing of the sculpture. Industrial-grade 3D printers can print about 1 meter in size, but the procurement cost of the equipment is very high. Therefore, in general, the enlarging production of the sculpture factory still uses traditional processing modes and technologies.

B. Limitations of the Materials

3D printers can print with a lot of materials, such as ABS resin, PLA (polylactic acid), PVA, wood fiber, SL material liquid photosensitive resin, rubber, wax, porcelain clay, SLS sinterable powder materials, etc. However, PLA (polylactic acid), ABS resin, and PVA (polyvinyl alcohol) are more used in the field of sculpture production. In particular, PLA (polylactic acid) materials have been widely used because of their low melting point and environmentally friendly properties. However, the sculptures printed are still not suitable for the harsh requirements of the outdoor environment, and their hardness and firmness are limited. They can only be placed in indoor environments.

As the most famous ancient ceramic country, ceramic sculpture is also a kind of sculpture that is loved by the people in China. Because of its material characteristics, the process of ceramic sculpture production has always been very complicated, and the production cost is also high. Developing a highly efficient ceramic material 3D printer has been highly anticipated by the industry. In recent years, Chinese 3D printer manufacturers have been able to produce ceramic materials 3D printers of various print sizes. From the perspective of print size and printing cost, the Chinese 3D printer manufacturer's ceramic material 3D printer has met the basic requirements of the ceramic industry, but its printing accuracy needs further improvement.

C. Limitations of the Cost

Although the current 3D printer can also print metal materials, basically only a small metal sculpture of 20-30 cm can be printed. The price of metal material 3D printer is also extraordinarily high. The indigenous ones are generally several million yuan per one, not to mention the imported ones. Moreover, the operating environment of the metal material 3D printer is also very strict, and the printing takes a very long time. For example, if a 10 cm metal sculpture needs to be printed, it will take about a day. After printing, it will be necessary to polish the surface. The price of metal powder material is also very high. Therefore, it is almost unrealistic to make a sculpture of an outdoor environment with a 3D printer. There is still a long way to go before the marketized application of large-scale 3D printed sculptures, especially when the printing of large-scale metal sculptures still requires further technological innovation.

D. Limitations of 3D Sculpture Modeling and Design

The production of 3D sculpture modeling software has greatly liberated the sculptor's productivity and enhanced the predictability of the sculpture creation effect. The powerful ability to enlarge, reduce, and splice enhances the sculptor's work efficiency, and is also very eye-catching in the performance of sculptural texture. However, it is difficult to be as casual and natural as real clay in the performance of



clay texture. Sometimes it will be a little stiff and rigid. After all, it is a virtual space. It will be affected by many factors such as perspective and lighting. Finally, there will be some differences between the printed and the real expectations.

The operation of 3D sculpture modeling software has certain complexity. Especially, it takes a lot of time to practice to master the related software. Some performance skills can only be acquired through communication and study. The production of many 3D sculptures requires some software to work together. For example, the shape created by Zbrush software often needs to be imported into 3Dmax to furtherly shape. After the sculpture details are completed, it needs to be imported into the rendering software to carry out the rendering of the final effect. Only professional software can achieve optimal rendering results. This means that if someone wanted to be skillful at 3D sculpture modeling, it will be a must for him to master more than two kinds of 3D sculpture software, which greatly limits the threshold for the entry of older sculptors.

V. CONCLUSION

3D printing technology is an emerging technology that transcends the times. It subverts production methods in many fields. Materials are the core of 3D printing technology. Similarly, materials play a vital role in the development of sculpture art. The same sculpture shape, if different materials are used to produce it, the artistic effects contrast between the sculptures will be huge. The new materials determine the performance of the new molding process, production technology and finished products. With the continuous development of 3D printing technology, it is believed that the influence on sculpture creation will be deeper and deeper, the efficiency of sculpture production will be higher and higher, and the application of commercialization will become wider and wider. It will be significant to continuously promote the deep integration of 3D printing technology and sculpture creation.

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