

Additive Manufacturing in China: Threats, Opportunities, and Developments (Part 1)

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In Part 1 of this series, an overview of China's additive manufacturing industry is presented, including a discussion of its threats and opportunities, the role of government, and key industry players. In Part 2, focus will be placed specifically on developments in China's aviation and aerospace industries.

Introduction

In his 2013 State of the Union address, President Obama drew attention to additive manufacturing (AM, also known as 3D printing) for its “potential to revolutionize the way we make almost everything,” highlighting the formation of the National Additive Manufacturing Innovation Institute opened in September 2012 in Youngstown, Ohio.

Across the Pacific, China has also been bestowing honors on additive manufacturing. At its annual State Science and Technology Awards ceremony in January, China awarded a Beijing team of AM researchers one of three first prizes for the State Technological Invention Award (国家技术发明奖), the highest honor a technological achievement can receive. The achievement was the use of laser metal deposition (LMD), a type of additive manufacturing, to produce a four meter long titanium alloy primary load-bearing structure that meets aircraft capacity requirements—a milestone Chinese sources claim the United States has tried but failed to achieve.¹

AM is officially defined as “a process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing technologies.”² In most applications, a digital 3D image is created using a computer-aided design (CAD) system and divided into numerous layers. A 3D printer then prints successive layers of material and fuses them together to create a single object. The applications are widespread. Already, AM has been used to create complex aircraft parts, small pieces of beef, dresses, movie props, and a jaw implant. Over time, researchers hope to expand to other areas such as human organs, cement walls, and cars. While

1 Shi Yang, “钛合金3D打印 2012中国第一发明” [Titanium Alloy 3D Printing—2012 First Prize Invention in China], Guanchazhe, January 21, 2013, http://www.guancha.cn/shi-yang/2013_01_21_122111.shtml.

2 ASTM International, “Standard Terminology for Additive Manufacturing Technologies,” F2792–12a.

This material is based upon work supported by, or in part by, the U.S. Army Research Laboratory and the U.S. Army Research Office through the Minerva Initiative under grant #W911NF-09-1-0081. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the U.S. Army Research Office.

the applications cover many industries that hope to use AM for different purposes, almost universally, AM allows greater flexibility in design and customization, less scrap, and shorter production cycles.

The Threat to China

China has clear reasons for pursuing AM research. Additive manufacturing impacts almost all of China's strategic emerging industries, including advanced equipment manufacturing, information technology, biology, new materials, and new-energy vehicles. This, however, is not the only reason China is pouring investment into the technology. The Chinese government sees 3D printing as both a threat and an opportunity. The threat comes from AM's potential to disrupt China's deep-set manufacturing base.

China's manufacturing base currently benefits from aggregate demand, low-cost labor, and pro-producer government policies. As additive manufacturing grows, however, manufacturing is likely to become widely distributed, small-scale, and customizable. This poses a problem for China, since over time much of the outsourced manufacturing to China from the United States and other developed countries may relocate back home. As one writer put it, "this new techno³logy will change again how the world leans."

The second threat is illustrated by State Council counselor and economist Tang Min. Recalling China's "century of humiliation," he comments that if China's economy cannot keep pace with 3D printing technology trends, there could be a figurative recurrence of China's 1840 defeat by British steam-powered iron warship *Nemesis*.⁴ Like additive manufacturing, the *Nemesis* was state-of-the-art technology in its time, able to travel in shallow rivers and move with speed against the winds. Its use by the British led to China's defeat in the First Opium War and to the turnover of Hong Kong in 1842, the beginning of a series of losses and defeats China faced over the next century. Chinese policymakers fear that if China fails to become one of the major players in AM technology, it could deliver a similar, decades-long blow to Chinese progress.

China's Opportunity

The opportunity China sees in additive manufacturing does not come from fear. In AM, China hopes to leapfrog current manufacturing technology and place itself at the global frontier. In the early 1800s, China lost its global manufacturing lead during the advent of the steam engine and the Industrial Revolution. Since then, each subsequent technology revolution has begun in in the Western world.

Additive manufacturing, however, as one of the pillars of the new industrial revolution, could allow China to regain its share in the advanced manufacturing market.⁵ In the most hopeful sense, this would allow China to overcome its current gap in advanced manufacturing capability and leapfrog to the front with the United States and other developed countries. Furthermore, if AM does disrupt current mass manufacturing models (as many believe it will), China's large population and growing domestic demand for advanced products put it in a strong position to benefit from the market changes caused by AM.

Government Push

To bolster its industry at home, China has recently announced government plans to support additive manufacturing. In his opening remarks at the 2012 Additive Manufacturing Technology International Forum and the Sixth National

3 Richard A. D'Aveni, "3-D Printing Will Change the World," Harvard Business Review, March 2013, <http://hbr.org/2013/03/3-d-printing-will-change-the-world/ar/1>.

4 "3D打印开启新工业革命 中国制造能否变成引领者" [3D Printing Opens New Industrial Revolution—Is China's Manufacturing Able to Become a Leader], 中国青年报 [China Youth Daily], February 22, 2013, <http://scitech.people.com.cn/n/2013/0222/c1007-20564994.html>.

5 "3D Printing Opens New Industrial Revolution."

Additive Manufacturing Conference held in Wuhan, Vice Minister of Industry and Information Technology Su Bo outlined a three-step plan. This includes creating a medium- and long-term development strategy for AM, promoting the formulation of codes and standards, and increasing efforts to support AM technology development and commercialization through special fiscal and taxation policies.⁶

Already, media reports state that researchers at the Ministry of Science and Technology are currently working on a 3D printing strategic plan that will be published shortly, possibly in conjunction with the China-sponsored 2013 World 3D Printing Technology Industry Conference being held this May.⁷ Additionally, the Chinese Academy of Engineering has launched a one-year investigation to evaluate the future of 3D technology, with the report to be submitted to the State Council in 2014.⁸ This focused national attention will add to the ongoing support that AM technology has already received for more than a decade from the “973” and “863” programs, the National Natural Science Foundation, and the military.

Another early manifestation of the new investment push is the announcement made just two weeks after Su Bo’s comments. On December 25, 2012, Yu Shengshi, director of the Fast Manufacturing Center at Huazhong University of Science and Technology (HUST), announced that China’s first 3D printing industrial park would be established in Wuhan. This will include the establishment of a large rapid prototyping and manufacturing center. As part of the project, Wuhan Science and Technology Commission and Shenzhen Capital Group Co., a large government-affiliated investment firm, will cooperate with HUST to establish a company to provide 3D printing machines and services to domestic and international markets.⁹

Key Players

Chinese media usually cite three universities and one company (三校一企) as the main bases of China’s AM development. These include Tsinghua University, Xi’an Jiaotong University, HUST, and Beijing Long Yuan–Automated Fabrication System (AFS). However, there are increasingly more players in China’s 3D printing industry. Locations and areas of research for some of the key players are listed in table 1.

The challenge is that China’s main drivers of AM research and development (R&D) continue to be university research centers and their closely held companies. Private companies exist, but reportedly only one (AFS) has its own R&D capabilities.¹⁰ This is likely related to the high investment costs needed to purchase or develop a 3D printing machine. For example, it took six years after first introducing 3D printing to China in 1988 for Tsinghua University professor Yan Yongnian to acquire his first printer after entering into a partnership with a Hong Kong-based company.¹¹

6 “2012年增材制造技术国际论坛暨第六届全国增材制造技术学术会议在武汉召开” [2012 Additive Manufacturing Technology International Forum and Sixth National Additive Manufacturing Conference Opens in Wuhan], December 28, 2012, <http://www.nmgjxw.gov.cn/cms/zbhygzdt/20121228/7986.html>.

7 “工信部 3D打印战略规划有望在两会后出台” [Ministry of Industry and Information Technology: 3D Printing Strategic Plan Expected Introduced After the Two Meetings], March 13, 2013, <http://office.pconline.com.cn/321/3212623.html>.

8 “China’s 3D Tech: From Drawing Board to Real World,” January 6, 2013, <http://english.hebei.com.cn/system/2013/01/06/012392838.shtml>.

9 “华中科大将建国内第一个3D打印工业园” [HUST to Become First Domestic 3D Printing Industrial Park], 和讯网 [hexun.com], December 25, 2012, <http://tech.hexun.com/2012-12-25/149450181.html>.

10 “3D Printing Challenges Chain’s Manufacturing Industry,” *Caijing*, January 8, 2013, <http://english.caijing.com.cn/2013-01-08/112418962.html>.

11 “China’s 3D Tech: From Drawing Board to Real World,” January 6, 2013, <http://english.hebei.com.cn/system/2013/01/06/012392838.shtml>.

Table 1. Some Key Players in China's AM Industry

Organization	Location	Key Researcher	Research Focus
Tsinghua University http://www.cims.tsinghua.edu.cn/html/kuaisu.html	Beijing	Yan Yongnian Zhang Renji	Bioprinting
Xi'an Jiaotong University (State Key Laboratory for Manufacturing Systems Engineering) http://sklms.xjtu.edu.cn/	Xi'an	Lu Bingheng	Bioprinting
Huazhong University of Science and Technology (Fast Manufacturing Center) http://mat.hust.edu.cn:8080/3d/	Wuhan	Yu Shengshi	Selective laser melting, drip irrigation parts, bioprinting
Beijing University of Aeronautics and Astronautics	Beijing	Wang Huaming	Laser additive manufacturing (LAM)
Northwestern Polytechnical University (State Key Laboratory on Solidification Processing)	Xi'an	Huang Weidong	LAM
Beijing Long Yuan – Automated Fabrication System (AFS) http://www.lyafs.com.cn/	Beijing		Selective laser sintering

Another challenge facing China's AM industry is that almost all current participants focus on device applications, ignoring the upstream industry chain supplying the field. These include materials, precision nozzles, and CNC design, most of which are currently purchased from abroad. In fact, the newly formed China 3D Printing Technology Industry Alliance states that China's 3D printing technology is "basically on the same level" as the United States, Israel, and other leading countries as a whole, but still lags far behind in materials and software development.¹²

Conclusion

3D printing is making quick progress in China and has already accomplished notable achievements. In 2012, China had only 8.6 percent of the world's installed 3D printing systems, but it also had the largest growth in installed systems worldwide.¹³ This trend is unchanged from 2008, when China's installed systems grew 39.7 percent, from 1,986 to 2,472.¹⁴ HUST President Li Peigen states that R&D and production in additive manufacturing in China is almost on par with developed countries.¹⁵ Following a visit to China, additive manufacturing consultant Graham Tromans expressed that "China will ultimately become one of the largest and possibly the strongest [country] in applying and developing AM technologies."¹⁶

12 "3D Printing Opens New Industrial Revolution."

13 Graham Tromans, "View From the East," TCT Magazine, February 21, 2013, <http://www.tctmagazine.com/articles/view-from-the-east/>.

14 Wohlers Associates, "Industry Briefing: Additive Manufacturing Around the World," July 2009, <http://wohlersassociates.com/brief07-09.htm>.

15 "3D Printing, China's New Growth Point," Xinhua, December 17, 2012, http://news.xinhuanet.com/english/china/2012-12/17/c_132046613.htm.

16 "View From the East."

China still has a long road ahead. Guo Ge, general manager of Beijing Tiertime Technology Co., China's largest maker of 3D printing systems, describes the industry as still in its start-up stage—needing strong improvements in both materials and operational capacity.¹⁷ Currently, China has only 3.6 percent of the 3D printing market, compared to the nearly two-thirds of the market held by the United States, Europe, and Israel.¹⁸ Price and manufacturing efficiency are other major setbacks, according to Lu Bingheng.¹⁹ Many of these challenges are not unique to China, but the ability of China's industry to overcome them may determine its stance in the next technological revolution.

Part 2 of this series will examine the application of additive manufacturing in China's aviation and aerospace industry.

17 "China's 3D Printing: Not a Revolution—Yet," Caixin, February 18, 2013, http://english.caixin.com/2013-02-18/100491820_2.html.

18 Rose Brooks, "3D Printing in the Emerging Markets: China," TCT Magazine, March 11, 2013, <http://www.tctmagazine.com/articles/3d-printing-in-the-emerging-markets%3A-china/>.

19 "华中科技大学院士专家解读3D打印技术" [Huazhong University of Science and Technology Academician Deciphers 3D Printing Technology], 中国高校报网 [China High Education Net], <http://www.cunews.edu.cn/Article/huazhong/keyan/201212/57644.html>.