

Types of 3D Printing Industry Bases: A Chinese Perspective

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Abstract: *China's 3D printing industry has achieved rapid development in recent years, and a number of 3D printing bases are also emerging rapidly. The 3D printing bases from China, including centers and parks, were classified in this paper according to the following 5 different classification criteria: base position, the main body promoting development, industry division, professional fields and industry combination. At last, 15 types of 3D printing industry bases were gotten, such as government-oriented type, technology industrialization type base, creative industries base and so on. The research can make governments and enterprises understand the types of 3D printing industry base better, which is conducive to promoting the development of 3D printing industry.*

Keywords: *3D Printing, Industry bases, Type, China.*

1. INTRODUCTION

3D printing has made rapid progress in recent years [1]. The research report from Canalys points out that the progress of technology and cost decreases will lead to 3D printing market to grow from \$2 billion 500 million in 2013 to \$16 billion 200 million in 2018 with the compound annual growth rate 45.7% [2]. Luo Jun, China 3D printing technology industry alliance Secretary General, said that China's 3D printing technology to achieve the output value of only about 300 million Yuan last year, however, the scale of the Chinese market in the next 3 years will be increased to 10 billion Yuan. Therefore, 3D printing industry is becoming a sweet pastry Chinese local governments scramble for [3].

Chinese cities announcing to establish 3D printing industry innovation center, 3D printing technology industrial park or 3D printing industry base include Nanjing, Wuhan, Zhuhai, Wenzhou, Qingdao and Chengdu Since 2013. Qingdao has taken 3D printing as an important strategic emerging industry and compiled the 3D printing industry action plan. The 3D printing technology industry innovation center in Sichuan Shuangliu city has begun to popularize 3D printing technology for the surrounding electronics, automotive, mechanical equipment and other enterprises [4]. The 3D Printing Industrial Park in Wuhan East Lake High-tech Development Zone is led by Huazhong University of Science and Technology, which integrates 3D printing equipment manufacturing, material manufacturing and product processing service, and it will be the largest 3D print production base in Hubei province and central China [5]. The 3D printing technology industry innovation center and the 3D Technology Industrial Park in Zhuhai formulated the related encouragement policy [6]. Jiangsu Province issued a supporting policies related to the development of 3D printing industry [7]. China's first 3D printing technology industry innovation center officially settled in Nanjing [8]. In addition, Guangdong province is also brewing the investment of over 1 billion Yuan to establish 3D Printing Industrial Park [9].

In order to further promote the vigorous development of 3D printing industry base, and assist the government and enterprises to carry out scientific construction, we conducted a statistical analysis of many existing 3D printing industry bases including centers and parks in China. In the section 2, the classification standard is introduced. The types and detail of these bases are analyzed according to the classification in the section 3. In the end, we sum up the conclusions of the study.

2. CLASSIFICATION CRITERIA OF 3D PRINTING INDUSTRY BASE

Combined with the industrial characteristics of 3D printing [10] [11], we determine the classification criteria based on the following five factors, namely base position, the main body promoting development, industry division, professional fields and industry combination. The base position is the core which decides the future development goal and the development trend of the base. Different main

body to promote development will make relevant decisions from different perspective. The different division in the 3D printing industry will make the 3D printing industry base present a distinctive development style. It is because the professional fields 3D printing is involved in are different that different types of 3D printing industry bases will emerge. Finally, from the development perspective of modern economy, a lot of economic forms are often intertwined, so it is necessary to analyze the types of 3D printing industry base by the industry combination

3. DIFFERENT TYPES OF 3D PRINTING INDUSTRY BASE

In accordance with the above classification standards, combined with the investigation and analysis of the status of the 3D printing industry bases that have emerged out in China, we classified the types of 3D printing industry bases as follows.

3.1. Dividing Bases based on the Base Position

3.1.1. International Federation Type

The international federation type 3D printing industry base has the advantages of integration of global resources, which can maximize the strengths of all parties to promote the rapid development of 3D industry. Nanjing 3D printing industry base and Weifang 3D printing industry base are the representative. They build the international industry alliance integrating a lot of world resources to promote the development of the world's 3D printing industry.

3.1.2. Domestic Federation Type

The domestic federation type 3D printing industry base is just relative to the international federation type base. The 3D industry alliance, local governments, universities, enterprises and so on contribute to this kind of industrial base to promote the development of one country's 3D printing industry jointly. In China, such representative bases include China 3D printing technology industry Innovation Center (Zhuhai), Longqiao Industrial Park in Fuling District, Sichuan Deyang High-tech Industrial Park and so on. To promote industrial upgrading and structural adjustment, China 3D printing technology industry innovation center (Zhuhai) help some companies to transform and upgrade the traditional industries in Xiangzhou district with 3D printing technology. It integrates the superior resources of China's 3D printing technology industry alliance and Hong Kong, and has been a co-founded forefront of China's 3D printing technology industry. Longqiao Industrial Park in Fuling District is the first 3D printing technology project in Chongqing that is led by Beijing Calve Deef International Trade Co., Ltd. Which cooperates with Tsinghua University, Wuhan University of Science and Technology, Institute of Beijing University of Chemical Technology and many other universities and research departments. Sichuan Deyang High-tech Industrial Park established an industry-university-research partnership between with Tianjin University, Tsinghua University, Sichuan University, Shenyang Institute of Metal Research Chinese Academy of Sciences, and other universities and scientific research institutes. At present, there are more than 40 3D printing and other High-tech enterprises in this Park.

3.2. Dividing Bases Based on the Main Body Promoting Development

3.2.1. Government-Oriented Type

The government-oriented type 3D printing industry base is led and established by the government. The purpose is to promote the development of 3D printing industry and improve the level of regional 3D printing industry. The most 3D printing industry bases in China belong to this type at present. The representative bases include Weinan High-tech zone 3D printing industry cultivation base, Qingdao High-tech zone 3D printing industry base and so on. Weinan High-tech zone 3D printing industry cultivation base puts forward the development strategy of "6+1", trying their best to build national 3D printing innovation manufacturing demonstration base. Qingdao High-tech zone 3D printing industry base is a key construction project led by Shandong province and Qingdao municipal government. During promoting the transformation and structural adjustment of traditional industries. It actively play the role of 3D printing and other emerging industries. It has introduced a number of incentive policies to support the development of 3D printing, robotics and other advanced technologies.

3.2.2. Enterprise-Oriented Type

The enterprise-oriented type 3D printing industry base is relative to the government-oriented type 3D printing industry base, which is led by enterprises. The purpose is to promote the development of enterprises. Haier group 3D printing technology research and application base is a representative base. As famous international home appliance enterprises, the development direction of Haier has already tend to be diversified in recent years. As known, some well-known universities in China have set up research platforms in Qingdao and carried out related research and development in the field of mechanical control, product design, 3D scanning and printing material. As the local leading enterprise, Haier is also in constant pursuit of innovation, and has begun to research and develop 3D printing technology and related applications.

3.3. Dividing Bases Based on Industry Division

For an industry, there are not only the upstream research and development stage, but also the downstream industry stage. These different stages own different characteristics generally, Therefore, these industrial bases will have different development options. They can concentrate the advantages of resources to develop in a certain stage, or in broader stages such as the total supply chain. Based on this, we divide industrial bases into the following three types.

3.3.1. Research and Development Type

As the research and development (R&D) type 3D printing industry base, it usually focuses on the upstream stage of the industry chain. It must own a first-class technology, perfect facilities, superior policy environment and strong financial support. It is because all aspects of the requirements are very high that there are only a small number of this kind of bases. China 3D printing technology industry innovation center (Zhuhai) is a representative base. The center carries on mainly the R&D and innovation of 3D printing products to provide technical support for the industrialization of Chinese 3D printing technology, trying to become the leader of China's 3D printing technology industry services and innovation.

3.3.2. Technology Industrialization Type

The technology industrialization type 3D printing industry base focuses on the downstream stage of the industry chain. It has no more demand as the R&D innovation type base, and also no high failure risk of technological innovation and R&D. Its key task is to use the existing 3D printing technology to the actual production so as to promote its industrialization. But it is also subject to the constraints of the upstream industry chain. Representative of the industrial base is China 3D printing technology industry processing and service base located in Weifang. The base has made full use of global channels and membership networks to dock with the advanced 3D printing industry platform, enterprises, and scientific research institutions and so on from Europe and the United States. It also has carried out the overall planning packaging for related industry projects. The advantage of this kind of bases is to reduce the uncertainty of R&D on 3D printing technology in the early stage and ensure the smooth development and operation of the base to the greatest extent, which also means that it is impossible to independently master the core technology and it may be constrained by other in the future.

3.3.3. R&D and Industrialization Type

The R&D and industrialization type 3D printing industry base usually has a more powerful core competitiveness. The advantages are obvious in the process of technological innovation and transformation. Especially in terms of technical transformation, it does not have to be restricted by the upstream technology research and development. But it also requires the base owning a more solid strength. Chengdu additive manufacturing (3D printing) industry technology innovation alliance is one of the representatives. The alliance takes the manufacturing enterprise as the main body, voluntarily formed by Chengdu's higher education institutions, Materials research and development enterprises and institutions, Industrial Design Enterprises, Scientific research institutes, 3D printing service application providers and other groups. It provides the reference and recommendations for the government's decisions on industrial development planning, industrial policy, and other major policies. It is the first 3D printing industry technology innovation alliance in western region of China. According to the analysis of China's 3D printing technology industry bases, we find the vast majority of the base belong this is kind of type at present in China.

3.4. Dividing Bases in Accordance with Professional Field

3.4.1. National Defense Base

Base is mainly research 3D printing technology to service for the national defense and/or produce the related 3D printing products. In 2013, Beijing Ligu Minmetals International Trade Co. Ltd signed an agreement on the 3D Printing Defense Science and Technology Industrial Park Project with Yangqu County, Taiyuan City. It marks the birth of China's first 3D printing defense science and technology industrial park. The content of the project mainly includes the production and sales of 3D printing equipment and supporting materials, 3D printing manufacturing, rapid economic mold, rapid precision casting and other related services.

3.4.2. Electronic Device Base

This kind of industry base is mainly to achieve the integration development of 3D printing technology and electronic information industry. Qigihar High-tech Zone focus on the introduction and development of ten major industries, such as mobile phones, computers, large TV, rescue system, 3D printing, all optical communication, LED, Internet of things, life robots and electric vehicles. This is the typical representative of this kind of bases.

3.4.3. Automobile Manufacturing Base

In the process of verifying the design reliability of vehicle products, 3D printing technology can make sample verification at the early stage of the design so as to reduce design risks and R&D costs. Using the application advantage of 3D printing technology in the field of automotive parts and components, Daqing Technology Industry Development Zone relying on Volvo automotive manufacturing base, has begun to apply 3D printing technology to customize headlights, seats, steering wheel, tires and other parts.

3.4.4. Bio-Medical Device Base

To drive the transformation and upgrading of the city's industrial structure, Weinan High-tech Zone is trying the best to build a 3D Printing and Bio-Medical Device Industry Demonstration Base. In the meeting of 2014 3D Printing and Bio-Medical Device Industry, Zhao Yixin, the president of China Medical Device Industry Association, officially announced that the Weinan High-tech Zone become the Chinese medical 3D printing technology innovation industry base.

3.4.5. Creative Industries Base

Jinding Science Park is an important cultural industry park in Yunnan province. To develop cultural and creative industries, Yunnan province will establish a 3D printing production line here to provide creative ideas for cultural and creative enterprises in the park. Changchun High-tech Zone 3D Printing Creative Center promote the city's deep integration development among culture, technology and economy through extensive cooperation with the creative design organizations and enterprises, while guiding and the cultivating more innovative enterprises, at the same time.

3.4.6. Other Types of Bases

In addition to the larger-scale industry bases mentioned above, there are also some other 3D printing industry bases, such as Jinchang 3D printing Base which engages in the production and development of non-ferrous metal powder new materials, Sanya High-tech Industrial Park Base which produces statue, car shell, sailing and furniture with 3D printing technology, Baoji High-tech Zone Base that manufactures sports goods, toys and modern food with 3D printing technology, and textile machinery parts printing base of Longqiao Industrial Park in Fuling District and so on.

3.5. Dividing Bases According to Industry Combination

3.5.1. Single Industry Base

The characteristic of single industry base is that it can concentrate all the resources and energy to build a kind of industry which is integrated with 3D printing technology. Examples are as follows. Daqing Technology Industry Development Zone promotes 3D printing technology to be applied only in automobile manufacturing field. Qigihar High-tech Zone integrates the development of 3D printing

technology only with IT industry. Taiyuan national defense science and technology industrial park focuses on the application and development of 3D printing industry only in the field of military. Jinchang 3D printing industry base is concentrated only on the research and development of new non-ferrous metal powder materials.

3.5.2. Compound Industry Base

The compound industry base can reduce the risk caused by the failure from a certain area to the maximum extent, but this may also lead to the problem that the core competitiveness is not prominent. In China, the number of such industrial bases is not much. Nanjing National Economic and Technological Development Zone is a good representative, where the 3D printing technology has been applied widely in so many fields, such as industrial manufacturing, Bio-Medical, and culture creativity and so on.

4. RESULTS AND DISCUSSION

From China's perspective, we classify the current 3D printing industry bases in China. According to the 5 different classification criteria, these bases are divided into 15 types. In accordance with the base position, the bases are divided into international federation type and domestic federation type joint type. Based on the main body promoting development, the bases are divided into government-oriented type and enterprise-oriented type. Research and development type, technology industrialization type, and R&D and industrialization type are given in terms of industry division. According to the professional field, the bases are divided into national defense base, electronic device base, automobile manufacturing base, bio-medical device base, creative industries base and other types of bases. In the light of the industrial combination, the bases are divided into single industry base and compound industry base.

The research can make governments and enterprises understand the types of 3D printing industry base better, which is conducive to promoting the development of 3D printing industry. It is because the construction and development of 3D printing industry base is similar in many cases, that other countries, regions and many enterprises all can get useful reference. In a follow-up study, we will have a more extensive collection of data, so as to carry out a more comprehensive analysis.

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