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REVIEW ARTICLE

OPPORTUNITIES AND CHALLENGES OF 3D PRINTING TECHNOLOGY - AN INDIAN PERSPECTIVE

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ABSTRACT

The 3D printing industry can be seen as a growing industry with developments being made at every stage. No wonder newer technologies are emerging. But there is requirement of new 3D printers that can be used for multiple platforms with multiple filaments. 3D printing has been evolving as a technique to create 3D models and prototypes, in many industries, namely, automotive, aerospace, healthcare, and consumer products- in order to investigate the possibility of completing a project in lesser time and with few resources. It was 2010-11, when the term 3D printing was just beginning to enter the public mindset. More companies were realising the potential of 3D printing, also known as additive manufacturing or rapid prototyping. However, in the last two decades, 3D printing has made a radical shift from rapid prototyping to rapid manufacturing mainly, because of its advantages over traditional manufacturing practices such as injection molding, CNC machining, and vacuum casting. The major driving factors which makes the Indian firms that support the exponential growth of 3D printing include - the development of new and improved technologies, financial support from governments, large application areas, rapid product development at a low cost, and ease in development of custom products. Since India shows a positive signal towards 3D printing which provide tremendous growth opportunities especially in manufacturing technologies. India is aggressively taking initiatives such as huge investment and government funding in R&D, to promote 3D printing as a manufacturing technique across all the sectors. 3D Printing was initially a solution looking for a problem. With any world changing technology, it only matters once it actually does change the world.

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INTRODUCTION

3D printing technology has seen a fast paced growth in all corners of the globe since its advent. With its massive potential for application in endless areas, 3D printing has become a topic that has caught the attention of technology enthusiasts, manufacturers and mainstream media with a sense of wonder. In the past year, the 3D printing industry has seen a spurt of low-cost printers entering the market due to the expiration of certain technological patents which helped in popularizing 3D printing further. Globally, 3D printing is already a $6-billion market and is expected to cross $8.43 billion by 2020, which is not too far ahead. It may be a good time for India to seriously think of a 'Print in India' campaign.

Presently all Indian firms going to revolutionize manufacturing and those have an ability to tailor properties and achieve property combinations that would have been previously impossible to create. Hopefully firms will be a new way of manufacturing with a lot more possibilities and less cost, time and real estate needed to manufacture things.

The power of 3D printing in the ideation and design of new products across all industries is really where the revolution is taking place and will continue to thrive. Imagine bringing ideas to life throughout the development process from the spark of an idea, to the final scoping stages – so that everyone involved can see, touch and use a product concept. Now 3D printing goes on mobile across globally designs fabricated without even being physically close to a printer. Engineers do not have to be near the 3D printer any more. They can prepare the code on their app even when they are travelling and give a print command to their 3D printer kept in their lab or at office. The only requirement is that the mobile phone running the app should be connected to the printer and the printer should be, in turn, connected to Wi-Fi.

There being a wide array of commercial scientific and personal uses for the technology revolving around it, 3D printing is one that needs to be comprehended in the best way possible. Lately,

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India has seen many advances in the 3D printing sector, with the rise of many companies building healthy competition in the market.

Wide range of applications, increasing usage in orthopaedic/prosthetic goods, and expiration of key technology patents have been identified as key driving factors in the market. Low degree of awareness, high capital cost, and complexity of use in manufacturing large size models are some of the restraining factors in the market.

Usually, the printers are not something you can assemble at home, but with 3D printers this is not the case. Besides buying a low-cost 3D printer you also have the option to assemble your own 3D printer. There are many online global communities like RepRap that offer the do-it-yourself kits for assembling your own 3D printer.

Presently, India 3D printer market is at nascent stage but holds tremendous potential for the manufacturers, local assemblers and distributors due to increasing use of rapid prototyping and 3D modeling across various industry sectors. Adding to the above factors, the location of research and development bases of various industrial and engineering companies fuels the existing growth of 3D printer market in India. Opportunities for 3D printing have been identified in organ replacement, furniture modelling, educational models, fashion & apparels, animation and gaming, chocolate and drug printing. Latest trends in the market are assembly of low cost 3D printers, joint replacement, customized footwear designs, and interior decoration.

3D printer market offers tremendous potential in the commercial segment such as healthcare sector, architecture, educational, art & craft. Other niche applications include special purpose applications, use in organ replacement, extent of customization, animation & gaming fashion & apparels customized footwear designs, interior decoration, furniture modeling, educational models, chocolate and drug printing.

Major Indian players

There are many companies that have established their base in 3D printing industry such as Stratsys and MakerBot. These companies have established partnership with many Indian companies in order to increase their customer base. Major players active in India 3D printing market (including manufacturers and distributors) space are Altem Technologies, Imaginarium, Brahma 3, KCbots, and JGroup Robotics.

The above said players are re-imagining their existing supply chains by networking printers where logistics may be more about delivering digital design files from one continent to printer farms in another.

In the last 12 months, India has seen a transformation in the 3D printing industry with the emergence of local 3D printer manufacturers. The country has a very vibrant 'maker' community, and many new entrants and hobbyists are developing 3D printer variations based on the open source RepRap initiative.

All the Indian players believes that 3D printing could have huge potential in India as remote printing of products becomes reality and also helps in recycling of household plastic waste for feeding the printers.

CaddCentre offers a great range of 3D printers for both personal and enterprise use. They offer a series of printers in the range that are catered towards professional use to manufacture real parts. Z Corporation also offers its own line of 3D printers in India, using CaddCentre as a distributor in India.

Ikix is a Chennai based company that produces 3D prints for clients based on their designs. Their services are heavily focused towards the architecture and real estate industry, as they specialize in making models that real estate agents can show to clients which have a realistic and accurate level of detail. Ikix claims that its 3D models allow for easy customer visualization. They also offers something called "Building in A Box", which means marketing models can be packed as components into a box for portability and be assembled on the spot for client meetings. One reason why Indian entrepreneurs have not taken more rapidly to 3D printing is the high cost of 3D printers. But those costs are falling sharply. Gartner, a technology research firm, predicts that "enterprise class" 3D printers, which are meant for industrial use, could cost only as much as high-end PCs by 2016.

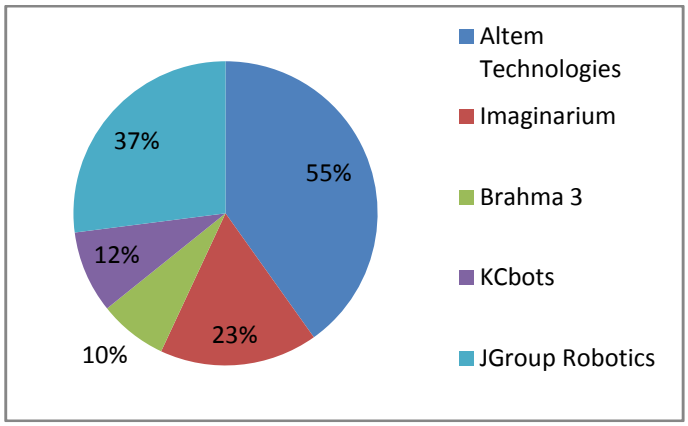
Indian companies have already spotted opportunities in 3D printer manufacturing. Wipro has set up one by transforming its conventional hydraulics business and its early customers include Hindustan Aeronautics and a two-wheeler manufacturer, both of whom want printers to make components using the 3D route. Globally, 3D printing is already a $6-billion market and is expected to cross $8.43 billion by 2020, which is not too far ahead. It may be a good time for India to seriously think of a 'Print In India' campaign.

By 2017, Indian companies across the industry have jumped headfirst into the 3-D printing business. Market leaders like HP, Mazak and even Autodesk are producing new brand name printing technologies while traditional businesses from UPS to Staples have positioned themselves to become the first viable 3-D printing service chains in the world.

The applications of 3D printing have been identified in the field of electronics, automotive, medical, architectural, aerospace, educational, industrial, and others. The predominantly used technologies in the market are selective laser sintering, stereo lithography, fused deposition modelling, and polyjet. As of 2013, electronics application leads the market (volume share of 24.1%) followed by automotive (21.2%), medical (15%), industrial (13.8%), aerospace (10.8%), architectural (5.2%), and educational (3.0%). India 3D printer market revenue is projected to reach $46 million by the year 2019.

All Indian traditional OEM king lending its clout, infrastructure and expertise to the 3-D printing world to make the technology more viable than ever before because of latest innovations and enhancements of 3D printing.

Current usage of 3d printing by indian firms



From the above graph, Altem technologies is basically an Indian distributor for Stratasys 3D printers only 55 percent of respondents currently using the technology, but a significant number of businesses and processes within the firm are evaluating and fine-tuning the process.

Imaginarium claims to be the largest Rapid Prototyping and Rapid Manufacturing Center in India with 23% of the respondents has more than 30 years of experience in Rapid Prototyping and it uses this experience to deliver complete solution to the needs of the customers.

Brahma 3 is a startup company which is all set to explore the potential of 3D printing with the help of powerful hardware and very creative members on board. With 10 percent are evaluating this technology without any solid plans. The major buyers include dentists, fashion designers and shoemakers. A high-end 3D printer finds great use in architecture, construction, industrial design, aerospace, military, civil engineering, biotech (human tissue replacement), geographic information systems, education and many other fields.

Also in India 3D printers market, which is considered as a commercial segment leads where majority of the demand for these printers are emerging from commercial segment including healthcare sector, architecture, educational, art and craft, and other 3D printing service provider companies. Private usage of 3D printers in India is yet to gain considerable adoption due to lack of awareness and their expensive characters. On the other hand, in industrial application these are used in the areas of automotive, aerospace, construction, and others. These industries majorly utilize 3D printers for prototype generation, creation of complex shapes and geometries, and customized designs.

Indian industries focus towards 3d technology

3D printing has become quite popular in India with both hobbyists and large corporates realizing the value that it brings. There has been a surge in 3D printing startups in India who are focusing on either low cost 3D printers or their own innovations.

Amazing opportunities comes along with prototyping technologies, three-dimensional (3D) printing gaining momentum across various industries from printing a mobile phone cover to reconstructing human organs. Emerging as a technology of choice for a wide range of applications 3D printing is expected to increase its market share rapidly to about 40 percent by 2016. 3D printing long ago moved from being theoretical to a reality, and in recent years 3D printers have become cheaper to produce; several models are now available for sale, as well as designs for products. It is predicted that 3D printers will be common in homes in coming years. Our news and feature articles cover the science and technology behind 3D printers, from how they work to the history, progress and future of the technology and what kinds of things can be made.

Most of the industries follow the traditional method of manufacturing (for example: CNC Machines) and the price of 3D printers is almost equivalent to the price of any other conventional machine. This brings in an air of reluctance among the manufacturers for adapting 3D printing into their manufacturing process. The main focus of the Indian market is low-priced 3D printers. Even though the consumers are apprehensive about quality, the main concern of the market is to ensure that the low-priced 3D printers meet the customers' requirement.

Today 3D printing is used to make components for aircraft and automobiles, medical prosthesis and also human organs. Even in India, automakers have begun using it to make entire dashboards, tail-lamp covers and other parts; Indian orthopedists and dentists are using it to get accurate models of their patients' bone structure to better diagnose their problems; GE has set up 3D printing machines in India that will create components for jets, engines and turbines; and Indian jewellery makers such as Tanishq are adopting it because of the customisable aspect of 3D printing. Through 3D printing people can print custom jewelry, household goods, toys, and tools to whatever size, shape, or color they want. They will also be able to print make replacement parts right at home, rather than ordering them and waiting for them to be shipped.

Indian market is sensitive towards prices of 3D printer technology. Most of the established industries follow conventional approach of modeling through CNC machines on the flipside large format 3D printers are expensive and cost almost same as that of conventional machines, which raises reluctance among industrial consumers to opt for 3D printing. 3D printing market is still on evolving stage and yet to witness major transformation such as compatibility for mass production, easier designs capabilities, and manufacturing of large format objects.

Research Findings (As per 2015 statistics)

Firms include healthcare, aerospace, medical, education, manufacturing, pharmaceuticals, aeronautics, military, aircraft etc.

- 62% of the Indian firms are adopting 3DP in some way by developing prototyping or by producing final products.
- 32% of the companies plan to adopt 3DP in future (10% within next year, 13% within 3 years, 9% some time beyond 3 years)

- Less than 5% of companies do not plan to adopt 3DP ever.
- 60% of the Indian manufacturing will used this technology for after-market parts

It is also predicted from this study by 2020, Indian industries to be dominated by consumer products, automotive, medical and aerospace. These industries would perform billions of global business through 3D printing technologies. It was found that existing simple make-to-stock to complex, engineer-to-order production strategies in aerospace, defense, discrete and industrial production, 3D printing technologies are redefining the manufacturing value chain. Many Indian angel investors, venture capitalists are shown real interest in investing especially on 3D printing technologies since it tends and projects a larger return on investments for incoming years.

Key recommendations for Indian industries on 3D printing

- Firms need to maintain a strong mass-manufacturing base, but move up the value chain to high-margin, skilled-labor products in biotech, new materials, IT and specialized, high-end manufacturing;
- Grow the research and development (R&D) base and invest in universities by having much industry-institute interaction
- India's huge domestic market of consumers is becoming more sophisticated in its tastes. This increasingly affluent consumer base will demand novel and custom products that require advanced engineering and manufacturing capabilities.
- Indian government should take initiative to develop biotechnology and medical-device industries and expand high-end equipment manufacturing, in particular for aerospace and telecommunications equipment
- Government should reduce growing income disparities between low-wage, unskilled workers and growing middle- and upper-classes.
- Indian mass manufacturers use centrally controlled, or what some describe as "monolithic supply chains," to produce commodity products.

Future directions of 3D printing in India

Based on the study report I deliberately say a bright future for this sector in India as awareness increases and as the technology becomes more affordable. The current growth in this sector is 35% every year for large scale B2B 3D printing companies while the growth rate for startups working in the low cost sector is about 50%. The 3-D printer market is transforming rapidly. 3D printing will not emerge overnight. It will slowly improve and creep into the mainstream. Robust innovation at established vendors and among entrepreneurs and hobbyists is providing a test ground for filling the market with more midrange systems that bring enterprise-class capabilities at much lower prices. 3D printing has a bright future, not least in rapid prototyping (where its impact is already highly significant), but also in the manufacture of many kinds of plastic and metal objects, in medicine, in the arts, and in outer space. Today's market for 3-D printers and services is still largely bifurcated—at the low end are limited-function offerings of interest to hobbyists. At the high end are expensive printers that have a limited total available market. The key for market growth is the continuing development of printers in the middle price range to achieve advances in performance, in multi-material capability, and in printing complete systems. 3D printers have many promising areas of potential future application. NASA has already tested a 3D printer on the International Space Station, and recently announced its requirement for a high resolution 3D printer to produce spacecraft parts during deep space missions.

Another possible future application is in the use of 3D printers to create replacement organs for the human body. This is known as bio printing, and is an area of rapid development. This technology uses inkjet-style printers to make living tissue. This process allows 100 percent of the cells to live instead of the 50 to 80 percent that normally survive during the current process. All of this naturally raises questions about the development of complex organs, so bio-printing is destined to turn into a big debate due to moral, ethical, and political concerns. The printing of live tissue and cells may see the possibility of 3D printing replacement organs to order in the future, which will obviously have huge implications for transplants. A 3D printed jaw has already been successfully implanted into a patient during facial reconstruction surgery, complete with the complex hollow bone structures necessary to allow blood flow.

Conclusion

Given the huge opportunities that exist in the market and the rapid consolidation that is taking place, it is certain that 3D printing will be adopted a lot more across industries. Added to this is the fact that startups and entrepreneurs in India are seeing immense potential and benefits in 3D printing technologies. India boasts millions of new university graduates, a large consumer population and well-funded academic research. The result will be a tremendous amount of intellectual horsepower that will rapidly enrich the nation's scientific and industrial knowledge-base. Today 3D printing tucked away in garages, hacker spaces and labs to keep a vigilant eye as they grow. Thousands of Indian new companies and industries will bloom in the wake of widespread 3D printing, they may not exist when the large companies start calling for increased protections. The basic outline of this revolution have not yet been filled in many ways, this is a gift. Setting the tools free in the world will produce unexpected outcomes and unforeseeable changes. As incumbent companies begin to small 3D printing as a threat, they will inevitably attempt to restrict it by expanding intellectual property protections. New materials and techniques are also enabling highly complex and innovative designs previously impossible to produce, and the technology enables designers a method of low volume production of highly bespoke items. The proliferation and mass adoption of the technology and its accompanying capabilities will invariably make it harder to protect a design from adaptation, copying and reproduction, both authorized and unauthorized.

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