# **3D PRINTING IN KOREA**

Overview of the Component and Service Aftermarket

# **Ipsos Business Consulting**

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### A NEW INDUSTRY FINDS ITS WAY: PLOTTING A COURSE FOR 3D PRINTING IN KOREA

The groundbreaking technology of 3D printing is still in its infancy, and massive rewards seem assured for the first companies to develop the powerful and versatile tools necessary to disrupt the current manufacturing paradigm. With 3D printing's holy grail of speed, accuracy, high volume and affordable up-front costs coming closer with each passing year, questions surrounding the technology become less a matter of if than when – and for the players involved, the focus inevitably turns to the ever more critical question of who.

With Korea acting as a fast follower rather than an innovator in this industry, Korean companies are now setting their sights on catching up to the field in this quickly-developing sector. In this paper, we review the Korean 3D printing industry in its present state, including its most promising opportunities as well as the barriers to success it currently faces. We then put a special focus on the major Korean players, the parts of industry where the technology is most likely to take hold in the coming years, and how both government and business are stepping up to the challenge.

### MARKET POTENTIAL OF THE 3D PRINTING INDUSTRY

With eventual success expected across all sectors of commerce and society, the most realistic avenues of success for the early years of 3D printing are likely to come in the form of B2B undertakings, namely health care, public services (national defense, railway, firefighting, etc.) and the manufacturing industry.

The Korean 3D printing market is expected to undergo a 22.9% CAGR from 2016 to 2019, which is lower than that of the global market at 31%. This difference is mainly due to the relatively late adoption of the technology compared to other advanced countries, which means a longer initial stage is required within the Korean market.

Following current projections, 3D printing is on course to reach a total industry value of US\$376 million by 2018. This continuing rise highly correlates with the understanding shared by both government and the general public that the fourth industry revolution, including 3D printing, is the key to future growth.

# 2 main reasons for this growth 2

# **1.)** A rapid increase of interest within the education sector

The general public's interest is generated from the media and early adopters: 3D printing is frequently reported in the media, and 3D printing departments have appeared in several universities. Also, interest from primary, middle, and high schools has increased 3D printer sales in the education sector.

### 2.) The government's strong support for the industry

The government's commitment to the 3D printing industry began in 2014, and is becoming more concrete in its effect on industrial performance: Although the Korean government started somewhat behind the worldwide curve in embracing this burgeoning field, it now sees the potential in 3D printing's anticipated rewards of concrete technology R&D, industry infrastructure reinforcement, and relational base foundation. Details are on page 9.

Sources: Korean Ministry of Science, ICT and Future Planning (MSIP).

Note: Korea's May 2017 national election and subsequent fallout (the election has not yet taken place at the time of this writing) may prove to be a significant moment in the government's relationship to this industry, as new leadership could result in government incentives taking a different direction in the years to come. Positive government involvement is crucial when guiding a young industry toward success, and observers will be keeping a close eye on the new administration for any changes in its level of support.

BARRIERS TO GROWTH

In a fast-moving field, Korea's 3D printing industry still remains at an early stage and requires strong support from the government. The Korean government decided to begin earnest support of the 3D printing industry in 2014, which lagged slightly compared to other countries. Shortfalls from the supplier side may be just as consequential, as Korea's 3D printing industry currently remains highly dependent on imports for relevant equipment and materials. Overseas manufacturers presently account for more than 80% of total 3D printer sales in Korea.

# **3D** printing suppliers face several additional barriers to development, such as:



# Low quality of 3D printing equipment and infrastructure

 SMEs (Small and medium-sized enterprises) are the majority: 68% of the companies in the Korean 3D printing industry are start-up firms that were established within the past 7 years. Also, about 90% are SMEs with less than 1B KRW (=approx. 0.9M USD) in annual sales and fewer than 10 employees.<sup>2</sup>



### Inadequate talent pool in the workforce

Shortage of 3D printing professionals: Due to its short history, the industry is perceived to lack 3D printing experts. In a 2017 survey, 96 out of 194 3D printing related SMEs answered that they have difficulty sourcing their 3D printing workforce, and the most heavily cited reasons for explaining the inadequacy of

applicants are their lack of technical skills (56.3%) and working experience (25.0%).<sup>3</sup>

# Under-developed support system for 3D printing business development

 No centralized controlling unit of the government regarding budget execution: There is no sole body tasked with overseeing execution of the budget surrounding the Korean government's 3D printing working groups, despite more than 11 related government authorities involved. It is therefore difficult to form a coherent overall strategy to ensure the validity, efficiency and effectiveness of the budget as executed.

### Insufficient technological capability

 Low level of 3D printing technology capability compared to leading countries: Korea is behind the US by 2.6 years in terms of the 3D printing technology level. Furthermore, by 2014, Korea only accounted for 6% of total patent applications for 3D printing technology, compared to 35% from the US and 29% from Japan.<sup>4</sup>

Another barrier exists from the customer side:



### Manufacturing companies do not feel the need to introduce 3D printing in their manufacturing sites

 Insufficient expected benefits to justify the risk: To introduce 3D printing in the manufacturing site is to change the manufacturing process that has driven the industry forward up to this point. Strong incentives are required before companies will agree to make the diverse investments necessary (money, employees' agreements, etc.) for such a dramatic transition in operating procedure, and there are as yet no distinct success cases among Korean companies to show the way forward. These hurdles represent a clear challenge to the effective development of Korea's 3D printing industry. However, by focusing their efforts on the delivery of quality products and services for the most promising individual business sectors, Korean 3D printing companies can nevertheless set realistic and potentially very lucrative targets for themselves over the coming years.

### **DETAILED TRENDS BY SECTOR**



[3D Printing Sales Share by Segment in South Korea]

The first step toward identifying the right avenues for exploration is to give a clear review of how the wider landscape presently looks. The market is divided by product (3D printer and material), software and service. The servicesector includes manufacturing services, such as design services, acting as a print agent, and delivering education. Through design services, the end-user can submit a sketch drawing or 2D drawing and receive a converted version as a 3D drawing. The service sector company that prints the end-user's 3D drawing and creates the printed output, is referred to as the print agent. Through 3D printing education, end-users learn the processes of design and manufacturing through 3D printing.



Moreover, compared to the industry leading products, the quality of Korean products is relatively low. In a 2016 survey, the companies that use 3D printers in their process indicated that their preference of overseas products is due to "Output surface quality (38.5%)", "Diverse products (21.9%)", and "Convenience of after-sales service (9.4%)".<sup>6</sup> In contrast to current Korean output, Chinese products are already cost-competitive, and their quality is improving.

However, while industry-leading countries' services are mainly geared towards assisting manufacturing-related industries (by providing print agents, design services, etc.), Korean companies are finding fertile ground for expansion in other areas. Current trends show the software/service market to be rapidly increasing in Korea, especially in the service sector where education-centered services have taken a main role.

2015



(Note: 3D printing sales also include overseas companies' sales in Korea)<sup>5</sup>

Despite changes in the market, product continues to account for a high proportion of total industry sales. In 2015, however – the last year for which figures are available – its standing at 68% of the market is down significantly from the previous year. It is noteworthy that over 80% of product sales are derived from overseas manufacturers. The stated reason for this high dependence on overseas products is "cost-effectiveness".



⁵Source: MSIP.

Source: 3D printing industry condition survey from Korea's National IT Industry Promotion Agency (NIPA).

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### 3D Printing Sales Share by Technology Type in South Korea

Туре	Photopoly merization (PP)	Material Extrusion (ME)	Binder Jetting (BJ)	Material Jetting (MJ)	Powder Bed Fusion(PBF)	Directed Energy Deposition (DED)	Sheet Lamination	Total
Local Manufacturers	1.6%	4.7%	-	-	-	0.6%	0%	6.9%
Overseas Manufacturers	10%	24.2%	17.1%	39.7%	1.7%	0.2%	0.2%	93.1%
Total	11.6%	28.9%	17.1%	39.7%	1.7%	0.9%	0.2%	100%

Within the 3D printing hardware market, clear trends have already begun to emerge, as Korean manufacturers' 3D printer sales are presently limited to PP (Photopolymerization) and ME (Material Extrusion), which are highly related to polymer material technology and B2C needs.<sup>7</sup> In general, polymer material related technology is first-generation technology, having high popularity among the general public. Polymer material allows for lower prices and significantly faster 3D manufacturing time than metal materials. Technology related to polymer material can be used to check prototypes, but is not sufficient for use at actual manufacturing sites. To utilize 3D printing tech at the actual manufacturing site, metal-related technologies should be developed further.

### Current industry leading 3D printing companies in Korea are listed below, together with their sales figures

No.	Company	Company Sale (Thousands USD, 2015)	Established	Business Details
1.	Sentrol	4,587	2013	<ul> <li>Established manufacturer of controllers for CNC (Computer numerical control) machines</li> <li>Introduced and sold powder bed fusion systems for sand, plastic, and metal in 2015</li> <li>Developed a hybrid system that combines metal powder bed fusion with CNC milling</li> </ul>
2.	Carima	2,123	1983	<ul> <li>Started film processor (Photo Photoconductor Development) company</li> <li>Announced its continuous additive 3D printing technology (C-CAT) in 2015</li> <li>Working to increase the industrial application and market for its precision DLP photopolymer machines</li> </ul>
3.	Insstek	342	2001	<ul> <li>Refers to the technology as laser-aided direct metal tooling (DMT)</li> <li>Provided 3D printers to LG</li> </ul>

Other companies, such as Hyvision, Hebsiba, and TPC, invest in 3D printing while simultaneously operating a stable business in another field. Currently, Hyvision's main business focuses on image test/measurement services and

digital imaging devices. For TPC, pneumatic equipment and motion sectors' robot/cylinder/motors are the main products. Hebsiba mostly operates portable air conditioners and renewable energy inverters.

<sup>7</sup>Source: Korean 3D printing market report from the Korea Evaluation Institute of Industrial Technology (KEIT).

No.	Company	Company Sales (Thousands USD, 2015)	Established	Main Business Areas	Details reated to 3D Printing Manufacture and Sales
1	Hyvision	77,156	2002	<ul> <li>Image test and measurement service</li> <li>Digital imaging device</li> <li>3D printer</li> </ul>	<ul> <li>3D printer line called</li> <li>'Cubicon' (DLP)</li> <li>3D printer materials and accessories</li> </ul>
2	ТРС	65,631	1973	<ul> <li>Pneumatic equipment (Actuator, directional control valve, air preparation unit, etc.)</li> <li>Motion (Cartesian robot, electric cylinder, linear motor, linear stage, etc.)</li> <li>3D printer</li> </ul>	- 3D printer line called 'Finebot' (FFF) - 3D printer materials
3	Hebsiba	20,350	1986	<ul> <li>Portable air conditioner (Far infrared rays heater, large-capacity dehumidifier)</li> <li>Renewable energy (Inverter, solar photovoltaic power generation system, small wind turbine)</li> <li>3D printer, 3D solution education business</li> </ul>	<ul> <li>- 3D printer (ME(FFF), DLP, Stereo Lithography Apparatus)</li> <li>- 3D scanners</li> <li>- 3D printer accessories</li> </ul>

### EDUCATION AND HEALTH SECTORS ARE RECEIVING SPECIAL ATTENTION FROM GOVERNMENT AND INDUSTRY

### Education

The Korean 3D printing market is currently being led by the education sector, which represents the highest proportion (21.4%) of the 2015 Korean 3D printing market.<sup>8</sup> The success within education is due to high sales of devices related to PP and ME 3D printers, which are linked to B2C needs. In 2014, the government established 3D printing as an important plan, which generated high interest from the press. Also, as the general public became receptive to 3D printing, it triggered the increase in demand for 3D printing in the education sector.

Although the education sector is leading the Korean 3D printing industry due to high B2C demand, B2B needs from the industrial side will increase in the future. This development is expected to lead to a shift of focus within the industry, facilitating growth in the healthcare, public, manufacturing (aviation/energy), and automotive sectors for 3D printing companies.

### **Medical Industry**

Largely due to the strong support from the government, medical industries have taken a leading role in adoptingand implementing 3D printing technologies. Healthcare accounts for the highest proportion in the government's 10 priority sectors, which were announced in 2014. Furthermore, the government's pilot project to 'foster new demands' is mainly intended for the healthcare industry. This clear emphasis implies that from the government's standpoint, healthcare is the best option to drive visible and quantifiable output in the Korean market at the initial stage.

It is notable that all of the successful 3D printing R&D cases in 2015 and 2016 belong to the healthcare industry, as described below:

- The first 3D printing implantable biodegradable medical structure localization (Sep, 2016, Korea Polytechnic University)

- Metal materials related 3D printer tech development and exportation. Bio 3D printing technology development (2015, 2016)

- Development of implantable bio ink for damaged spinal cord tissue parts (Oct, 2015, Ulsan National Institute of Science and Technology)

- Development of 3D printed temporal bone for dissection practitioners' use (May, 2016, Samsung Medical Center)

The Korean government encourages relevant institutes and companies to improve and apply 3D technology, particularly in the form of dental equipment, medical devices for transplant, and personalized treatment devices.

Dental equipment is used for treatment devices such as dental models, temporary teeth, clear aligners, and dental implant materials. Medical devices for transplant refers to implants for the replacement of human tissue, treatment devices for permanent/semi-permanent usage such as scaffolds, artificial cartilage, and insert type devices. Personalized treatment devices are external treatment tools that had been difficult or impossible to develop through previous manufacturing methods.

3D technology enables the production and use of customized treatment tools for temporary insertion into the human body, as well as tools for surgical procedures. For example, artificial ears and artificial skulls have already been produced by 3D printers.

In 2016, the MFDS (Ministry of Food and Drug Safety) revised the regulations to shorten the permission process surrounding the 3D printing of medical devices in emergency situations. By the end of the year, 19 3D printing medical devices were officially registered by the MFDS. The largest proportion consists of orthopedic devices such as artificial ears or prosthesis. The companies Medyssey and Cellumed are most actively involved within the private sector of 3D printing's healthcare field.



### **GOVERNMENT POLICY REGARDING** THE 3D PRINTING INDUSTRY

The Korean government firmly believes that the 3D printing industry will provide ample opportunity to produce added value in relevant industries.

In order to develop the overall 3D printing industry, the Korean government has initiated 4 major strategies and 3 corresponding leading achievements, and 12 corresponding action plans as below. However, there is no sole controlling unit supervising and executing the budget, and the character of the roadmap could be changed by the direction of the newly-elected government.

#### **3D Printing Roadmap by the Government**

To leap for 2019 3D Printing Global Leading Country

Foster global leading	Increase global	Secure independent
company	market share	technology
# of companies	% of M/S	% of M/S
("15)1 → ("19)5	("15)4.0% →("19)6.0%	("15)9.9% → ("19)20%

### **4** Strategies

1. FOSTER NEW DEMANDS

TRENGTHEN VITALIZATIO

A. CREATE REPUTATIONAL BAS

### 1. Plan

- · Find convergent business model
- and pilot project
- Promote leading business (healthcare)
- Create demands in manufacturing industry

#### 2.

**Outstanding Achievement** Set up strategical R&D roadmap

#### Plan

- Develop and support next
- generation R&D Support manufacturing industry
- tech R&D
- Lead 3D Printing technology standard

Outstanding Achievement Establish on integrated infra for 3D printing

#### Plan

- Upgrade 3D printing supporting infra
- Nurture 3D printing professional companies • Nurture 3D printing professionals

### 4.

**Outstanding Achievement** 3D printing industry Promotion Act

#### Plan

- Make the base for
- · Quality certification and assessment for reliability
- Regulation for industry promotion
- Safe environment

The above chart maps out a series of milestones that are expected to affect the market in the coming years, including:



#### **Priority Applicable Sectors Identified in the Plan**

Industries	Applicable Sectors
Healthcare	Dental Equipment, Medical Devices for Transplant, Personalized Treatment Devices (e.g. artificial ears)
Manufacturing	Smart Molding
Industrial	3D Electronic Components, Power Generation Components
Automotive	Vehicle Parts
Personal	Customized Private Supplies (e.g. Customized sports gear, jewelry)
3D Printing	3D Printing Design Service, 3D Printing Content Distribution Service

# Establish and upgrade integrated infrastructure for 3D printing (Plan from 2017)

This plan aims to support existing industry with an integrated infrastructure that allows players to easily utilize and connect with 3D printing technology. Central and local governments have established 8 'K-ICT 3D printing regional centers' in the region, as shown in the map on this page.

These centers offer 3D printing infrastructure and provide consulting services for efficient usage of 3D printing technology.

The MSIP will then lead the formation of industry-academic cooperation consultative groups with the regional center as the central base. Universities, related research institutes, and related associations of each region will be the stakeholders of these consultative groups.



The MSIP will also work to develop an online information system to provide businesses and the general public with information on the current status of 3D printing equipment and technologies. The initiative will also cover the latest industry trends, as well as reference material pertaining to safety education and the function of business registration declaration.

# Establish and upgrade integrated infrastructure for 3D printing (Plan from 2017)

The government has developed and initiated new 3D printing industry regulation, in addition to carrying out several proactive measures. These include regularly reporting on the general status and upcoming plans within the 3D printing business, compiled by sources including the local government as well as central government organizations including the MSIP, MOTIE, MOHW (Ministry for Health, Welfare and Family Affairs), and others. Other benefits from this initiative include the training of professionals within the industry, the promotion of new and standardized technologies, and the establishment of a quality certification system.

### GOVERNMENT INVESTMENT WILL FOCUS MORE ON TARGETED SECTORS, WITH EFFECTS THAT WILL SPREAD TO OTHER INDUSTRIES

The government's plan from 2014 to 2016 was intended to foster the country's 3D printing industry, in particular the B2C side. The plan for the next 3 years involves strengthening its role in B2B activity, especially as it pertains to healthcare, public services and the wider manufacturing industry.

The government should also prepare the wider business community, as well as society as a whole, for the systematic changes that may come about as a result of 3D printing technology becoming a global reality. According to a Korea Employment Information Service study in 2014, the development of 3D printing technology will have a negative impact on future employment in the molding manufacturing and machine tool industries. Furthermore, the effect on job security will be significant in the near future for workers involved in the production of orthopedics materials as 3D printing technology is applied with increasing regularity.

In short, some industries will face more adverse effects and increased unemployment rates, depending on their relationship with 3D technology. It is therefore critical for the central government to lead the way in supporting and developing the infrastructure to minimize damages and risks to the existing workforce in affected industries.



### HOPES AND PROSPECTS FOR THE YEARS AHEAD IN KOREA'S 3D PRINTING INDUSTRY

Breaking through companies' initial hesitation to bet their future on new and unfamiliar technology is always a difficult hurdle to overcome. Ultimately, however, progress for all parties involved depends on passing through the crucial stage of confidence-building. Korea's 3D printing industry is currently in its infancy, and highly dependent on government assistance to find its way forward. But when larger industries come to accept that 3D printing is an essential upgrade for their production process, the more successful 3D printing companies within Korea will be poised to grow rapidly.

That growth could take many forms, considering the variety and complexity within the 3D printing industry itself. Demand for 3D printers is one area where suppliers may capitalize, while demand for associated services is also set to create new opportunities. Niche industries such as healthcare and education have already showed great interest in the possibilities provided by the technology, and this appetite can be cultivated and extended to other sectors provided the proper communication techniques are developed to clearly explain the potential benefits.

Government has a central role to play in nurturing the industry, and its continued enthusiasm for 3D printing is essential if Korea is to expand its influence in the global market. Current plans include an admirable multi-pronged approach to bring about improvement on the demand side, the supply side, and the infrastructure connecting them.

There are, however, opportunities for improvement within the government's own efforts, and strong leadership in the years to come could have a significant impact on the fortunes of players within the industry. As the country recovers from its recent political turmoil, many are watching the incoming administration for signs indicating the extent to which it plans to continue nurturing the young 3D printing industry – and the wisdom contained in its approach.

A consolidation of hitherto disconnected government policies could add an additional element of strategy, stability, efficiency and confidence to further encourage growth and investment within the industry. Furthermore, a forward-thinking policy of support specifically geared towards 3D printing companies attempting to enter new areas within the industry would be helpful in diversifying Korea's output within this new field. By clearing the way forward, the Korean government will provide the best opportunities to its home-grown businesses, with potentially massive rewards for such investment in the years ahead. While Korean society must also attend to social difficulties that may arise as a consequence of this new technology, the 3D printing companies need share no such concern. They must keep a close eye on the potential within fields they are familiar with, such as healthcare, education and public services, while also looking to expand outward into other fields when conditions are right.

In the near future, a focus on other non-polymer and industrial needs will provide Korea with its best chance at positioning itself for success as the market moves toward manufacturing. The increase in B2B demand for 3D printing technologies is a clear sign that industry R&D on metal-related technologies should be conducted further, for use in the production of goods.

For industrial needs that require metal-related 3D printing technologies, companies Winforsys, Hyvision, and Maxrotec are notable for their investments in the field. However, these three companies' metal-related tech is not a main business model but rather an investment sector. To encourage a deeper level of development within this area, the government should provide more active support to companies interested in investing in metal-related technology. As the field of 3D printing develops, companies will need mature decision-making skills to navigate a fast-changing landscape. Even the strongest businesses, however, will look to government as well as the private sector for valuable advice and cooperation.

Choosing the ideal moments for the adoption of new technologies, adaptation to emerging trends, and expansion into growing markets requires up-to-date information together with a strong infrastructure of support. Long-term growth and success also depend on a wise investment strategy and a winning marketing approach, informed by timely, accurate, and in-depth studies incorporating management experience and rigorous market analysis.





Preparing for market entry has never been so complex. The rise of global connectivity, both online and in terms of real-world trade infrastructure, means that businesses need to adapt to rapid changes throughout the world of commerce. New trade partnerships allow competition to come from all sides, e-commerce requires a revolution in logistics, and the rise of internet advertising demands mastery of this new media platform.

These new market realities affect consumer preferences in terms of products and their method of purchase, advertising models, logistics in an e-commerce world, legal requirements at every step of the way, and competitors both local and overseas. Companies must remain ready to respond to real-time evaluations of sales performance, while continuing to monitor progress toward long-term goals.

Now more than ever, a detailed understanding of the market is an essential element of a winning business model. The Ipsos Business Consulting proprietary model for Go-to-Market strategy, combined with our world-class marketing research service in 88 countries around the world, puts us ahead of the pack in preparing our clients for the new realities of the global marketplace.

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