A Strategic Framework for 3D Print Application and Business Model in Taiwan

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The IAFOR Conference for Higher Education Research – Hong Kong 2018
Official Conference Proceedings

Abstract
In this article, the authors develop a conceptual framework for 3D Print Supply Chain Application and Business Model that helps broaden the understanding of 3D Print industry and its role in enhancing and integrating manufacturing and service industries in Taiwan. After review the current literature on additive manufacturing technology Industry, that is, 3D printing industry; the authors interviews fifteen 3D printing services provided firms in selected Taiwan's markets and, develop a new conceptual framework based on the need for consumer, the supplier and the combining the requirements of applicants and consumers. The results of this study provide an appropriate business model which can help organizations to evaluate and investment in this technology to stand firm at all times.

Keywords: 3D Print Supply Chain, Business Model in Taiwan

Introduction

3D printing is a future trend based on the development of industrial manufacturing towards intelligent manufacturing and intelligent service. In combination with the digitization of production information, the huge amount of data and IoT (Internet of Things) technology, and the front-end scanning technology, the 3D printing (additively manufacturing) is one of the important means to enhance the productivity and competitiveness of the future manufacturing industry. It is also the stage goal of the 4.0 development Plan of the Taiwan Executive Yuan. The additively manufacturing technology which owns the advantages of rapid, flexible, customer-oriented and complex manufacturing, meet the demand of a small variety of new state manufacturing in the future, but the related market is still in the early stage of development. It is an important task for the commercial application of the 3D printing to enter the growth stage from the innovation stage. Therefore, based on the development process and functional characteristics of the technology, this study explores the future commercial application model and market development strategy in Taiwan, and integrates manufacturers and service providers through innovative application models to drive the development of future new 3D printing industries.

Literature Review

Industrial Ecological Development

3D printing technology originated in the mid-1980s, Charles Hull, the father of laminate manufacturing, invented the Stereolithography (SLA) technology in 1983 and obtained the US patent in 1984. At the beginning, due to the technology of product manufacturing and the efficiency limitation of the economic level, 3D printing is mostly adopted by large-scale industries. In recent years, 3D printing has been widely applied in the promotion of productivity revitalization plans in various advanced countries. From the introduction of industries such as air space, automotive components, to medical aids, cultural creativity or the use of personal daily necessities, such as prosthetic limbs, hearing aids, jewelry, shoes, etc., there has been considerable progress and commercial space. . According to Wohlers Associates' 3D printing industry annual report, 3D printers and their surrounding services have reached a market value of $2.2 billion in 2012 with an annual growth rate of 29% (Wohlers, 2013). In 2013, it achieved the highest annual growth rate in 17 years, with a scale of US$3.07 billion and a growth rate of 34.9% (Wohlers, 2014). In 2014, it achieved an annual growth rate of 35.2%, with a market capitalization of US$4.1 billion (Wohlers, 2015). That's why Gartner (2015) predicts that 3D printing will reach the mainstream in the market in the five years from 2016 to 2020. As a result, Wohlers Associates further estimated that the market value of 3D printing and its surrounding services in 2021 could reach $10.8 billion.

The current advanced national multi-layer manufacturing industry can be divided into industrial and personal/home. In the manufacturing sector, for example, the German industry 4.0 has a 3D printing industry policy, and the development of medical technology such as artificial joint printing technology is leading the world; 2. The US-made AMP "Made in the USA" industrial policy is developing in the aerospace industry. For example, LEAP series engine developed by the company (Safran and GE joint venture) CFM has outstanding performance in saving aircraft fuel

consumption and airline maintenance costs. 3. Japan TRAFAM program, printed in metal manufacturing and sand casting 3D Achievements in industry. Personal/home, such as the promotion of education policies in the United States, the popularization of 3D education, the use of 3D printing machines to popularize additive manufacturing technologies, even to the pre-school stage, or the inclusion of 3D printing in university courses. The development and application of manufacturing industry is more extensive than personal/home.

Taiwan's additive manufacturing ecology

3 D printing ecosystems include a range of value creation activities, such as traditional manufacturing supply chains and digital production design and distribution. Figure 1 shows the architecture of the ecosystem proposed by Piller et al. (2015). The entire additive manufacturing system is divided into industrial upper, middle and lower reaches and a common basic environmental system according to the industrial function role. The upstream industry is equipment and system manufacturers and material suppliers, equipment and system manufacturers can be subdivided into mechanical equipment manufacturers and systems engineering design; the midstream industry is more diversified, functionally covering product design/ scanning, production processes and pathways. Figure 1 shows additive manufacturing ecosystem.

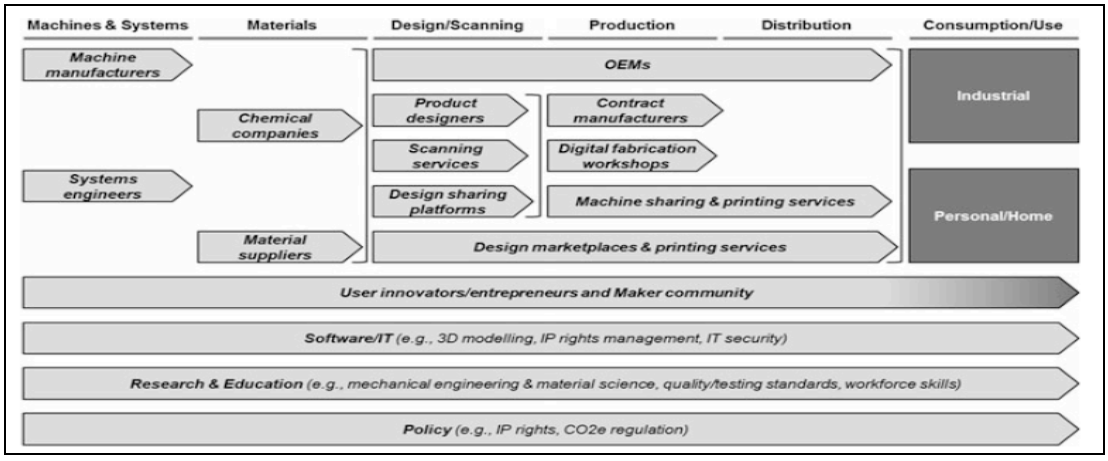

Figure 1: Additive manufacturing ecosystem, source: Piller et al.(2015)

There are five types of business types, such as the system integration vendor that includes above three functions provides complete production solutions for downstream customers, product designers and contractors, scanning services and digital modeling (CAD) vendors, product design platforms and printing services integrated design. The downstream can be divided into industrial customers and individual/family customers. The common basic services include user innovation / entrepreneur / maker community, 3D model, intellectual property management, IT security and other software, research and development education units, government / regulatory environment, constitute a complete industrial ecological environment.

According to the above-mentioned ecosystem, Taiwan's additive manufacturing industry structure includes the upstream 3D printing equipment/system supplier, material supplier, midstream design scan, process, access, and downstream application industry and final consumer.

In the upstream equipment manufacturers in Taiwan, with the expiration of related patent technologies since 2008, many domestic and foreign companies have continued to enter the ranks of manufacturing 3D printing equipment, but most of the printing machines produced are low-priced. Domestic manufacturers such as XYZ Printing, Aurora, Microjet Technology, Coretronic Corporation, MIICraft, Renishaw and tool machine factories such as Tongtai Machine & Tool (Tongtai) also have high-end equipment research and development.

In the desktop/personal printing machine, XYZ Printing, which aims at education/consumer level, has 25% share in the international market. In the fourth quarter of 2015, it sold 21,800 units and 31% of the shipments. In the whole year, it also won the championship with 50,100 units of shipments and 21% of shipments. In the manufacturing of metal materials, for example, Tongtai sold the first 3D printing equipment developed in 2015 to the Taiwan Creative Metals Museum, which is used in the creative factory of Taiwan's creative metal for cultural and creative purposes. Tongtai further signed a memorandum of cooperation on metal additive manufacturing software with the Materialise Software Company of Belgium and the Industrial Technology Research Institute (ITRI) of Taiwan, and marched towards the domestic manufacturing of self-made 3D printing smart devices. In addition, related component manufacturers, in the energy source part such as heater (Yao Hong Precision Technology co. Ltd.), print head (MicroJet Technology co. Ltd.), piezoelectrical ink jet printhead (National Taiwan University), UV light (Dingxin co. Ltd.), LD (Nichia Taiwan Corporation); Scanning Some are such as DLP (Young Optics), Transmission (Hiwin Technologies Corp, ChiefTek Precision CO., LTD, Motor (TECO Electric & Machinery Co., Ltd, Delta Electronics, Inc.) In the material manufacturers, plastics such as ABS (Chi Mei), PLA (Zhaoqing Co. Ltd.), UV Cureable Resin (Pro-magic Co. Ltd., Changchun Group), metal powder (ThinTech Materials Technology Co., Ltd, Solar Applied Materials Technology Corporation) and other manufacturers to participate. Taiwan's industrial policy has a lot of influence in this respect. Since 2011, ITRI has been actively investing in the development of key laser sources and systems for laser additive manufacturing and has achieved good results.

The mid-layer manufacturing industry can be divided into product design/scanning services, printing processes and channel distributors/agents. In the product design/3D scanning part, some manufacturers such as 3D Digitech Co. and Logistic Technology Corporation have invested in the field of equipment development. Although there are some applications for general consumer such as scanning with mobile phones, Such products are still targeted at enterprise users who are capable of controlling variations in the light, angle, etc. of the shooting environment. In the printing process and channel distributors/agents, Road Ahead Technologies Consultant Corp, Detekt Technology Inc, SolidWizard Technology Co.,Ltd and other agents represent foreign equipment manufacturers such as Stratasys, 3D systems, EOS, Envisiontec, Voxeljet, Mcor, Optomec, Matsuura to provide total integration solutions for the market. In terms of sharing, Detekt Technology constructed the “Ink network” cloud as a solution for 3D printing service platform integrating the design/printing process, but the market response is poor.

Research Methods

The purpose of this project is to view the current ecological system and challenges of Taiwan's 3D printing industry and to exploring the current applicable business application model.

In this study, literature review was adopted. First of all, the paper reviews the current situation of the development of the industry, carries out market research on Taiwan's 3D printing industry and the operation relationship between the upper and lower reaches of industry, explores the current application demand of the domestic industry, and then describes the application and business model with potential in the context planning. Put forward feasible strategy suggestion for the ecological system of the 3D printing industry.

Findings

In the middle of the printing service, the initial development of the industry is to use the 3D printer built by the company to assist customers in the rapid prototyping service, and collect the cost of the prototype. It is a kind of OEM service type state for manufacturing industry. As the price of 3D printers gradually declined, however, it would gradually spread to general even individual consumers or company numbers. The market has already appeared in advanced countries to provide a large number of 3D image files for general users to download. Consumers can print the works according to their needs and cooperate with the 3D printers purchased for educational, entertainment or other purposes. Taiwan players have also begun to build 3D libraries for general users to download, but there is still a gap in quantity and quality.

We find little in-depth strategy for the mid-stream industry in the Productivity 4.0 Initiative. Only two specific action measures were set up under the fourth and sixth key strategies of the program. Since both of strategies are based on the industrial innovation of key technologies, the specific actual cases of target industry innovation in research and development will be the key achievement and efficiency goal instead of industrial output. In other words, Taiwan government seems to focus on the establishment of upstream industries and the development of downstream industries such as medical, automobile, mold and metal manufacturing.

3D printing industrial basic common environment such as the development of design software includes four functions: 3D drawing, scanning, analysis reconstruction and printing format processing. We also observe Taiwan-related manufacturers in the 3D graphics software are foreign graphics software program agent, domestic software is less. These professional graphics software are expensive, but there are many free open for the drawing software, such as Sketchup, Auto123D Etc. Although the drawing function is not as good as the professional drawing software, it can still meet the needs of users such as education and consumer experience.

In addition, in the industrial policy of loosening the medical regulations, financing, tax reduction and other policy tools, the government's policy support and efforts can be seen in the main sixth strategy of Taiwan Productivity 4.0 Initiative. Regulatory lifting issues in the medical industry and biotechnology industry, such as 3D printing human organ reconstruction / transplantation clinical trials, 3D printing biomaterial

safety assessment issues, etc., will involve clinical or non- Clinical trial specifications, or biomaterial certification and experiments. At present, relevant Taiwan regulations are scattered in the relevant laws and regulations, inspection and registration, etc., and there is no exclusive regulation. The 3D printing application has been introduced in the medical supplies from orthopedic surgery guides and dental bed guides. For building a good industrial environment, government should continue to establish the relevant regulations to achieve the ultimate goal of introducing intelligent manufacturing and cross-border integration platforms.

Other legal issues arising from 3D printing technology, such as: 3D digital information intellectual property management, how to control the digital information intellectual property rights obtained through 3D scanning in the future, the 3D digital database wisdom built by the cloud platform Property rights management issues, bio-printing extensions such as medical ethics, ethics and legality related issues and legal norms, food printing safety GMP regulations and regulations, dangerous goods printing such as gun printing control issues, printing defects Dissipate control issues and so on. Figure 2 shows the 3D print supply chain and business model in Taiwan.

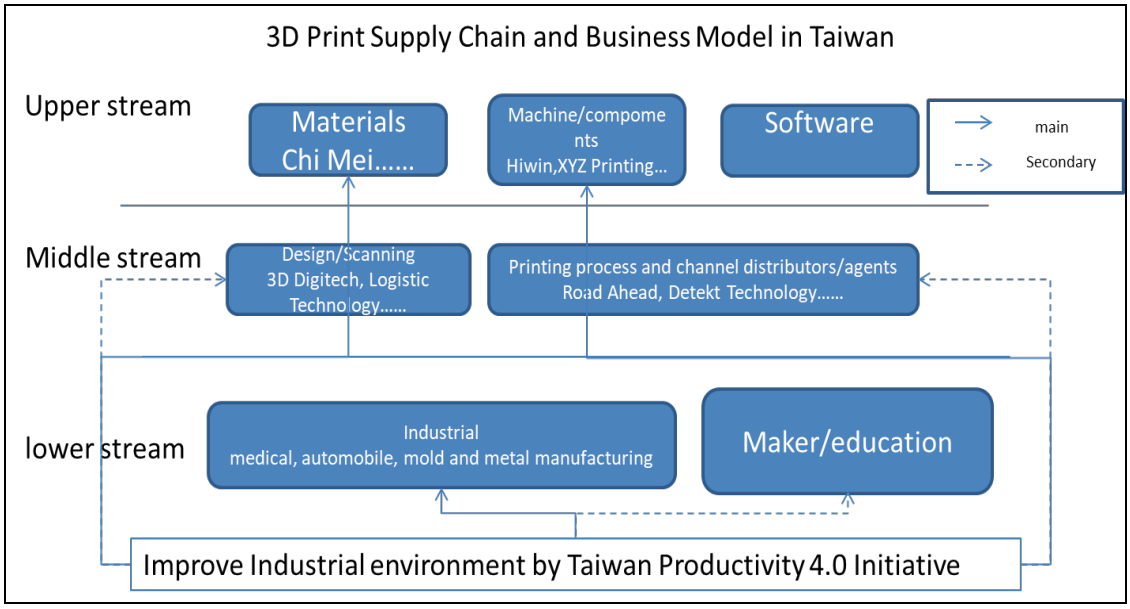

Figure 2: 3D Print Supply Chain and Business Model in Taiwan

Conclusions

Driven by the industrial 4.0 initiative, Taiwan is committed to the environmental creation and technology enhancement of 3D printing industry ecology to achieve the goal of Industry 4.0. However, advanced countries (Germany, the United Stated, Japan, etc.) is currently in a leading position, especially in aerospace, automotive, medical, precision manufacturing, printing equipment, and software. Taiwan government is aware of the fact that more and more products will be printed in 3D in the next five years. And the surrounding services will reach the mainstream position in the market. These developments will create economic value and market opportunities through the design of intelligent ecosystems and business models. Through the literature research, this research finds that most of the resources are concentrated in the upstream industry and specific downstream application industries under the fact. The development of the midstream industry mainly lies in the private

sector. Companies propose integrated solutions to serve the domestic market through the distribution of foreign equipment and software agents. The Market transactions show a very active phenomenon than the upstream.

This paper believes that the midstream industry has a lot of room for development and it is worthwhile to further observe the development of the Taiwan market in this regard. Taiwanese SMEs have considerable flexibility. In the future, more innovations will be discovered in commercial services. For example, the current cloud data platform is built, 3D printing technology is used to create product models, and product market testing is conducted among social media. This enables operators to conduct more accurate and effective market research before listing, and shorten the feedback process between manufacturing design and development and end users.

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