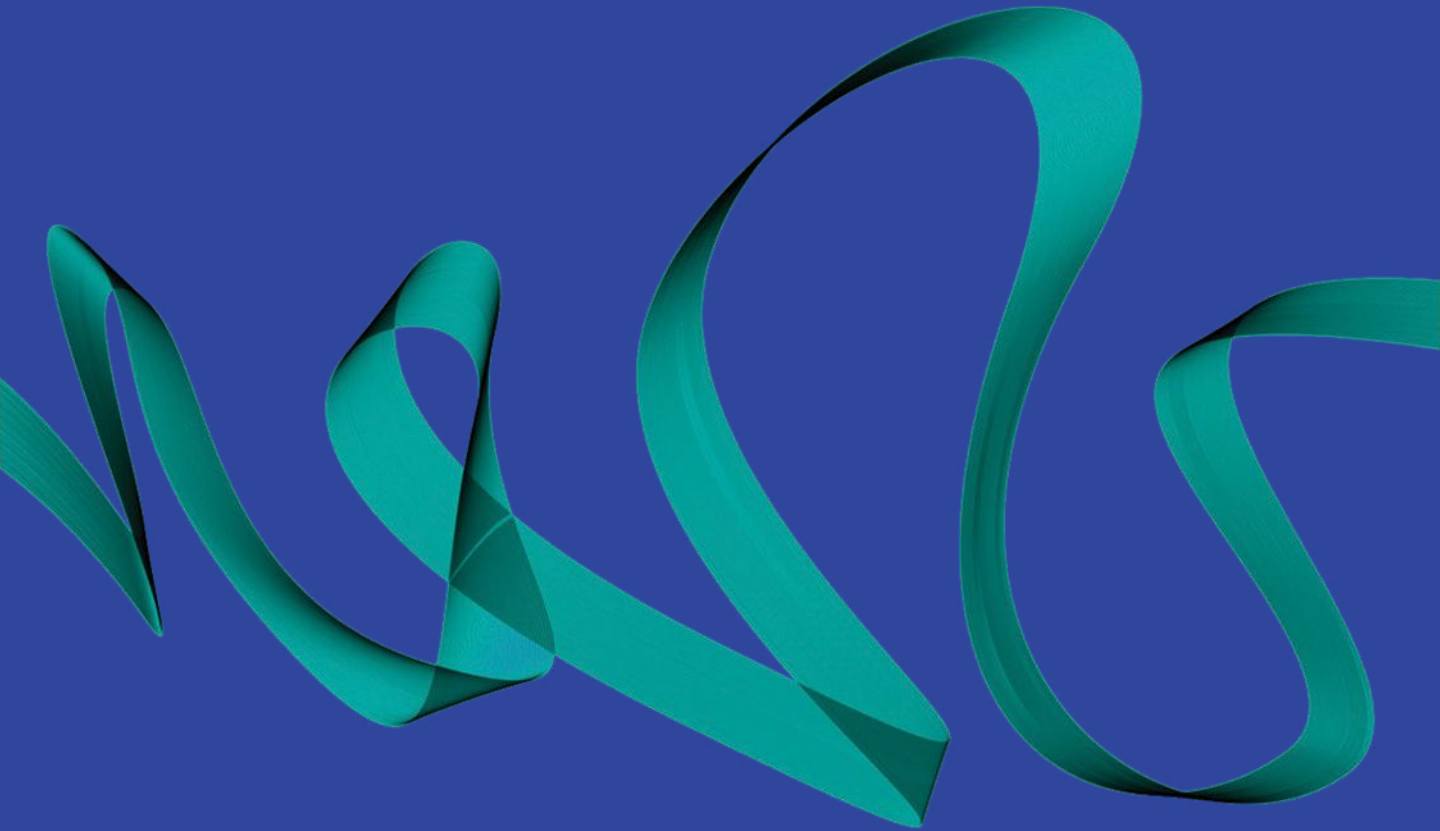




Opportunities and Challenges in China's 3D Printing Market





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May 2015

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Forward

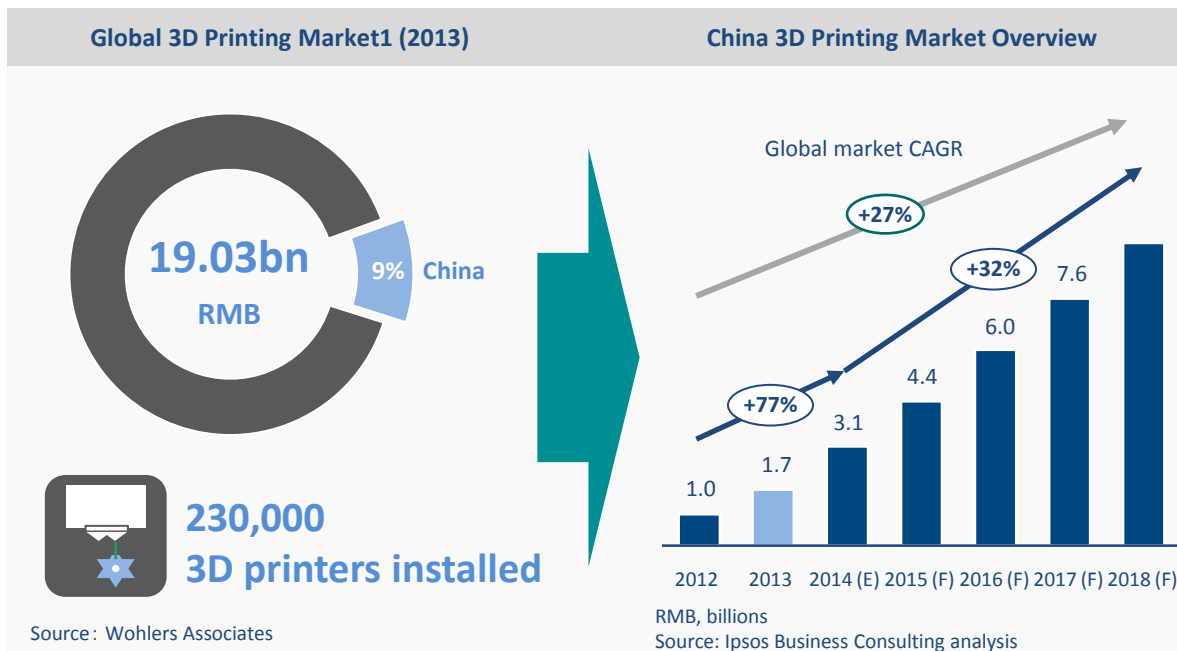
3D printing will likely prove to be one of the most disruptive and revolutionary technological developments of the current age. It has the potential to shake to the core every production and retail focused industry, with innovators claiming it will transform the home into a production centre for anything ranging from objet d'art to human organs.

Hardly a day passes without a new development in the technology making the news or the blogosphere. Even in China, where 3D printing got off to a relatively slow start, the idea of printing physical objects has started to capture the popular imagination. Both individuals and businesses alike are becoming increasingly intrigued with the potential of this revolutionary technology, yet a number of barriers are restricting its development across the country.

If you Google "3D printing for beginners" in English and you'll net myriad hits instructive websites and online resources about adopting the technology. The results of a similar search in Mandarin via Baidu are far less substantial. In China, implementation of the technology significantly lags that in more mature Western markets. While the world's most populous nation is not without its 3D printing success stories, there remains significant room for growth.

In a bid to identify and exploit this untapped potential, Ipsos Business Consulting and VNU Exhibitions Asia conducted this analysis of China's 3D printing industry. Launched in conjunction with the TCT + Personalize Asia 2015, a globally renowned 3D printing exhibition, the study provides a clear, concise overview of the industry, an assessment of its existing state and proposes solutions to the various challenges the industry faces in China.

The dragon wakes



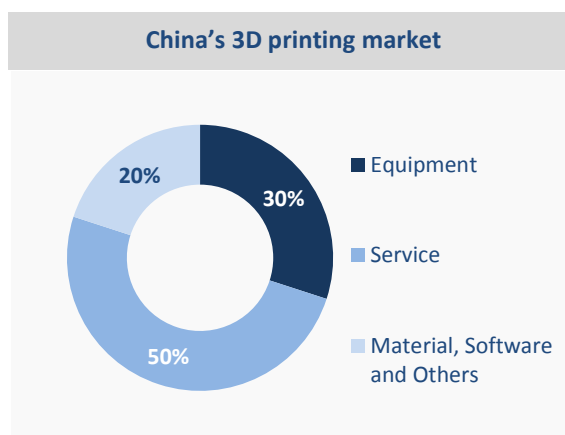
While 3D printing has recently been hyped as a key disruptive technology of our time, it was actually developed in the 1980s. The value of the sector has grown at an average rate of 18.7 per cent per year. However, the past four years, which coincide with the technology becoming more affordable and therefore of far greater interest to end users, has seen growth accelerate to 32.3 per cent a year from 2010 to 2013, rising further to a historic high of 34.9 per cent in 2014.

The technology has gained significant presence in China too, thanks to promotional policies from Beijing and widespread media coverage.

In 2013, the value of China's 3D printing market was estimated at 1.72 billion yuan, it was growing at 77 per cent a year and accounted for 9 per cent of the global market. Furthermore, the local industry is set to continue its phenomenal growth with some observers expecting it to top 9 billion yuan within the next few years. Printing services account for about half of the local 3D market's value, followed by equipment (30 per cent) and materials, software and others (20 per cent).

More than two-thirds of the 3D printing equipment manufactured in China is exported. There were some 200,000 3D printers worldwide in 2013, about 40 per cent of which were installed in the US while China only accounted for 10 per cent, despite its large domestic market.

China will undoubtedly become a key market to watch in its own right as well as for its impact on the global industry



Simple guide to 3D printing technologies

3D printing technology is a general term that refers to a series of additive manufacturing techniques. The technologies involved differ according to the materials they use, the precision of the final product and printing speeds. Each technology has its own advantages and limitations.

The technology, which leverages the strengths of additive manufacturing, has proven to be effective in producing components with highly complex structures where traditional manufacturing techniques are ineffective or costly. Despite its strengths and flexibility, 3D printing should not be perceived as a silver bullet. The technology is still in its infancy and limitations will persist for some time.

Firms need to understand the differences between the various 3D printing technologies and their relevant applications before venturing into this industry.

Apart from the few companies large enough to accommodate R&D and manufacturing for multiple technologies, most 3D printing players in China focus on a single printing technology.

Broadly speaking the technology can be segmented into (1) **industrial**, which includes metallic and non-metallic 3D printing; and (2) **non-industrial**, for both business and personal use. The section below illustrates currently available key technologies in China and their respective attributes.

Industrial 3D printing technology					
	Name	Material	Precision level*	Key characteristics	Key application areas
3D metal printing	Electronic beam melting (EBM)	Titanium and other metal powder	● ○ ○ ○ ○ 0.2 – 1 mm	Based on SLM technology, using an electron beam instead of a laser beam, accuracy is slightly lower than SLS technology	MED AERO AUTO
	Selective laser melting (SLM/SLS)	Titanium, aluminium, and other metal powder	● ● ○ ○ ○ 0.1 – 0.18 mm	Based on SLS technology, through creation of mould from metal powder. Complex post processing with more demand on manpower and equipment	MED AERO AUTO
3D non-metal printing	Selective laser sintering (SLS)	Nylon, plastic powder, glass fibre, etc	● ● ● ○ ○ 0.08 – 0.15 mm	Lasers generate heat to sinter adjacent powders. Complex post-processing and higher manpower and equipment demands	MED AERO AUTO DESIGN
	Photo-polymer jetting (Polyjet)	Ceramic powder, plastic powder, etc	● ● ● ● ○ 0.02 – 0.1 mm	The most advanced 3D printing technology. Supports a variety of materials and colours and produce precise products	MED AUTO DESIGN EDUCATION
	Stereo-lithography (SLA)	Liquid photo-polymer material	● ● ● ● ● 0.025 – 0.05 mm	Produces precise final products which are monochromatic and tend to be slightly brittle. Complex post-processing requires technically skilled operators resulting in higher operating costs. Suitable for R&D prototyping	MED AUTO DESIGN

* Precision levels are defined by the minimum layer thickness each 3D printing technology can produce

In summary, industrial 3D printing exhibits the following two points:

Enabling new product development through highly precise engineering and the use of a variety of materials

3D printing aims to produce smooth product surfaces. Furthermore, industrial 3D printing can reach thickness levels of 10 to 20 microns and also to use a variety of materials, ranging from plastics and nylon to metals.



High equipment costs, technically complex

To meet higher demands for precision, costs will often rise

in tandem. This area benefits industry players with high financial capabilities with the will to participate in it.

From the equipment producer’s perspective, industrial 3D printing requires significant investment, both in terms of finance, as well as talent development and experience. Domestically, R&D is lacking in maturity and technical expertise. This is where foreign firms have an obvious advantage. Metallic 3D printing is one such area where entry costs, in terms of technical expertise and financial investments, are high. It therefore comes as no surprise that there are currently about ten local firms engaging in this field in China.

Non-industrial 3D printing technology

	Name	Material	Precision level*	Key characteristics	Key application areas
Non-metal 3D printing	Fused Deposition Modelling (FDM)	ABS, PLA, wax, nylon etc	● ○ ○ ○ ○ 0.1 – 0.5mm	Easy to operate, open-source technology for corporate or personal use. Poor finish and low level of precision	  DESIGN EDUCATION

Three takeaways from non-industrial 3D printing are:

Low precision, limited materials, suitable for prototyping

With precision levels of just 0.1 to 0.5 microns thickness, non-industrial desktop 3D printers are not as precise industrial printers but they are suitable for individual use and for design and prototyping for businesses. Materials are limited to plastics, such as ABS and PLA.

Low cost of equipment and technical barriers

Affordability is a key draw for this technology, along with

ease-of-use due its lower technical complexity. Machine prices range from a few thousand yuan to tens of thousands, which is considered affordable by many smaller companies.

Promotion through open source technology

Fused deposition modelling, an open-source technology, has played a key role in the spread of 3D printing technology in China. Its lower cost and greater simplicity make it particularly attractive to entrepreneurs. However, most Chinese manufacturers are still lacking in the core technology development required to scale up.

Other 3D printing technologies

Beyond the aforementioned technologies, a number of other advances are being made, such as with 3D bio-printing.

China started researching 3D bio-printing around 2000. Bio-printers use bio-degradable materials with bio-compatible properties. The technology is divided into four categories according to material type:

1. Non-biodegradable, non-bio-compatible — moulding bone structures and pre-operation planning and design.
2. Bio-compatible, non-biodegradable — creating 3D printed joints or other implants.
3. Bio-degradable, bio-compatible — creating implants for bone joint or blood vessel repair. 3D printed implants are metabolised by the body once healing is complete.

4. Printing living cells — constructing embryonic organs through 3D constructed cell structures.

China has developed its own independent research into this field and is considered one of the leading countries for 3D bio-printing research. The first two categories are currently available with both metallic and non-metallic printing technologies. The third category is in the animal testing phase with about 10 years of research behind it.

Through an iterative process of testing and verification, research institutes are aware they face an uphill struggle due to limitations with their equipment and technical expertise. More R&D is needed to further develop the domestic technology to establish China’s dominance in 3D bio-printing.

As the technology is still in the early stages of human clinical trials, it will take some time before it reaches the market.

Industry analysis

3D printing in China — growth drivers

Government support shapes the market

Beijing has played a key role in developing the local industry, especially for desktop 3D printers. The government in 2012 launched a number of policies to promote and grow the 3D printing industry. Similar policy initiatives in the past have been used in other sectors to produce domestic industry leaders within a relatively short period of time. Unlike Western markets, China creates a protective environment to shelter flagship enterprises from the effects of local and foreign competition.

Along with setting up an education committee to promote the use of 3D printing technology, the government has started establishing a regulatory framework for the industry, which is crucial for its growth, including the creation of detailed plan and beneficial policies for the industry within 2015.

Media raises public awareness

Few people in China knew what 3D printing was before early 2012. That all changed over the following six months thanks to media coverage of technological breakthroughs within the industry. Focus on some of the more headline grabbing potential applications of the technology, such as 3D printed food and 3D printed cars, meant that some people thought 3D printing would immediately have far reaching effects that were more closely related to science fiction than the practical technology itself.

The challenge now relates to how media can leverage public interest in 3D printing to create a more educated understanding of how it can be applied than some of the previous hype has suggested.

Manufacturing’s shifting landscape

As China’s economy matures and becomes more focused on managing growth, industries which have been past pillars of its economic success will look for new ways to expand their business. Global manufacturing is set to become even more fiercely competitive, and Chinese manufacturers, as a result, will likely have to change the way they operate and adopt new technologies in order to remain on the competitive front foot.

Personalising product

The range of materials and colours that can be used in 3D printing has increased rapidly over the past few years. This trend is expected to accelerate, which means the technology will become increasingly flexible with a much greater capacity for customising products, making it more applicable to a wider range of industries.

These developments will also help deliver much greater choice for end users, who are looking for custom solutions to their unique needs and requirements. The flexibility of 3D printing means that companies will be able to feed this increased demand, while providing faster turnaround times and lower costs than are currently possible with computer numerical control (CNC) machines, even though the volumes for such custom orders will be relatively low.

Foreign firms drive adoption in China

While 3D printing is on the rise in China, its development still lags that in developed countries. Markets in Europe and the US are more mature in terms of their use of the technology. Large foreign corporations who use the technology and have business dealings in China (through wholly-owned or joint ventures) will drive adoption there providing opportunities for domestic companies to study how the can apply 3D printing to their own businesses.



3D printing in China — Challenges

Lack of technological understanding dulls industry vision

Our study of stakeholders within China's 3D printing industry, which ranged from government and equipment suppliers to end users, reveals low levels of understanding and awareness about the technology. The absence of easy-to-use 3D printers on the market means most potential end users are adopting a wait-and-see approach with the technology. Upstream players are restricted by their limited understanding of the expectations and needs of end users. Similarly, The general public's understanding of 3D printing is more often than not erroneous. They are unclear of its abilities and limitations.



3D printing is a good tool to solve real production problems.... The value of 3D printing is not in 3D printed products but its industrial applications
— Hang Qu, Assistant General Manager,
Suzhou Polymakr Co. Ltd.

Lack of core technology competency

Foreign companies own most of the 3D technologies being used in China, where domestic firms have traditionally focused on processing and production rather than research and development (R&D). Many local players fail to see the value of investing in innovation, which is required to catalyse the 3D printing industry.

An interesting phenomenon now being experienced is that while China's 3D printing market is growing rapidly, thanks to rising demand and interest, insufficient investment is being made in the technology to maximise its benefit for local manufacturing. Significant investment in the sector is a prerequisite of its success and wider adoption.

Design environment unconducive for experimentation

3D printing is typically used in the design phase and other early stages of product development where concepts or models used to be either hand-built or rendered on computer screens (the first approach lacking efficiency, the latter accuracy and physicality). However, designers and product developers are not currently leveraging the full potential of printing physical prototypes and designs because they lack requisite training and software expertise.

Conversely, western countries excel in the training and technical development of designers and product engineers. The emphasis on experimentation and small project development encourages innovative cultures within end-user organisations. China's domestic players could learn much by adopting a similar approach.

Practical adoption is relatively low

Technical barriers are a key limiting factor to the adoption of 3D printing in China, which currently accounts for less

than 10 per cent of the global installed base. The equipment can be difficult to use, and most local 3D printing equipment manufacturers are in their start-up stage using open source technology and doing little to simplify the operation of the devices. Adjusting equipment settings and printing parameters are so time consuming and complicated that many end users lose interest in learning how to operate the devices. In education, students are merely taught about 3D printing equipment without being encouraged to spend more time investigating the technology and its full potential.

Unregulated competition

As a nascent industry with limited scale, the 3D printing market is relatively unable to regulate itself. After rapid growth in 2012, the local market experienced a rush in investment from players in unrelated fields. This, however, resulted in a raft of cheap, low quality products. While the investment boom helped raise awareness of the technology, the public image of 3D printing was tarnished by sub-standard devices and services.

Introducing new technology is costly

3D printing equipment, especially industrial devices, is costly with price presenting a significant barrier to end user adoption. Many material and service providers have sought to control costs and reduce material costs by about 30 per cent, despite the fact that equipment costs have remained stable. Non-pecuniary costs — including time spent developing technical expertise, training professionals and re-organising the workforce — must also be accounted for.

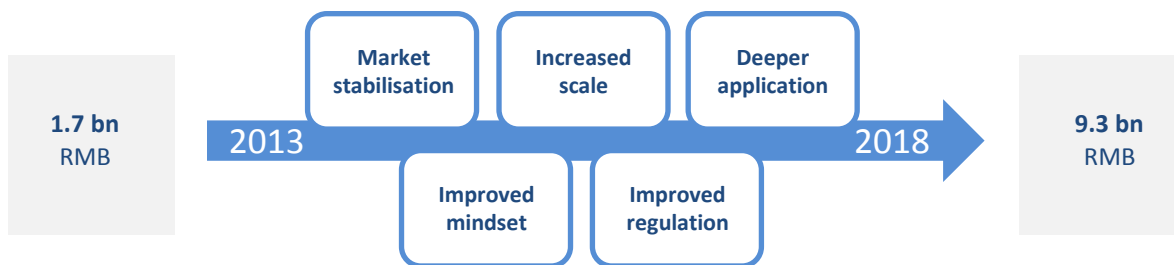


3D services are currently high cost. An ideal scenario would be the cost of equipment and materials decreasing by 30% to 40%. Using domestic equipment and materials will further reduce costs, but compromise has to be made on high equipment failure rates and poorer quality.
— Guoliang Zhang, GM,
Sunshine Laser & Electronics Technology

Supporting regulatory frameworks are inadequate

Market regulations and established norms for the application of 3D printing are lacking in China. For example, in the orthopaedic sector 3D-printed joints require China Food & Drug Administration (CFDA) approval. However, product inspection standards are unclear leading to delays in both R&D and production cycles. Furthermore, laws governing intellectual property for 3D printing are weak and relatively undeveloped. Robust legal frameworks are essential for raising the confidence of potential players in the 3D printing before they take the plunge and adopt the technology.

3D printing in China — facing the future



China’s 3D printing industry is set to grow rapidly now that it has the 10 years R&D under its belt, along with support from government and the media. This growth will be expedited by better regulations and increased public awareness of the technology’s applications.

Market stabilisation helps shape industry

There are currently 200 to 300 companies, engaging in manufacturing, distribution and services, involved with non-metallic 3D printing in China. This number is relatively low compared to foreign markets, and, as core technological competency does not lie in the hands of domestic producers, competition for domestic manufacturers is severe. Competition is set to intensify in the coming years, however, this will see the weeding out of players who lack long-term vision, sufficient investment or the ability to meet the changing needs of users.

The market structure for industrial 3D printing is much clearer as the sector requires greater technical expertise, capital investment and experience than at the end user level. It is likely that a few leading players will emerge over the next three years as the market consolidates. There may also be vertical integration, especially from major electrical engineering firms with strong financial and technical capabilities and the willingness to explore new opportunities.

Increased industry scale

The value of the global industry experienced record growth of 34.9 per cent in 2013, leading to increased optimism for the technology’s development and adoption over the next three to five years. The expected trend should see the installed base expand significantly. This will play a critical role in the 3D printing market’s development. It is not yet known when the likely tipping point will take place, but there will inevitably be a role-reversal whereby end users start seeking 3D printing equipment and service vendors to provide solutions to their needs, rather than the current model where vendors actively target and sell to end users.

Increased depth of application and small-batch production

Most industries, apart from medical and aerospace, use non-metallic 3D printing. While it is useful for rapid prototyping and concept development, the technology is limited in terms of materials and technical sophistication. Manufacturing in large batches is not yet possible, though more viable small-batch production will emerge in the next three to five years.

Furthermore, local companies will have to embrace new, more efficient manufacturing technologies to manage rising labour costs which have dulled China’s competitive edge in recent years.

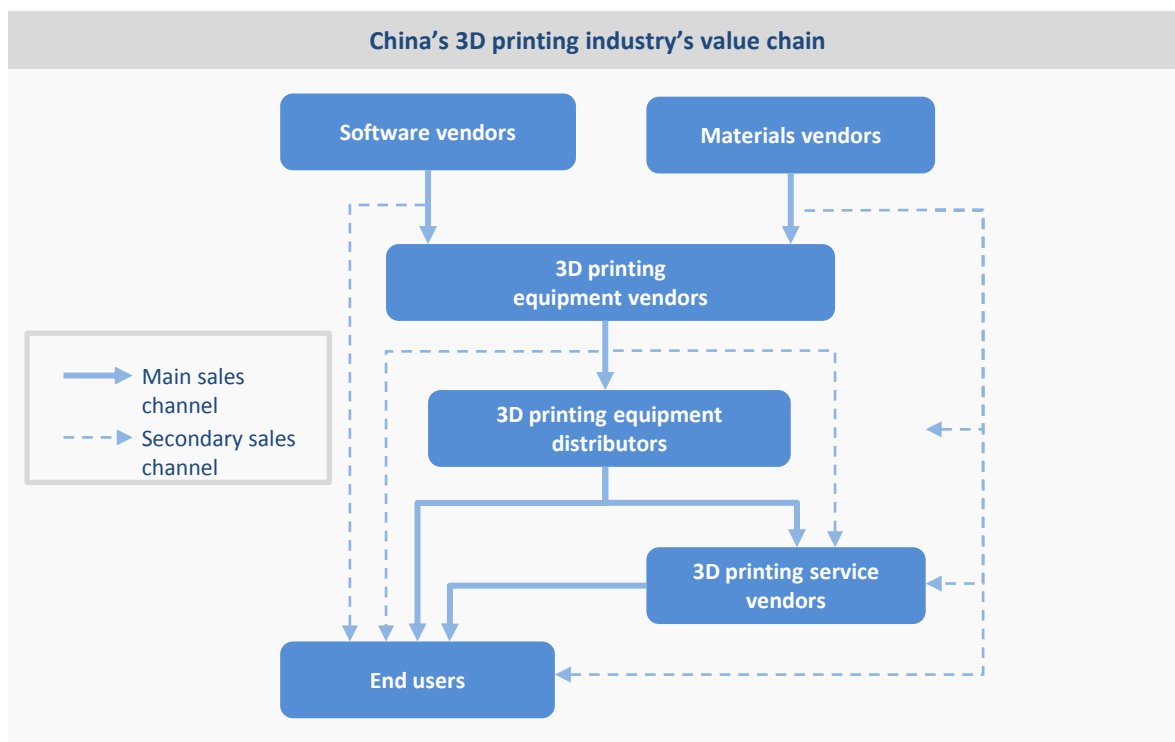
Continued government support and regulation

The government will continue to support the 3D printing industry through its related special committees and policy developments. Regulatory frameworks are expected to be implemented to standardise industry practices to increase adoption of the technology. For example, in the medical field, quality standard auditing procedures will be more clearly defined to expedite the CFDA approval process.

Increased understanding, improved mindset

Improving the mindset of industry players and end users is fundamental to the success of 3D printing technology in China. To maximise the potential of the technology, it will be essential to educate the market over the next three to five years about how 3D printing is not just a replacement technology but one that can upgrade and even revolutionise manufacturing capabilities and processes. 3D printing companies will have to play a leading role in educating end users about how they can integrate 3D printing in their businesses. Similar initiatives will be required to ensure the technology, and instruction in how to use it, becomes embedded in the school curriculum, thus ensuring the next generation workforce is skilled in 3D printing’s use.

Value chain weakened by information gaps and asymmetry



The value chain for 3D printing is fairly straightforward with only a few layers separating upstream suppliers from downstream end users. As seen from the above figure, the end user is often on the receiving end of sales pitches from a range of upstream players, with the resulting disorganised barrage of information often creating an additional barrier to adoption.

Industry value-chain players over the next few years will need to collaborate and be more organised about how they create and distribute information about 3D printing in order to develop a more conducive environment for end users and to drive adoption.

Equipment Vendors

There are about 200 players in China's 3D printing equipment market, with some local manufacturers doubling up as importers and distributors for foreign brands. Some manufacturers use their own printers and subsequently become printing service providers.

Distributors

Most 3D printing equipment manufacturers have emerged from research-focused organisations where the emphasis is not always on sales. Therefore distributors play a crucial role in the marketing both local and foreign printing equipment.

Service providers

These businesses often have their own equipment and provide services to customers that require 3D printing but who typically do not want to invest in the technology and often lack expertise in 3D printing as a result.

Materials

3D printing materials suppliers are generally separated into metallic and non-metallic materials. Domestically produced materials may have limited applications compared with foreign produced ones due to quality issues.

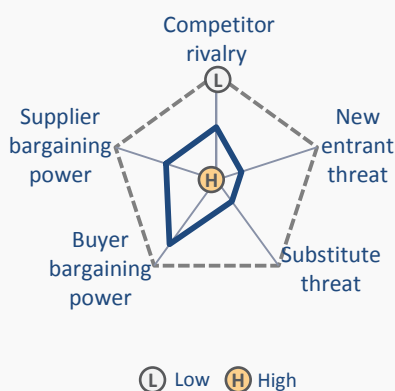
Software

The 3D printing software market is divided between third-party vendors and in-house developers. China's design software market is already mature, with developers more focused on how data management can optimise 3D designs thereby enhancing printing technology. Larger software developers also use open source platforms to crowdsource solutions for various 3D printing applications.

Competitive environments differ according to sector

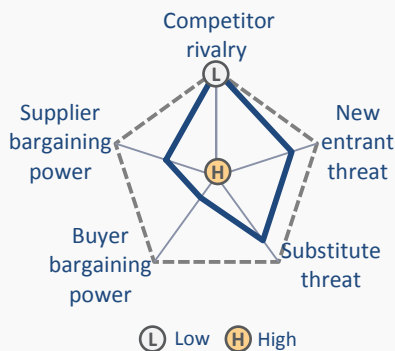
Summary: Price remains the key issue for end users in the **non-industrial 3D printing** sector where equipment is not highly differentiated. New entrants to this sector must **improve their cost structures** to be competitive.

Non-industrial sector competitive forces



Summary: **Industrial 3D printing equipment suppliers** compete in niche segments based on specific printing technologies. The low adoption rate is attributed to low exposure to, and weak demand, from end users. To remedy this, the sector must focus more on promoting the benefits of 3D printing and develop stronger industry collaboration with end users.

Industrial sector competitive forces



Competitive environment for non-industrial 3D printing

Competitive environment for industrial 3D printing

Competitive environment factors

Degree of influence

Competitor rivalry -----
Significant market growth, though sector has fewer than 200 foreign and local firms. Little differentiation between local firms due to low technological competence.



New entrant threat -----
Low technological and financial barriers. Rapid market growth will attract new entrants.



Substitute threat -----
Traditional manufacturing in China still benefits from low labour costs and much faster production speeds compared with 3D printing. Perception that short-term switching costs are high create a barrier to adoption.



Buyer bargaining power -----
Buying volume is low and irregular. Limited equipment providers means buyer negotiating power is weak.



Supplier bargaining power -----
Material, software and spare parts suppliers are not highly concentrated, however, high quality products are needed, a requirement which, coupled with low purchasing volume, increases supplier bargaining power.



Competitor rivalry -----
Only about 10 of the 100 or so industrial level 3D printing equipment manufacturers in China can print with metallic materials. Foreign brands have limited sales coverage too, which further reduces competition.



New entrant threat -----
Low threat due to high technological barriers and fixed initial costs. Equipment producers have a firm grip on intellectual property, supply and distribution channels.



Substitute threat -----
Low threat as 3D printing is deployed in niches where traditional manufacturing cannot do better.



Buyer bargaining power -----
End-users are limited with perceived high switching costs, resulting in 3D printing equipment suppliers having lower bargaining power than their customers.



Supplier bargaining power -----
Material, software and spare parts suppliers are fairly concentrated. Low adoption rates for 3D printing result in small purchase volumes, thus increasing supplier bargaining power.



Note: The assessment pertains to the 3D printing equipment producers. Material, software and spare parts suppliers are considered upstream suppliers. 3D printing end users and service providers are considered downstream buyers.



3D printing in China — key applications

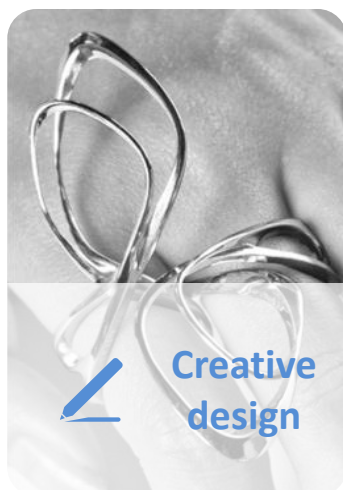
The flexibility of 3D printing enables it to support a diverse range of applications. Manufacturers can deploy the technology at any stage of the product cycle from development to final production. Currently, it is most widely used in the R&D phase, especially for rapid prototyping. Finished 3D-printed products are typically produced in industries that require high mix, low volume production.

On its own, 3D printing may not have an extremely high value. It's real value currently comes from its industrial applications. To realise its potential, the technology has to be known, accepted and eventually adopted by key industry players to increase their technical competency and meet customer demands.

Current users of 3D-printed products are often hesitant about making significant investments in equipment. This is

unlikely to change until the technology has become more widely used and proven across a number of industries. A number of 3D printing service providers have emerged as a result of this trend. They are not restricted to specific industries. The same machine can get the job done whether a customer requires prototype development or a mould to be made. In this way they too benefit from higher utilisation of their 3D printing equipment, thus increasing their return on investment. Hence Ipsos Business Consulting believes that the role of 3D printing service vendors will become increasingly important.

Within China, the 3D printing market is still relatively new compared to its western counterparts. However, certain industrial sectors have begun to take advantage of this new technology, supplementing its growth in recent years.



3D printing brings a designer's ideas to life. Its creative applications range from construction and engineering to fashion and jewellery, with speed and customisability being key strengths.

Given its relative newness, people working in 3D printing come from diverse backgrounds such as machining, lasers, materials and automation. However, many lack design experience. Therefore, 3D printing companies in China tend to focus on bridging the technical-design divide. Many local designers are also conceptually restricted by the limitations of traditional manufacturing, coupled with their unfamiliarity with 3D modelling. This makes it harder for them to grasp the benefits 3D printing can provide to traditional production methods.

On the other hand, the concept of additive manufacturing remains foreign to many Chinese designers and end users alike. Reports of 3D printed products are mostly exaggerated, which often serves to further mystify the end user, meaning greater effort is needed to better educate end users about 3D printing.

Aerospace engineering has successfully leveraged 3D printing to drive efficiency. By printing layered or honeycomb structures, the technology can reduce the number of parts needed in a design while ensuring the effectiveness of the finished product. Research shows that 3D printing has enabled designers to reduce the weight of some parts by as much as 70 per cent, with lighter weight parts translating into lower material costs. As a unibody manufacturing technique, it also produces joint-free products which are stronger and more reliable than those produced using traditional techniques.

Non-metallic 3D printed parts are already commonly used in the aerospace industry. Nylon parts, for example, can be produced in small batches and directly included in the aircraft manufacturing process. The adoption of metallic 3D printing, especially using titanium, is gaining traction, however, there is much room for improvement in terms of its precision.

Foreign market leaders still dominate the aerospace 3D printing industry due to their technical superiority and market credibility. Domestic printing equipment manufacturers must focus on learning from foreign manufacturers and improving their technological competencies to strengthen their reputations.





Rapid prototyping remains the most common 3D printing application within the industrial sector. In early-stage product development, the technology is used to create samples and moulds for auto parts, electronic goods and household appliances. Within China it is too costly to use 3D printing as a mass manufacturing technology. There is also significant resistance from traditional manufacturers to the idea of changing their production model, in addition to opposition from organised labour due to the reduced need for manpower.

Despite requiring significant initial investment, 3D printing equipment greatly reduces R&D costs by saving time and the quantity of materials used. Companies that employ 3D printing in this phase become strategically more competitive as they can cut the time-to-market for new products.

The technology is also a hot topic in the medical industry, especially with regards to body implants and medical assistance equipment. It has become popular within orthopaedics especially regarding intervertebral fusion devices, and artificial vertebral, hip and knee replacements. Clinical trials have shown 3D printed implants can fare better than those made from traditional materials.

With customisable implants, traditional materials are not durable enough to function normally and be fully integrated with the human body. For example, with 3D printing, an artificial acetabula cup, part of the hip joint, can be manufactured as a single integrated piece with a customisable porous structure, accurately adjusted for size and density as per the requirements of the patient, which enhances its compatibility. While possessing immense market potential, 3D printers for implant productions are categorised in China as grade-3 medical equipment, which have high barriers to entry. China also lacks the robust regulatory standards required to effectively govern the use of 3D printed implants. Legalisation of 3D printed implants will therefore take some time.

3D printed models also facilitate greater doctor-patient communication for pre-operation/operation guides and enable better pre-operation planning as a result. 3D printed models, used as an operating guide, can reflect a patient's specific problem allowing for more precise surgery, thus lowering risk. Denture production, a labour intensive industry where 3D printing will reduce labour costs, is seen as one of the most promising medical applications for the technology.



Desktop 3D printers are more prevalent in the education sector, in part due to the Ministry of Education's drive to educate the younger generation about the technology. 3D printing can also be used as a tool to teach creative thinking and problem solving. Government support in this area is relatively strong, as can be seen from the establishment of relevant government bodies and committees such as the Committee for Innovative Teaching through 3D Printing. The government has also initiated a programme to donate desktop 3D printers to 10,000 schools within the next two years. Middle and primary schools are also being encouraged to form interest groups to explore this technology.

Changing the mindset of Chinese student will be key to increasing the adoption of 3D printing technology. Continuity of usage is just as important as exposure to 3D printing. As such, students must be encouraged not only use the technology to support their education, but also explore its wider uses.

Lower costs, higher quality

Simply using 3D printing to replace current production techniques will not enable end users to maximise the technology's benefits. This requires a somewhat radical vision of how 3D printing can be incorporated from the product conceptualisation stage, as part of a solution rather than being viewed as just another production technique. It has also proven to be useful in areas where traditional manufacturing is lacking. Ipsos Business Consulting's study reveals the key benefits of 3D printing are twofold, affecting cost and quality.

Shorter production times



3D printing technology reduces production time by dispelling with the need for moulds (which can be very costly and time consuming to make) and through the ability to reproduce the same components without costly wear and tear (a problem with moulded products).

Lower production costs



The technology delivers the greatest savings in production costs in low mix, high volume manufacturing programs. Such products may have low demand in volume but require high levels of production due to their complex structures, which 3D printing can deliver while also reducing material wastage.

The aerospace industry provides a good case study with its nylon based (or non metallic) components which are 3D printed in small batches. The process saves manufacturing time, moulding and tooling costs and meets temperature tolerance, durability and hardness requirements.

Increases product life



Using 3D printing for maintenance and repair of worn components can halve regular replacement costs with said components providing performance comparable to that of a new part.

Produce complex structures



Traditional manufacturing processes are often unsuitable for producing components with complex structures. Even where such technologies can be used, they typically require multiple stages which increases the margin of error. 3D printing, however, is not held back by complex structures and can produce an entire component as an integrated mould.

In the medical field, 3D printing is a more practical and reliable choice for producing hip joints. It easily produces the micro-porous structure of the artificial joint surface with the ability to control pore size and density.

Printing 3D models during the design phase of architectural projects or aerospace parts increases the precision and scale of the models, thus allowing users to improve the accuracy and reliability of their designs.

Better reliability



Traditional manufacturing technology often cannot produce a finished product as a unibody. It instead requires multiple stages which are welded or soldered, which reduces the end product's reliability. 3D printing overcomes these problems. The technology has reduced the number of parts in some aerospace components from 20 to one, greatly increasing product reliability.

Highly customisable



Product designers can use 3D printing to edit and customise prototypes in a short time with minimal hassle. In the medical field, skeletal models, or models for operating guides are 3D printed to reflect a patient's actual condition. This allows for more targeted surgery which improves the operating procedure and/or implants being used.

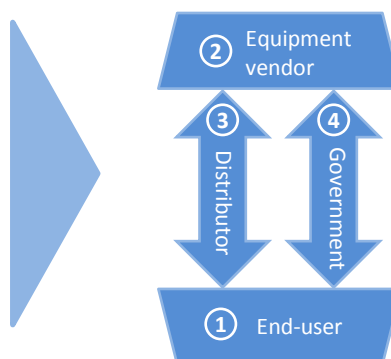
Quality

Cost

Building the installed base through industry collaboration

The model on the right illustrates the four key agents of change needed to expand the installed base for 3D printing equipment:

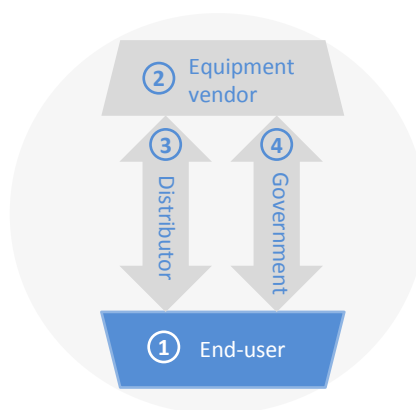
1. **End-user adoption** creates demand that forms the base
2. **Equipment players** require stronger go-to-market strategies
3. **Equipment distributors** must enhance interaction between end users and upstream players
4. **Government actors** will help create a conducive environment



1 What holds back end users?

We took the perspective of upstream players, end users and outsiders to establish which factors had the greatest effect on end-user adoption and arrived at the following three areas:

1. **3D printing equipment and materials are costly and the quality and variety of material is scarce.** This is especially true in the case of industrial grade printers where prices range from 100,000 yuan to tens of millions. These machines are classed capital expenditure and firms need to know exactly how to extract value and get a return on their investment before making a purchase. The fact that materials for 3D printing often cost more than traditional materials is another limiting factor.
2. **Insufficient application knowledge and experience.** 3D printing can be used across a broad range of applications. However, when end users are unfamiliar with the technology, they will not understand the interaction process between the technology and its industry. 3D printing equipment manufacturers are also more focused on developing the technical capabilities of products and not how the product can be developed to enhance how it can be applied within targeted industry segments. Furthermore, equipment distributors are under pressure to drive sales while lacking sufficient resources to effectively educate end users and familiarise them with the technology and its potential benefits.
3. **Inadequate related technical experience.** End-users require a certain technical background to make the most of the technology. For example, in product development, designers factor in the benefits of using 3D printing to their designs and then convert their designs to the format required by the 3D printing equipment. With no prior background in related fields, end users will face skills barriers to adopting the technology.



3D printing equipment suppliers are not experts in end-user industries. Application to end-user industries should be the focus for equipment development. End users face fierce competition, hence they adopt a conservative approach and do not invest enough into studying how 3D printing can be applied.

— Jack Wu, GM, EOS China

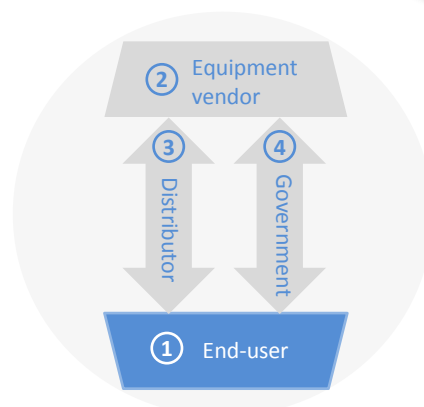


Industrial 3D printing requires end users to have knowledge of CAD software, and this has a direct impact on the outcome. More crucially, a key question that needs answering is: “How can someone from an irrelevant field be able to build models?” When it comes to actual operations, we even find a gap even between us and those with related experience.

— Caiyue Liu, Marketing Manager, Trustworthy Technology

1 Internal and external factors drive end-user adoption

The more widespread the use of 3D printing becomes, the more attention the technology will receive. A growing number of businesses are already incorporating 3D printing into their product conceptualisation process, especially to meet the demand for high mix, low volume products. But what drives end-user adoption of the technology? Motivating factors are predominantly internal, as such initiatives take about a month to take effect whereas it takes much longer for external influences to gain influence.



Industrial 3D printing end users

1. **Learning from within** — local subsidiaries learn from their counterparts in mature markets where 3D printing has been deployed successfully.
2. **Problem resolution** — 3D printing has a higher chance of adoption when it solves a problem that traditional manufacturing technologies cannot adequately resolve.
3. **Peer-to-peer communication** — domestic industries that have not been exposed to 3D printing may be influenced by media or leading enterprises in other industries to proactively seek out the technology.
4. **Upstream marketing** — 3D printing manufacturers and other upstream players penetrate the market by reaching out to end users through media, conferences and on-site demonstrations.



Non-industrial 3D printing end users

1. **Useful innovation tool** — 3D printing technologies enhance rapid prototyping for design teams who will adopt it enthusiastically as a result.
2. **Design tool** — 3D printing gains traction with creative companies, who become aware of the technology by observing competitors, media presentations and when they realise it can enhance their design capabilities.
3. **Government advocacy** — the government can increase supply-side interest in, and exposure to 3D printing by funding printing equipment and supplies to schools. On the demand side, the government can offer subsidies or grants to organisations that adopt 3D printing.
4. **Marketing by upstream players** — marketing campaigns and lower prices from distributors and manufacturers will make 3D printing more attractive for the general public.



Despite high material and equipment costs, the competitive advantages derived from more efficient production and better design brought about by 3D printing are the main motivators of industrial end users
— Weidong Shen, Technology department manager, Shanghai Volkswagen



The uniqueness of the final product is what attracts the public to 3D printing. Therefore the designer's input is just as important as the printing mechanism. The creative process is essential and irreplaceable.
— Leirah Wang, Marketing Director Xuberance

Potential short-term resolution of unmet needs

1. **Extent of usage is highly constrained**
3D printing operating capabilities are severely constrained for end users who lack related background knowledge. Training and practice sessions are too short for one to confidently adopt the technology. Upstream players should therefore focus more on providing education support as part of their sales strategy.
2. **Few case studies of successful 3D printing adoption**
Learning how to use 3D printing technology is a necessary but insufficient condition for adopting the technology.

Upstream players such as equipment manufacturers and distributors should engage more with end users through examples of how 3D printing has been successfully applied to related industries and provide guidance on cost and benefit analysis.

3. **Lengthy turnaround time for replacing spare parts**
This problem is mainly faced by industrial 3D printing users as most equipment is imported. Due to the China's limited market size, distributors and manufacturers of foreign brand equipment do not carry much parts inventory. This results in production delays which, if unresolved, may deter end-user adoption.

1 Unmet end user needs tend to be longer term

Globally, 3D printing technology is improving in areas such as precision levels, stability, material compositions and colours. However, these improvements have yet to filter through to China where the options for end users remain relatively limited.

- 1. Precision levels** — current precision levels for non-industrial 3D printing equipment are 0.15mm to 0.4mm, which is suitable for basic products. For industrial non-metallic printing, SLA and Polyjet technologies are most precise at 0.016mm to 0.1mm.

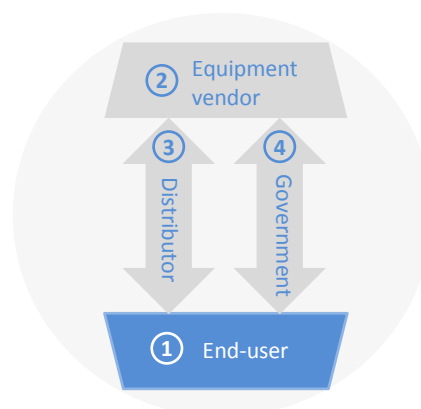


Current precision levels for non-industrial printers are rather low compared to end-user expectations. They are often disappointed after understanding the precision constraints.
— Anthony Huang, Sales Director (China) XYZ Printing

- 2. Material sophistication and variety** — this is less of a problem for non-industrial printers as they can deal with materials such as plastics (ABS, PC, PPSF, PLA, Nylon, wax, etc), composites, edible materials and more. Non-metallic industrial printers can use photosensitive resin, and polymer powder (nylon, synthetic rubber, ceramic powder etc). Despite recent advancements in material development, 3D printing is more limited than traditional manufacturing.



3D printing is an impressive concept, but its practicality is a different matter. With the limited current materials available, the technology's practical use is inhibited. There is much room for improvement with respect to materials.
— Biao Tang, CEO, Lepripter



- 3. Colour variety** — only Polyjet technology has the ability to print multi-colour, while FDM technology can use up to three colours by increasing the nozzle count. All other technologies are limited to monochrome.



Industrial 3D printers are generally monochromatic, requiring post process dyeing. The current practice is to either use SLA technology to print then manually dye after, or produce full-coloured plaster models with computer rendering.
— Feiying Chen, Marketing Manager, Union 3D Technology

- 4. Product size limitations** — product dimensions for non-industrial 3D printers are usually 20cm x 20cm x 20cm; 100cm x 80cm x 50cm for industrial non-metallic printers; and 63cm x 40cm x 50cm for metallic ones (excluding machines using powder material). There are extreme cases where very large printers have been custom-made for a high cost. Industry frequently calls for more affordable 3D printers with the capacity to produce larger products.

- 5. Fused Deposition Modelling (FDM) operating time limitations** — FDM printers frequently suffer from materials blockages after 10 hours of continuous use. End-users normally are not able to clear blockages and have to rely on material, equipment or service providers for support. This takes time, not to mention the additional time and cost to re-print the entire product.



1 Unmet end user needs tend to be longer term (continued)

6. Immature supporting industries — 3D printing designs are limited due to the lack of robust supporting industries. Occasionally the technology requires specific supporting structures to assist in finishing the job, especially within the creative sector. Therefore designers must consider the limitations of 3D printing, limitations which they may not find acceptable and create a barrier to adoption as a result.



Even though we are familiar with the equipment and how to design for 3D, we usually have to compromise our designs because of the immature supporting structures.

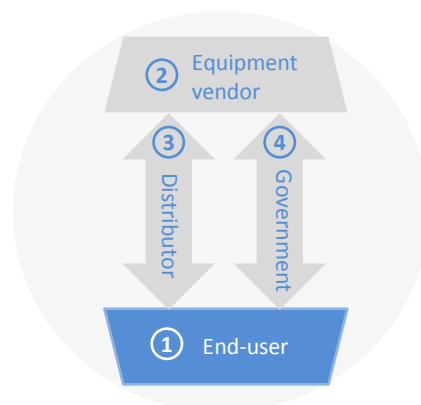
— Leirah Wang, Marketing Director
Xuberance

7. Deformation due to materials — over time, non-metallic 3D printed products will encounter deformation as material compositions may not be as stable as expected. Metallic 3D printed products are more stable, however, the materials used are denser and hence much heavier compared to non-metallic products.



Due to the nature of 3D printing materials, deformation frequently happens after a few days. However, we need it to last at least a year. Apart from better durability, better temperature tolerance and non-deformation are essential.

— Weidong Shen, Technology Development
Department Manager, Shanghai Volkswagen



3. Small talent pool — customers have limited knowledge of 3D printing. They tend to believe the technology can deliver products of a level of sophistication far beyond its current capabilities. The mass media’s exaggeration of the futuristic potential of 3D printing means many customers overestimate what the technology can do. Industry players should therefore listen more to customers and correct their misconceptions.



Some customers think 3D printing is useless, while others believe it is capable of producing everything. Both results are caused by inaccurate mass media reporting. In fact, 3D printing is no more than a new technology for products with complex structures and needs to be treated and used rationally.

— Jane Chen, General Manager,
Arcam AB China



2 Review upstream go-to-market strategies

Development of local companies in China

Some colleges and universities in China began researching 3D printing not long after the technology was conceived. About 10 years down the line, a few university researchers formed the first batch of local 3D printing equipment companies. Progress since then has been slow due to limited market participants. Government support and media promotion helped make 3D printing popular in 2012, since when the domestic market has enjoyed sustained interest and growth. However, despite more industries picking up on the technology and a greater number of 3D printing start-ups entering the market, the scale of the industry still significantly lags that in more developed countries.

Most Chinese 3D equipment manufacturers are producers of FDM desktop 3D printers, which is not industrial grade equipment. In fact less than 10 local firms are producing metallic 3D printers. Along with the low installation base, low market participation is a key limiting factor. Furthermore, the lack of core technological capacity within local 3D printing equipment manufacturers creates further limitations.

Development of foreign companies in China

Foreign companies own and have developed most key 3D printing technologies on a global basis. It is only natural they will try to penetrate China, the world's largest domestic market. However, weak protection of intellectual property along with investment risks mean most foreign firms prefer to use local distributors to market their products within China. Currently, all foreign-branded 3D printing equipment sold in China is imported.

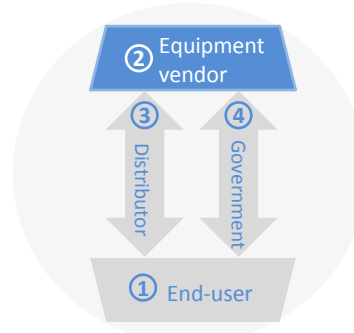
Indirect selling is the main strategy for market penetration

Most 3D printing equipment manufacturers, be they foreign or domestic, use distributors for their key sales channels in China, because:

1. Current demand is relatively low compared to foreign markets and it is spread amongst many different end user industries. As a result, setting up a dedicated sales force would require significant operating expenditure. Firms either view this as too risky or prefer to invest in R&D.
2. 3D printing equipment manufacturers are currently more focused on the technical development of their products than reaching out to the market.
3. Manufacturers avoid cashflow problems as distributors are responsible for collecting on sales.
4. Local distributors help circumvent problems arising from language or cultural differences.



Indirect selling is a preferred choice as it carries lower risk and has wider sales coverage. Western firms require visible returns before they invest more into setting up a permanent presence
– Wei Guo, Manager, Creaform China



Distributor selection considerations

1. **Distributor's technical and industry experience** — foreign manufacturers prefer issuing distribution licenses to local equipment manufacturers or local downstream industry players, as distributors with relevant technical backgrounds maintain a good level of service support.



When executing a distributor selection, we emphasise a lot on the relevance of the distributor's technical and industry background or to our industry value chain. This will enable us to be more relevant to customers, making market penetration easier.
– Jack Wu, GM, EOS China

2. **Distributor's market coverage and size** — distributor size, measured by revenue or headcount, is an indicator of distribution capability while market coverage, in geography or industry, has to be aligned with the manufacturer's market penetration strategy

1. **Manufacturer-distributor compatibility** — both manufacturers and distributors need a solid working relationship which is fully collaborative. It is therefore important to find a distributor that is not only capable but also fits with the manufacturer's organisation in terms of values and communication.

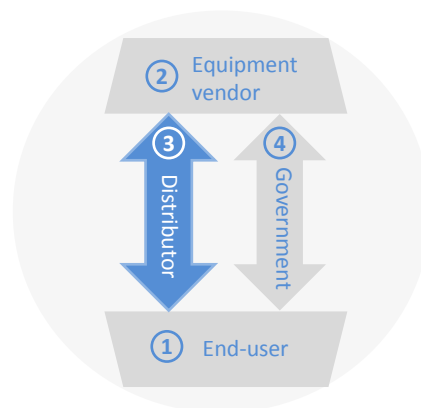
Non-industrial printer manufacturers are moving their distribution online to leverage the booming e-commerce market in China.



We leverage distributors' resources in each industry to approach end users. Therefore a good collaborative relationship with distributors is essential. Distributor selection criteria cover many areas including business size, sales capability and technical capability.
– Joseph Guo, Marketing Manager, Tiertime

Bridging the knowledge gap by communicating effectively

This study highlights the unmet needs of current end users and barriers preventing potential end users from adopting 3D printing in China. A key finding is the need for upstream players to proactively educate end users on how to best use the technology as a tool for building competitive advantage within their respective industries. For various reasons, foreign and local upstream players have also chosen to take a more indirect approach to reaching out to the end users. Therein lies a contradiction where end user education and service support demands are high yet 3D printing equipment players, being more research oriented, lack sufficient service capabilities to effectively interact with end users. This creates a knowledge gap, resulting in end users forming misconceptions of the capability of 3D printing technology, or how it should be integrated into their own operations. Accordingly, to avoid mismanaged expectations and disappointments, the Chinese government and local distributors will have an important role to play in bridging this gap.



3 Use distributors to enhance communication

Distributors must go beyond their role as sales organisations to become knowledge brokers between their principals and end customers.

Distributors can strengthen communication with upstream players by:

- 1. Understanding the customer** — distributors should do their homework and build the necessary knowledge in end-user industries. Relevant topics include the end user's R&D process, production methods and processes, as well as current challenges they face. Through exchanges, they can develop target 3D printing solutions for end users.
- 2. Collaborating on case studies** — currently end users receive training at the product level, with little involvement from distributors on how 3D printing technology can be used throughout the production process. Case studies provide a useful way to illustrate the benefits of adopting 3D printing technology.

From the end user perspective, social media can be used to illustrate innovative ways in which 3D printing can be used. Technology bloggers should be invited to review the latest advances in desktop 3D printing.

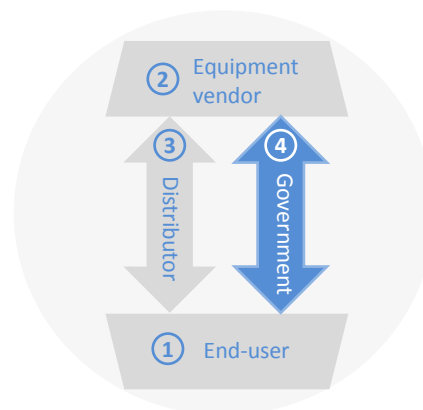
- 3. Establish stronger lines of communication between end users and equipment manufacturers** — Distributors function as mediators between the two parties, enabling end users to provide feedback their concerns and problems with the equipment, software and materials, while equipment manufacturers can provide prompt, precise answers. This increases end-user confidence and allows equipment manufacturers to understand the market's requirements better.

Distributors can strengthen communication with end users by:

- 1. Devising training curricula** — distributors can devise a training curriculum to train key end user stakeholders. Topics should range from operating equipment to the broader potential of 3D printing, encouraging them to brainstorm on how to use the technology to become more competitive.
- 2. Communicate regularly** — distributors must be close to the end users and listen to their needs, concerns and ideas on how to integrate the technology into their operations. This requires regular interaction.
- 3. Encouraging inter-customer communication** — due to the lack of successful examples and relevant experience, distributors provide a platform through which industry players can share their experiences and aid knowledge creation within the sector.
- 4. Consider using lease-to-own models** — given the current high cost of 3D printing equipment (especially for industrial grade), distributors should consider leasing 3D printing machines. With a lower upfront cost, end users will be more willing to experiment with the technology.

4 Government should create a conducive environment for 3D printing to thrive

1. **Understanding the commercial value of 3D printing** —China’s government is providing subsidies for 3D printing, indicating support for the sector, however, a deeper appreciation of what the technology can do will help make subsidy allocation more efficient. The state can also learn from successes in the west.
2. **Provide a platform to develop technical competence** —the government can help build innovative cultures in the public and private sectors by attracting talent, funding research programmes and promoting experimentation.
3. **Improve the regulatory environment** — reducing the approval process for 3D printed medical implants is a key example. Europe and the US have had necessary regulations in place since 2010, but China has yet to implement a similar framework.



Conclusion — 3D printing: neither magic bullet nor buzzword

China’s 3D printing industry is certainly a market to watch, with double-digit growth expected for the next five years and optimism the industry’s value will top 9 billion yuan in 2018. From a macro perspective, the country’s expanding middle class and tech-savvy end users combined with its powerful manufacturing sector means there is clear potential for the industry to grow. However, China’s nascent 3D printing market is not without its fair share of challenges, some of which, if allowed to persist, could cause severe problems for current stakeholders as well as limiting the technology’s development. The local 3D printing market is both relatively immature and lacks a substantial installed base. A thorough review of the technology, its pros and cons, application areas and industry participants, brings major issues to light. Poor domestic technical competency, inappropriate allocation of resources and a contradictory industry structure prevent the free flow of knowledge between upstream players and end users. While both parties have shown great interest in the technology, their interaction has been less than fruitful.

Ipsos Business Consulting has identified four key stakeholders who all play crucial, potentially catalytic roles in accelerating growth across the industry:

1. 3D printing equipment producers,
2. end users,
3. distributors, and
4. relevant government departments.

Both distributors and the Chinese government will be pivotal change agents tasked with bridging the knowledge gap between upstream firms and end users.

Careful planning, collaborative partnerships and productive relationships are required to successfully navigate the domestic 3D printing market and realize, as a foreign company respondent aptly stated, “the potential goldmine of opportunity”.

Partner acknowledgement

Ipsos Business Consulting jointly initiated this study with the following partners:



Participants acknowledgement

Ipsos Business Consulting expresses our sincere appreciation to the following companies and organisations, for their valued discussions, input and insights throughout the course of this study (in alphabetical order):



3D Hubs



Renishaw (Shanghai) Trading Company



Arcam AB (Beijing)



Shanghai Industrial Technology Institute



Aurora Group



Shanghai Union 3D Technology



Autodesk (China)



Shanghai University
Rapid Manufacture Engineering Center



Beijing Tiertime Technology



Shanghai Volkswagen



Bright Laser Technologies



Shining 3D Technology



China Aerospace Science and
Technology Corporation (Shanghai)



Sunshine Laser & Electronics Technology



Creaform China



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EOS China



Trustworthy (Beijing) Technology



Leprinter 3D Printing



Tsinghua University
Laser Rapid Modeling Center



Materialise (China)



Xery 3D Printing Technology



Peking University Third Hospital



Xuberance



Polymakr (Suzhou)



XYZ Printing

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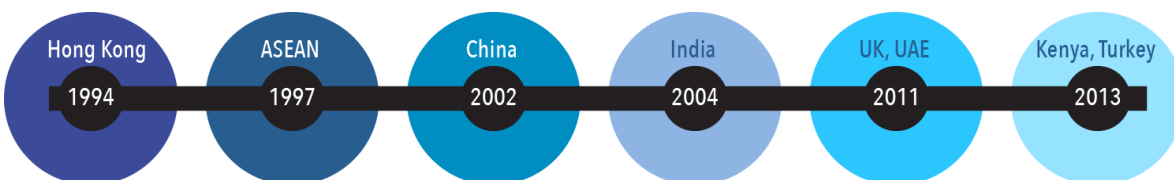
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Since 1917, VNU Exhibitions Europe, affiliated to Royal Dutch Jaarbeurs has started to organize trade fairs in Europe, dating back to almost one century. It is one of the exhibition organizers with the longest history and the largest scale. The history to organize trade fairs in China of VNU Exhibition Asia can be traced back to 1993, when China's exhibition industry started to take off. It was one of the earliest joint venture exhibition companies in the country.

Currently the company has offices in Shanghai, Beijing and Guangzhou, hosting more than 20 exhibitions and conferences each year with the biggest exhibition of 200,000sqm. The company is a member of Union of International Fairs (UFI), and "Level A Qualification Unit" of Shanghai Conference and Exhibition Association.

About Rapid News Communications Group



Rapid News Communications Group is a leading international B2B and B2C communications company that serves communities in design, engineering, manufacturing and sales across diverse industries. For over 21 years TCT Magazine + Personalize has been the de facto source of information and intelligence for 3D printing, additive manufacturing and product development technologies across the end user, enterprise and industrial sectors. TCT Show + Personalize is the UK's definitive and leading Additive Manufacturing, 3D printing and product development technology show for every level of interest from hackerspace to aerospace.

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