

3D Printing in Sculpture

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ABSTRACT

3D printing, also known as additive manufacturing, assembles objects by subsequently layering and fusing material together. It has made progress in various fields, fueling creativity in prosthetics, architecture, construction, and more. Fine art and sculpture are no exception. There are 3D modelling tools that mimic the sculpting process digitally. 3D printing completely opens up new possibilities in the creation of scriptures and fine art. Rapid and affordable mass manufacturing utilizing 3D printing is faster and less expensive. 3D printing has allowed artists to explore in fields where it was previously unthinkable. This paper explores the use of 3D printing technology in art and sculpture.

KEYWORDS: *art, sculpture, 3D printing (3DP), additive manufacturing (AM), 3D printing in sculpture, 3D printed artwork*

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INTRODUCTION

Traditionally, a printer is used at home or in the office to print out text and images on paper. This conventional printer prints in a flat two-dimensional (2D) space using the dimensions length and width. A three-dimensional (3D) printer uses length and width but also adds depth to the print. A 3D printer has more manufacturing capacity than a traditional manufacturing machine. It is regarded as a disruptive technology that will change manufacturing. It has been used for decades in the automotive and aerospace industries. The 3D printer is also used by hobbyists, small businesses, creatives, manufacturers, architects, and most importantly contractors to instantly create a variety of products.

Three-dimensional printing (3DP) has come a long way since its inception in 1976 when the first inkjet printer was invented. Today, we can use materials to print 3D printed objects such as sculptures. All artists are trying to say something with their art, whether it's a political statement or developing a scene, they have a message they are trying to convey. By using 3D printing, they can make sure their message is going to come across precisely as they want.

WHAT IS 3D PRINTING?

3D printing (also known as additive manufacturing (AM) or rapid prototyping (RP)) was invented in the early 1980s by Charles Hull, who is regarded as the father of 3D printing. Since then it has been used in manufacturing, automotive, electronics, aviation, aerospace, aeronautics, engineering, architecture, pharmaceuticals, consumer products, education, entertainment, medicine, space missions, the military, chemical industry, maritime industry, printing industry, and jewelry industry [1]

A 3D printer works by "printing" objects. Instead of using ink, it uses more substantive materials—plastics, metal, rubber, and the like. It scans an object—or takes an existing scan of an object—and slices it into layers, which can then convert into a physical object. Layer by layer, the 3D printer can replicate images created in CAD programs. In other words, 3D printing instructs a computer to apply layer upon layer of a specific material (such as plastic or metal) until the final product is built. This is distinct from conventional manufacturing methods, which often rely on removal (by cutting, drilling, chopping, grinding, forging, etc.) instead of addition. Models

can be multi-colored to highlight important features, such as tumors, cavities, and vascular tracks. 3DP technology can build a 3D object in almost any shape imaginable as defined in a computer-aided design (CAD) file. It is additive technology as distinct from traditional manufacturing techniques, which are subtractive processes in which material is removed by cutting or drilling [2].

3D printing has started breaking through into the mainstream in recent years, with some models becoming affordable enough for home use. Many industries and professions around the world now use 3D printing. It plays a key role in making companies more competitive. The gap between industry and graduating students can be bridged by including the same cutting-edge tools, such as 3D printing, professionals use every day into the curriculum. There are 3D printed homes, prosthetics, surgical devices, drones, hearing aids, and electric engine components. As shown in Figure 1, 3D printing involves three steps [3]. A typical 3D printer is shown in Figure 2 [4].

3D PRINTING IN SCULPTURE

The arrival of 3D printing technologies in the 1980s opened a world of possibilities not only on the industrial level, but also for creative developments. Sculpting is one of the most established forms of art. It requires creativity and skills to be able to come up with interesting structures or objects that can be considered as art forms.

Sculptures have always been 3D, but it takes years to learn the skills necessary to create artworks. 3D printing technology allows artists to use their sketches or photographs to create amazing works of sculpture straight from a computer. 3D printing allows the artist to see how their artwork is going to look before they begin the work on the final piece. With rapid advancement in technology, now larger than life metal sculptures are possible with 3D printing and 3D printed sculptures. Figure 3 shows an example of creating sculpture using 3D printer [5], while Figure 4 shows artwork using 3D printer [4].

TYPES OF 3D PRINTED SCULPTURES

3D printed sculptures use a variety of technologies and processes, and the inspiration behind them also differs. Different types of sculptures, including traditional sculptures, modern/contemporary sculptures, abstract sculptures, and corporate and public art sculptures can be created through 3D printing. Replicas of ancient sculptures can also be made with 3D printing. Materials such as bronze, aluminum, gold, silver, titanium, ceramic, plastic, clay, resin, polyamide, etc. can be used or combined to create stunning sculptures. 3D printing has made it

possible to create big and small 3D printed sculptures that have the perfection of a sculpture made with traditional methods. Though it takes longer to create larger pieces of art, the result is nothing less than exceptional. Due to its brilliant golden color and durability, bronze is widely used to create beautiful sculptures. Figure 5 shows a typical 3D printing with bronze [6]. Though bronze is the most common material used in making sculptures, aluminum is a valuable medium used for creating impressive sculptures. Smaller sculptures made entirely of gold or silver, or larger sculptures made with a combination of materials is now possible in 3D printing [7].

APPLICATIONS

In the field of sculpture and art, 3D printing has proven time and again that it can be very useful. Museums and cultural heritage institutions around the world have been using 3D printing technology to duplicate cultural relics to offer access to a wider audience. The following varied applications are only typical.

1. The Embrace was created in honor of Martin Luther King Jr, as shown in Figure 6 [8]. It depicts him and his wife, Coretta Scott King, sharing an embrace after Martin Luther King Jr. had won the Nobel Peace Prize. Though the statue itself is not 3D printed, 600 individual pieces were 3D-printed and used for the model. The result is a 6-meter-tall statue that now stands in Boston in remembrance of King.
2. Token Homes is a reflection of the state of London's housing crisis. This artwork by British artist Matthew Plummer Fernandez is a critique of the way many homes are seen as an investment rather than a place to live. The 10-foot tall sculpture is composed of 400 miniature homes, made by 3D printing. Figure 7 shows the Token Homes [8].
3. The Yinyun is art installation consists of 85 3D printed ceramic pieces, located in Taipei, Taiwan. Additive manufacturing technologies was used to create each of the parts using ceramics. The main feature of the Yinyun installation is that the complex shapes of the pieces mean that none of the units is the same as any other. The art is shown in Figure 8 [9].
4. Living plants can absorb air toxins when placed inside the house and that is one of the reasons people have been adding plants to their decoration indoors. 3D printed plant sculptures act as air purifiers for your indoor space. 3D printed plant-looking sculptures for decoration are shown in

Figure 9 [10]. 3D-printed plants serve as air purifiers to make the indoor air you breathe a little bit healthier.

- The world's tallest 3D printed sculpture is shown in Figure 10 [11]. It weighs 2,800 pounds and is 30 feet tall. Creating this statue takes a lot of creativity, planning, attention to detail, and teamwork. White Clouds was commissioned to build a 30-foot-tall statue, named Scout for CONEXPO-CON/AGG 2020 in Las Vegas. This awe-inspiring statue was made to honor women in the construction industry.

BENEFITS

A significant benefit of 3D printing is that artists can solve all of their design problems as they enter the information from their images into the computer. 3D printing specifically helps contemporary art unlock creative potential and make it tangible. 3D printers allow sculptors to create more intricate cavities, twists, and turns with sculpture work, and create proof-of-concept for clients before final execution. Other benefits include the following:

- New Possibilities:** Whether new objects, sculptures, or replicas of valuable works, whatever is constructively conceivable can be printed. In addition to the possibility of limitless geometric construction, size now plays a minimal role. 3D printing gives a completely new meaning to the saying "art knows no boundaries," proving that new technologies and creativity are in fact very compatible.
- Complex Geometries:** Working with additive manufacturing processes enables the realization of highly complex geometries with a high level of detail and precision.
- Scaling:** From miniatures to life-size, everything is printed in one piece. 3D printed art can be scaled almost infinitely and combined with conventional manufacturing processes.
- Precision:** State-of-the-art print head technology ensures that even the finest details and filigree structures can be reproduced with maximum precision.
- Rapid prototyping:** The speed of 3D printing greatly reduces the time from approved drawing to finished prototypes and even final production runs.
- Cost effectiveness:** The process is more economical than using hard tooling; the technology is far less costly than creating molds and it eliminates the need for expensive tooling. And once the design has been approved, printing on demand becomes a welcome convenience.

CHALLENGES

While 3D printing offers numerous advantages, it will not completely displace conventional production methods. It is still a developing technology with hurdles that should be considered when choosing a product development approach. These hurdles include the following:

- High Cost:** Due to the restrictive cost of 3D printing, we have so far only been able to recreate pieces with a guaranteed market.
- Threat:** With the development of 3D printing, it appears that the art tradition is being threatened. 3D printing may cause sculpting to become less popular as sculptors get less job opportunities.

CONCLUSION

The 3D printing technology is increasingly being adapted by artists and sculptors as a tool with which the realization of an idea knows hardly any limitations. Both commercial and fine artists and sculptors are always exploring new mediums. They are excited to experience and experiment with this relatively new medium. Currently the relationship between 3D printing and sculpture is already an established fact. From students to artists of great experience they have begun to give creative use to 3D technologies.

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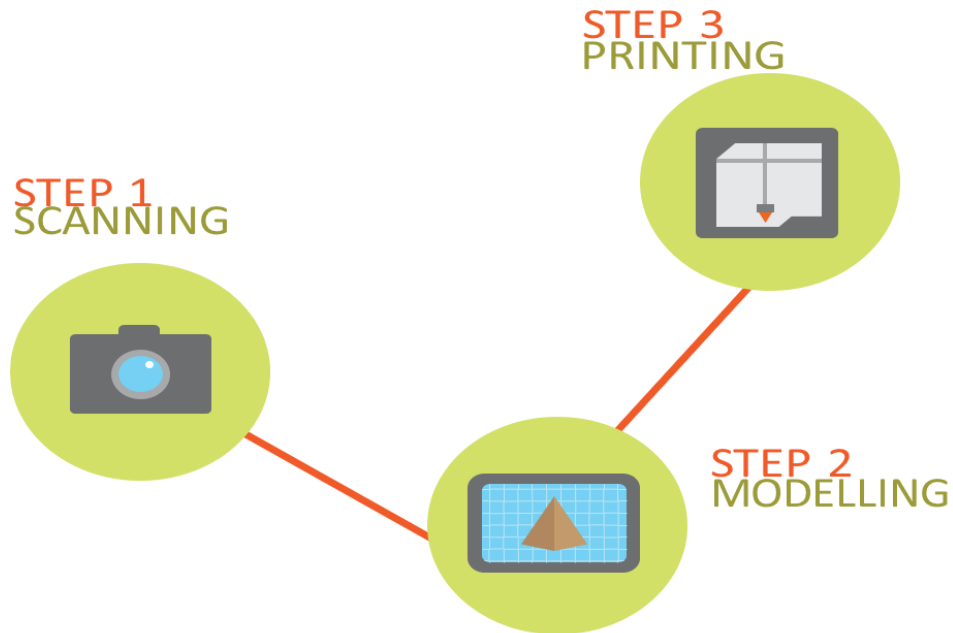


Figure 1 3D printing involves three steps [3].

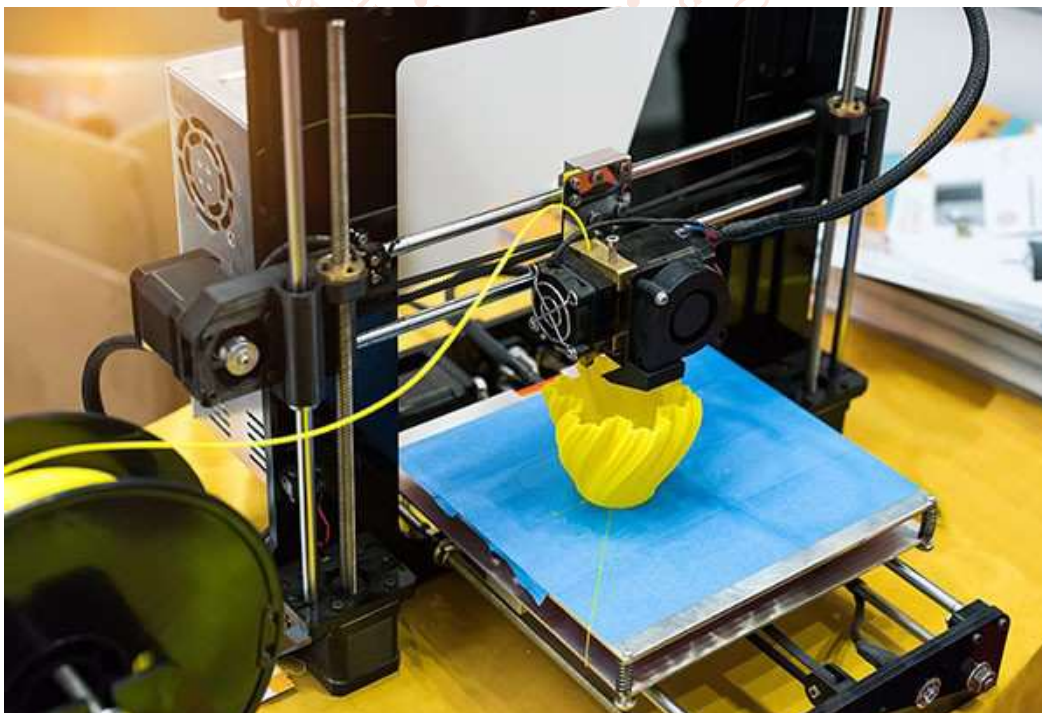


Figure 2 A typical 3D printer [4].



Figure 3 Creating sculpture using 3D printer [5].



Figure 4 Creating artwork using 3D printer [4].



Figure 5 A typical 3D printing with bronze [6].



Figure 6 The Embrace in Boston was created in honor of Martin Luther King Jr [8].

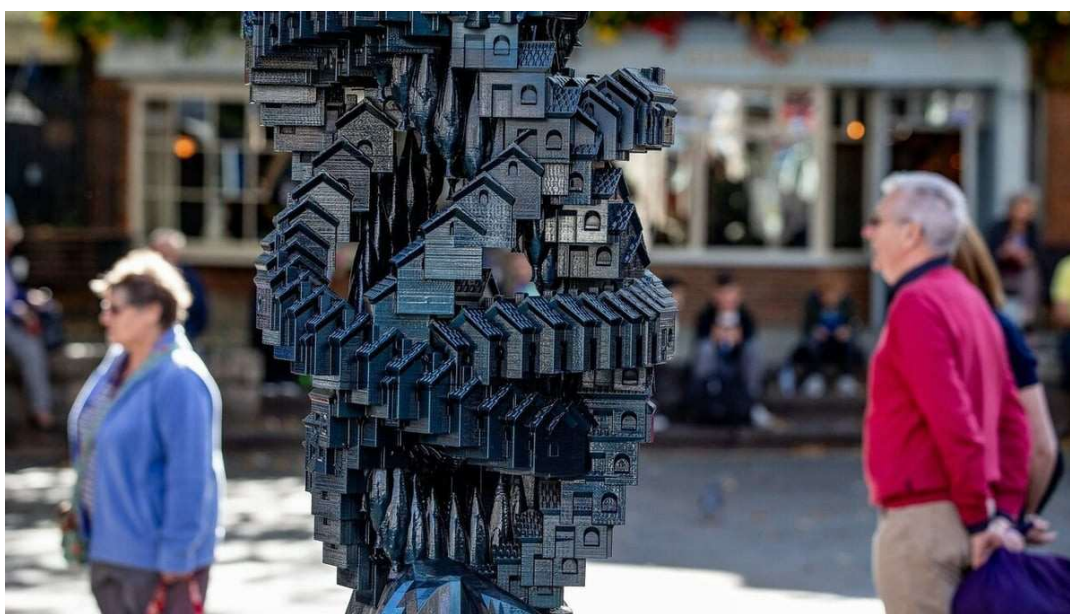


Figure 7 The Token Homes in London [8].

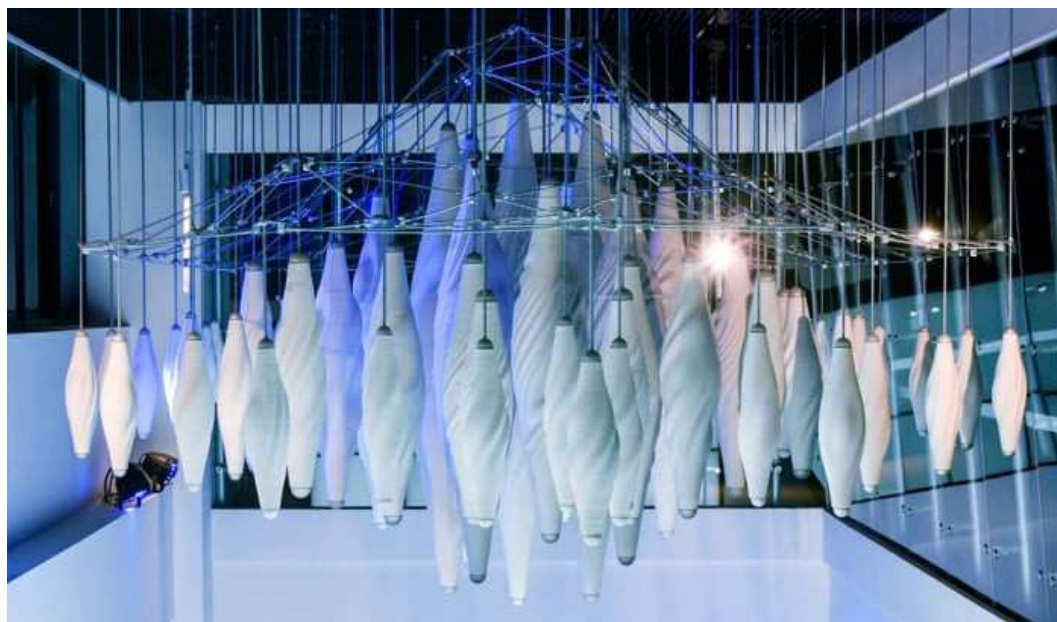


Figure 8 The Yinyun art installation in Taiwan [9].



Figure 9 3D printed plants for home decoration [10].



Figure 10 The world's tallest 3D printed sculpture in Las Vegas [11].