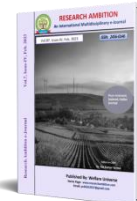




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Application of 3D printing in the field of industrial design products

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ABSTRACT

The important method direction of the 14th Five-Year Plan, the additive manufacturing of advanced manufacturing, is highly in line with the goal of low-carbon and zero-carbon environmental protection, the rapid application of 3D printing in innovative product design of industrial design, ultra-high-speed 3D printing of consumer products, exploring and breaking through the tradition. The production process breaks the limitation of product mold opening and enriches the application of industrial design cultural and creative products, which is a milestone in the development of industrial design.

What can 3D printing do?

You can see the ‘innovation driven’ float at the celebration of the 70th anniversary of the founding of the People’s Republic of China.

On October 1, 2019, the 70th anniversary of the National Day, the “innovation-driven” float designed by the Shangpin industrial design team completed the docking in front of Tiananmen Square. This is a historic moment. I am very proud as a designer and at the same time as a 3D printing practitioner. And it can’t be more appropriate to apply 3D printing to this float representing “innovation”.



Picture: 1 Innovation Drive float

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The Innovation Drive float is divided into three vehicles, which represent land, air and sea respectively. The three aspects demonstrate China’s technological innovation capabilities since the 18th National Congress of the Communist Party of China, such as “Tianhe-2 Supercomputer”, “Yutu-2”, “Beidou Navigation Satellites, Long March series rockets, C919 airliners, Haima unmanned remote-controlled submersibles, Sky Eyes, etc., all technological elements surround the “Fuxing EMU”, heralding the revival and rise of China’s science and technology. The multiple element parts on the board are made by 3D printing, and the principle verification at the beginning of the design also uses the technological advantages of 3D printing.

3D printing has been considered a disruptive new technology since its appearance.

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In the 1980s, Charles Hull was the first inventor engaged in commercial 3D printing manufacturing technology. He established 3D Systems to focus on the development of 3D printing technology. Because of smart manufacturing and carbon emissions, all countries in the world attach great importance to 3D printing research and development. In the next three decades, China has become the second most important market in the global 3D printing industry after the United States, accounting for more than 10.8%. The term “3D printing” has long been heard, but it is invisible and intangible, as if it is far away from people’s lives!

How far can 3D printing technology go today? What fields can it be applied to? In fact, it happens around people with food, clothing, housing, use, transportation, all comprising 3D printing.

Today, “3D printing consumer product application research” has become an emerging field, and it is also a proposition that the global additive manufacturing circle is exploring. At present, there are not many practitioners, and every time I see the 3D printing products I designed are successfully launched, I feel a sense of pride spontaneously. People’s food, clothing, housing, use, and transportation all have the application of 3D printing. The direction of research is 3D printing in “use”. For online applications, designers first have a preliminary understanding.



About 3D printing “eat”

Picture 2 3D printed “eat”

People depend on food, and Chi Wei, a leading teacher of food design, shared about the 3D printing of French desserts, which was very successful.

It indicated that 3D printing is now used in food. In fact, many desserts, chocolates, cookies, snacks, etc. have already begun to use 3D printing technology. Especially in recent years, in terms of environmental protection, health, safety, and efficiency. Under the diet concept, with the printing method of stacking deposition, functional food artificial meat, including some plant-based beverages, has begun to be applied by food manufacturers such as Starbucks and KFC, which represents the rapid rise of innovative food 3D printing. Especially nowadays, many young people have the needs of fitness and weight loss. For a healthier diet, chefs have made 3D printed food that is more in line with the taste of Chinese people. Because Chinese people have special eating habits, most of them focus on the taste of carbohydrates, and they cannot completely restrict their appetites according to light meals. In this case, 3D printing has played a very good role, simulating the taste of carbohydrates with vegetarian, protein and other ingredients, keeping the ingredients healthy and organic, and developing some unique shapes. Many food printing companies have also become unicorns. For example, China’s MOODLES (Fodelaibo) company uses 3D printing technology to launch “super staple food” customized for different groups of people in four directions: muscle gain, fat loss,

sugar control and children's nutrition; Novameat company in Barcelona, Spain Created a 3D-printed plant-based steak whose blue color is derived from phycoyanin; Israeli company MeaTech currently dominates the market for 3D-printed animal and plant-based meat products.

About 3D printing "wear"



Picture 3 3D printed "wear"

It's become apparent to us that 3D printing is shining in the field of "wear", thanks to the rich shapes and different materials of 3D printing.

First of all, people want to talk about shoes, which must be an indispensable item for people's daily travel.

Nike designed the 2014 World Cup exclusive 3D printed sports shoes, bags and accessories for Ronaldo, Neymar and Wayne Rooney at the earliest. People can see the stud part of this football shoe, which has a very unique shape. It distributes the position and trend of these studs by collecting the mechanical force of different angles during sports, and uses parametric modeling technology to build a digital model, and finally prints it through 3D. manufacturing. The football suit made can be said to be completely tailor-made.

There is also the example of Adidas, the German sportswear manufacturing giant that pioneered 3D printing in the shoe industry. It has managed to revolutionize the way shoes are made, as evidenced

by the successful launch of Future craft 4D, Alpha Edge 4D, 4D Run 1.0 and other product lines over the past few years.

For nearly a decade, adidas has focused on transitioning its manufacturing techniques from analog to digital, and the 3D printed footwear project has been a driving force behind the shift. Adidas has struck a fine balance between compelling designs, use of data, revolutionary 3D printing technology, and proactive and timely decision-making.

What makes Adidas full of confidence in 3D printing technology, and why can it master 3D printing technology in the shoe industry?

It is clear at a glance that it combines foot mechanics sampling, simulates various data during exercising, walking, and standing by software, uses parametric modeling, and 3D printing production. This brand-new technology can greatly improve sports performance and wearing experience.

Now, people can see that many cutting-edge designers and fashion brands have begun to enter the field of 3D printed shoes. Whether it is Paris Fashion Week or the World Shoe Museum, 3D printed shoes can be seen.

Moreover, the current technology and innovative design are still being updated. In the picture on the right, people can see the development of a pair of boots. It is redesigned and produced with 3D printing on the upper. When walking and bending, the crystal lattice is expanded to the best wearing experience of the human body, and at the same time, it also realizes the differentiation of the shape and the sense of individuality.

In addition to shoes, it includes sports backpacks,

knee and ankle protectors, protective helmets, etc., many of which are also realized by 3D printing.

For example, Kellerstone's rock climbing helmets are more about reducing weight and increasing ventilation. Therefore, the multi-layer lattice used in the inner tank is not only a difference in appearance, but also has an improvement in function.

People have been talking about adult shoes, so are there any companies that pay attention to the growth of children's feet? People are now talking about the baby's first pair of shoes, baby toddler shoes. Squirrel Beibei has made innovations in toddler shoes. The 3D printed lattice structure of the sole can achieve a quiet effect, and it is breathable from the sole to the upper. The large area of the sole, heel, and instep is wrapped to stabilize the bones of the foot and prevent impact injuries.

Talented female designer Iris van Herpen combines traditional sewing craftsmanship with rapid prototyping to form a stunning visual effect. She cuts the plastic material into strips, uses the "3D laser sintering" process in mechanical processing to form a three-dimensional effect, and then adds artificial sewing. When haute couture meets high-tech, the collision of classical art and future technology is really amazing.

There is also the just-concluded Beijing International Film Festival. Whether it is "Lonely Walking on the Moon" or "Tomorrow's War", many film and television props are made by 3D printing. In the big movie "Three Lives Three Worlds Ten Miles of Peach Blossom", the armors of the two protagonists Liu Yifei and Yang Yang,

as well as various film and television props such as swords and knot lanterns used in the scene, were all completed using 3D printing technology. Yes, this kind of hollowed-out three-dimensional armor piece is exquisite and full in shape. At that time, I was very honored to participate in the production of some film and television props for 3D printing. The movie "Three Lives III, Ten Miles of Peach Blossom" was shot in 2015. The 3D printing material at that time was still hard nylon material. In order to make this three-dimensional effect. The presentation is aesthetically pleasing, the weight of the real thing is very heavy, and the actors have to work under pressure. Later, in 2017, 3D printing had the tough material of TPU. Subsequent film and television armor can cover a larger area of the body and complete more unique shapes. Of course, now in 2022, with the advent of 3D printing fabrics, lighter and more colorful clothing will be used in film and television, and even high-end clothing.

About the "living" of 3D printing



Picture 4 3D printed "living"

In terms of architecture, a large number of 3D printing buildings are being developed and applied at home and abroad. Not only can houses be printed on the earth, but the personnel responsible for the lunar exploration project of the Chinese Academy of Sciences revealed that China would

apply 3D printing technology to build a lunar base. The concept of the 3D printed house in the Czech Republic in the upper left corner is that the printed building can be placed at will, in the countryside or in the city, or even on the water, and the house can be placed by placing a floating board base. The one on the right is a community of 52 houses, which is the largest 3D printing affordable housing project in Africa.

In the 2022 Beijing Zhangjiakou Twin Cities Winter Olympics, athletes from all over the world participated in the Winter Olympics. People made a concrete 3D printed farm house in the Zhangjiakou competition area. This project was presided over by Professor Xu Weiguo of Tsinghua University and his team, which has become a well-known check-in “attraction” and receives many visitors every day.

In addition to the architectural printing construction of the facade, the interior soft decoration is also in full bloom. It can better reflect the unique artistic taste of the homeowner.

In the field of furniture, many well-known designers and teams have devoted themselves to combining 3D printing with art, design, craftsmanship, and environmental protection to create amazing furniture works. The picture shows the 3D printed special-shaped chair designed by Nagami Design Company of Spain.

In Kohler’s high-end bathroom faucet design, designers break the traditional tubular design, eliminate the limitations of traditional design aesthetics and utilize the visual impact of negative space. In fact, this faucet is only contoured, which makes users wonder where the water is coming from. When you see this product, you will exclaim

“WOW”. It uses a light frame structure, retains the function of smooth water flow, and has a simple and novel shape.

About the “use” of 3D printing



Picture 5 “use” of 3D printing

Everything can be printed, and all products can be upgraded again with 3D printing.

People can imagine the future. From waking up in the morning to falling asleep at night, the products around people are all 3D printed. What kind of picture is this?

Imagine you living in a 3D printed house, waking up in the morning from 3D printed mattresses and pillows customized for your bones, putting on 3D printed silent slippers, using 3D printed breakfast machines, coffee machines, etc., and presetting breakfast. Then you go to the sink to pick up a 3D printed custom toothbrush or a razor to freshen up. Wearing a printed breathable backpack and wearing 3D printed shoes to start a day’s work, when you are tired from work, you can also use a 3D printed massager to relax your muscles. At night, accompanied by the printed night light, you swipe the printed goods on the mobile phone and so on. This complete life process will actually be the ultimate expression of people’s personality concepts and customization.

Although it was an idea just now! But some of

these products have already been realized.

The 3D printed razor is a real consumer product application. The entire handle is completely printed and produced through 3D printing light curing technology. People can look at the right side of the picture, which is the production process. The printer can print dozens of razors in one full page. The material performance has also made a breakthrough. In the tests of waterproof, antibacterial, thermal shock, and drop, the performance has reached a very high product level. Another example is this foldable night light, which is convenient for storage when you go out, and you can also customize the pattern on the surface.

Such a Chinese-style bedside lamp or small candlestick is also very beautiful.

Pen, a unique pen in daily work is also a first choice for many business people. It can show their own taste, and the practicability of the pen itself must reach a very high level.

It is known that Mercedes-Benz will produce 1 billion dollars of defective spare parts every year, and the first thing to bear the brunt of this is the wheel hub of the car. As a large metal part, the impact on the environment is particularly obvious. Based on this background, people and Mercedes-Benz jointly created the LAB1886 project, hoping to use sustainable design ideas to make some contributions to the world.

As we all know, the car hub is relatively large in size and heavy in weight. People did a lot of thinking and planning on how to regenerate it, and finally successfully implemented 23 models. For example, this rattan tea table is made by wrapping the wheel with rattan and fixing it with brackets.

For this purpose, people went to Chongzhou, Sichuan, and Huaiyuan Town to learn about the craftsmanship and help the project land. People also make the hub into a floor-standing Bluetooth speaker, which can accompany people's lives for a long time at home. Many of them are combined with 3D printing, such as the metal strip on the front cover of the audio system, which is the effect of 3D printing and electroplating. The final product was exhibited at the Mercedes-Benz headquarters in Germany, and received unanimous praise from the designers. The important thing is that designers have made their own contribution to the earth.

In the direction of cultural creation, in fact, printing and restoration of cultural relics and non-heritage cultural and creative products will also be applied to 3D printing.



Picture 6 3D printed "cultural creation"

This is collaboration with Mr. Zhang Lijun, the inheritor of Beijing School of intangible cultural heritage paper-cutting, to present the two-dimensional paper-cutting art in a three-dimensional way. Make it into a piece of jewelry that girls wear every day, pass on the intangible cultural heritage to young people, and stimulate the vitality of traditional art.

The next more interesting project is a set of trendy figures, lattice mech warriors. Compared with the current commercial figures, it is obvious that there

is a relatively big breakthrough in the structure. Use the hollowed-out lattice to endow the character with unique modeling characteristics. Overall, it looks more technological and more future-like, as if putting the shape of science fiction in people's reality. In addition to the MechWarrior series, people have also developed IP figures for companies such as Little Swan and Meiji, and the 3D printing process is used as a prototype for rapid prototyping to improve development efficiency. People are very concerned about the field of health.



Picture 7 3D printed "massage pillow"

The 3D printed massage pillow is innovated through the parametric design of the massage head. Compared with the traditional massage pillow, what advantages does it have?

The advantage lies in the point-to-point stimulation of people's acupuncture points. Each small massage head has 5 small contacts, and one group has 80 contacts, which can stimulate people's massage points more accurately.

Designers pay attention to consumer-grade 3D printing products. In the future, more products and categories will be applied to 3D printing technology.

What I just said was external massage. From the perspective of health, many pharmaceutical companies are also researching the printing of medicines. 3D printing technology allows small-

scale production of medicines. For solid drugs, 3D printers stack inks with excipients and active pharmaceutical ingredients to print the finished product. By adjusting printing parameters, drug dosage, drug combination, release profile and even taste can be personalized.

Apreece Pharmaceuticals is the first, and only, commercial 3D printed drug manufacturer to receive validation from the U.S. Food and Drug Administration (FDA). Their goal is to make the drug easier to take and reduce the number of pills patients need. The drug load of the tablet is as high as 1000 mg, and the porous structure is formed by printing. After the patient takes it orally, the tablet can quickly dissolve and be swallowed easily.

In the field of invisible correction, 3D printing technology is widely used. In invisible orthodontics, the doctor will print out the orthodontic mold of the entire orthodontic solution, and quickly form a complete set of invisible braces by means of thermoplastic.

Among the dental implant technologies, people have also begun to use pure titanium printed implants and zirconia crowns to complete the implantation of single or multiple teeth in 3 operations. Invisalign, Beauty Immediately, Angel of the Times, etc. are all outstanding pioneers in this field.

Also in medicine, after the doctor scans the diseased organ through CT, the model of the diseased organ can be restored by 3D printing, which can intuitively communicate between the medical team and between doctors and patients, and can repeatedly simulate surgery on the model to predict the risk of surgery in order to prepare the

tools and products needed for surgery in advance. In some special and complicated spinal patients, South Korea adopted a 3D printed spinal implant, which has good anatomical adaptability and porous structure, and has a clear effect on postoperative stability and fusion effect. 3D The printed titanium implants have an average closed-cell porosity of 3%, which can successfully accelerate the fusion of proteins and bone marrow mesenchymal stem cells. Sudden scoliosis, which occurs during adolescence, can also be treated with a 3D printed brace. There are three main parts to the treatment: First, the patient's torso is scanned into the software by 3D scanning. In the second step, the orthopedist combines X-rays to create a scoliosis orthopedic brace model in the software, and finally prints the orthopedic brace through a 3D printer. Due to the degree of freedom of printing, hollow graphics can be customized on the brace, which reduces the weight of the brace, increases ventilation, makes it more beautiful to wear, and minimizes the impact on the daily life of teenagers.

The latest scientific news reports that for the first time in human experiments, humans have successfully implanted an ear that was 3D printed from the patient's own cells. This is still in the experimental stage.

3D printing of human organs requires proprietary therapeutic-grade bioinks, as well as clinical-grade 3D printers. The printed ears need to be sent to the hospital to be implanted by doctors. According to the news, in June of this year, 3DBio has officially announced that the 3D printed ear has been successfully regenerated into the patient's body. The company says the success of the case lays the

groundwork for next steps, including treating nose and spine defects, breast reconstruction after breast cancer surgery, and even organ transplants.

There is also the protection and care of animals. There are special 3D printing animal protection associations abroad. Using 3D printing, animal prosthetics can be customized to replace missing limbs for injured animals.

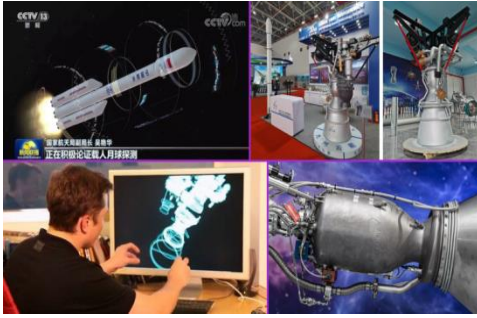
Focusing on health, people cannot avoid sports. In this regard, this year's 2022 Beijing Winter Olympics, people have seen through the news that 3D printing has begun to be applied in the field of sports.

This is a ski tool in Switzerland. The snowboard company uses AI to design a prototype and 3D print the buckle of the ski. Through optimized algorithms and mass customization, he provides unique and tailor-made products to meet the differentiated needs of consumers.

This time, China's ski helmet was made by a research and development team led by associate professor Li Nan of Dongguan Institute of Technology by collecting data from each athlete, integrating 3D scanning, design, and 3D printing technologies, and customizing it according to the actual needs of each athlete.

The inner lining of the helmet is a parametric lattice design, which makes it more comfortable for athletes to wear and improves safety. The printing of the inner lining is done using ASUS Hi-Tech's laser sintering 3D printing technology and printed with TPU material.

About the "transportation" of 3D printing



Picture 8 3D printed “row”

There are more and more 3D printing applications in the “country’s most important weapon”, including the fields of aerospace, navigation and automobile. Printing cars are not far away now, which are taking place around people.

In the future, everyone may be able to go to a 4S store or at home to directly print an auto part of the color or specific shape that people want. BMW of Germany launched a project in April 2019 with the goal of continuously producing auto parts with AM. In the same year, Audi and Volkswagen, and even the Renault F1 team announced that they would expand the production of 3D printed parts. In China, XEV-YOYO, a light electric vehicle produced by Hefei Youyao Technology Co., Ltd., is the world’s first mass-produced electric vehicle with both interior and exterior trims using 3D printing technology.

Regarding the aviation field, satellites, rockets, etc. are all areas where a large number of 3D printing technologies are used, and it is also a technological competition between China and the United States. Musk’s SpaceX company has a rocket engine composed of 3D printed parts. It can be seen from the figure that Musk is a loyal customers of 3D printing.

C919 is a domestically produced large aircraft with complete intellectual property rights in China. Academician Wang Huaming’s team used metal

3D printing technology and titanium alloy parts to be successfully applied in C919 for the first time, effectively reducing the structural weight of the aircraft and prolonging its service life. In addition to civil aircraft, his laser additive manufacturing technology has provided key large-scale components for large domestic aircraft such as the Yun-20 and J-15 and new fighter jets, and has made indelible contributions.

China’s three ships, the Liaoning ship, the Shandong ship, and the Fujian ship. The micro-smart machine is equipped with a 3D printing “aircraft carrier” to repair the environment, and it has been applied on China’s three ships.

The Chemical Biology Laboratory of Nanyang Technological University and the State Key Laboratory of Wuhan University of Technology have used 3D printing to manufacture large motors. The 3D printed motor consists of a conical head and a tubular body.

After sharing so many cases, many products are printed by magical 3D printers. Many enthusiasts have no problem with 3D printing DIY, but they are not directly commercially available. In addition to printing itself, there are a series of post-processing processes, which require 3D practitioners to help to improve. Most of them combine traditional manufacturers to integrate and improve the entire industry. This is a process of gradual development and improvement, so I would like to remind everyone: “3D printing is not a panacea, it also has its own technical bottlenecks, and additive manufacturing is a powerful supplement to traditional manufacturing.”

Next, let’s do a science popularization with the

designer on some of the current printing methods. I believe that many viewers have always understood that 3D printing is just an early FDM high-temperature melting process. In fact, in the past ten years, 3D printing has undergone great upgrades in terms of equipment and materials. I hope that today we can change a little bit. Designers' misunderstanding of 3D printing!

3D printing needs to have a 3D model of the product first. Real objects can be converted into digital models through 3D scanning, or digital models can be generated through computer-aided design.

According to the required materials corresponding to the corresponding printing equipment, the products produced can be applied to various fields. Let me introduce the three mainstream molding methods of 3D printing. I will try my best to share it with designers in an easy-to-understand way.



Picture 9 3D printing molding method

The first method is fused deposition, which is referred to as FDM. He uses a method similar to that of pottery and mud sticks, like people pouring cream on a cake, layer by layer and gradually superimposed.

FDM materials are currently the most widely used. There are ceramics, metals, PLA, cement mixed soil materials for house construction, special inks

for biology, food printing, etc., all of which can be realized using FDM technology.

The second is powder laser sintering, referred to as SLS/SLM. It can have nylon, glass fiber, TPU and various metal powder materials. The high-temperature laser sintering is superimposed layer by layer, and finally the final product is completed. Look at the picture, laser sintering is completed in a powder cabin, after the printed finished product is cooled for several hours, the worker will take out the solid parts in a similar flour cylinder. The advantage of SLS technology is that there is no need to add additional supports, and many complex structures can be easily generated.

The third is light curing, referred to as SLA. Due to the different light sources, there are also technologies such as DLP and LCD. Their raw material is a liquid photosensitive resin material. Resin materials also have many components, including flexibility, toughness, or steel, and some are bio-based materials. The liquid resin is cured layer by layer by ultraviolet light to form the desired product.

At present, some industrial prototypes are widely used in the industrial design industry. There are also dental, trendy toys, elastomeric helmet liners, shoes, bags, etc. that people just shared. Many consumer products mostly use light-curing 3D printing technology.

In the printing process of light curing technology, the product seems to grow out of the liquid.

Summarize several advantages of 3D printing.

First, it enables the creation of “metamaterials” with complex structures.

Second, the manufacture of special structures can

reduce weight and cost, and save the use of expensive materials.

Third, the investment in high-end manufacturing is small, it does not require molds, and it can be customized for a part.

Fourth, because of its short processing cycle, the market response speed can be faster, which can speed up the progress of product development.

Of course, compared with the hundreds of years of traditional manufacturing history, 3D printing can only be regarded as the initial development stage of the industry in just 30 years. The choice of materials is still narrow, and the surface accuracy of the finished product also needs further post-processing. Compared with the traditional assembly line, the mass production speed of 3D printing is slow, and the cost of a single component is high.

CCTV's financial channel once reported that academician Lu Bingheng, the father of 3D printing, proposed: "3D printing technology creates an advantage for the high-end manufacturing industry. Everything can be 3D printed, but at the same time, it is necessary to use different manufacturing methods rationally. Their respective advantages to carry out the production of people's products."

With the gradual development of 3D printing technology, the performance of materials will gradually improve.

Broader product applications are gradually being

developed to make products that the public really needs. People are very persistent in the unique production technology of 3D printing. Combined with the unique structural model design, it will definitely be able to improve the appearance and performance to a new level. Hope that designers can create more 3D printed products!

At the same time, many Chinese manufacturing companies are also actively introducing 3D printing technology to replace or improve the original production methods, improve the intelligent level of enterprise production, and meet the government's needs for transformation and upgrading of Chinese-made products.

What can 3D printing do? The answer is that all products can be re-made with 3D printing! 3D printing can upgrade people's quality of life!

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