How 3D Printing Adds Up: Emerging Materials, Processes, Applications, and Business Models

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ABSTRACT

Currently, 3D printing's largest applications are for making prototypes, molds, and tooling. Direct production of end use parts, however, is beginning to grow in industries including aerospace, medical, automotive, consumer products, architecture, and electronics. Leading 3D printer companies' razor/blade model could inhibit growth, but emerging third party material suppliers and equipment manufacturers with more open models are beginning to challenge their dominance as core patents gradually expire. In addition, emerging intuitive design tools point the way to more efficient part design. This report forecasts the future market size of 3D printing and finds that materials, printers, and parts will total $12 billion in 2025.

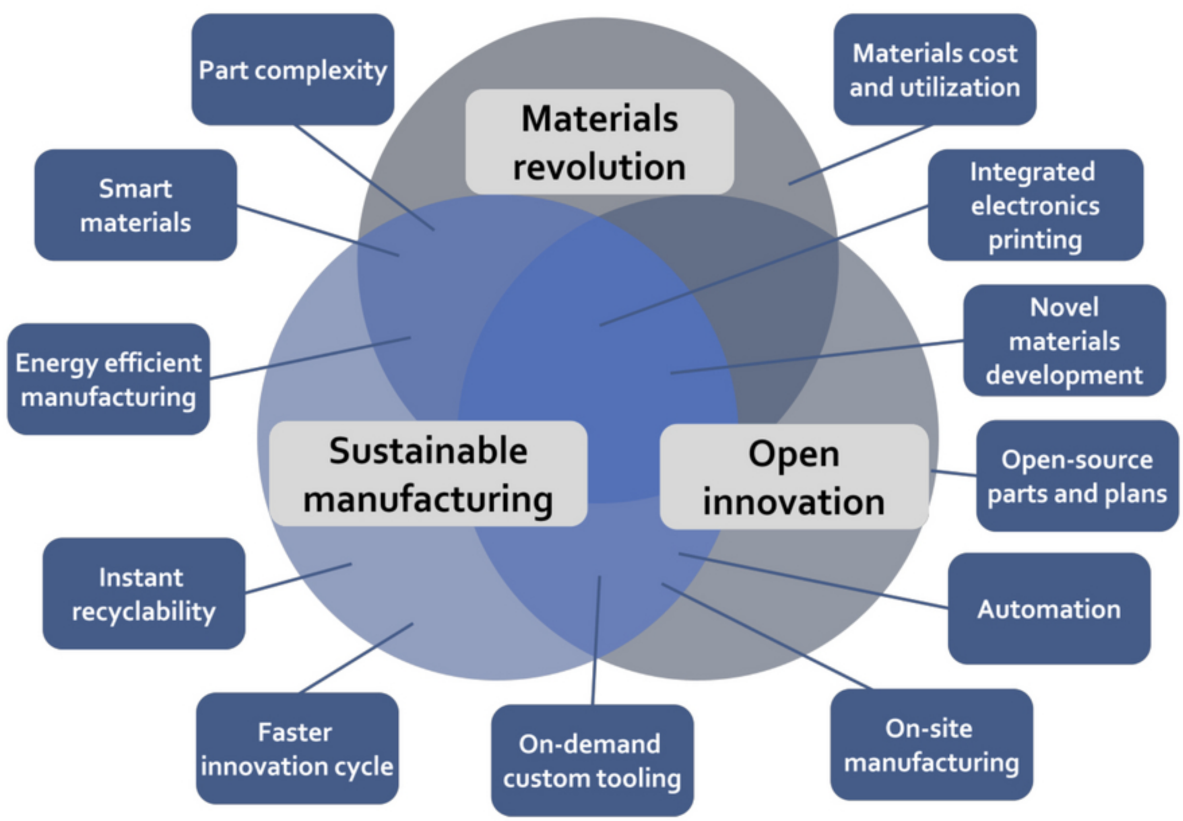
Keywords: 3D printing, additive manufacturing, market forecast

1 INTRODUCTION

3D printing – the additive fabrication of objects by depositing and patterning successive layers of material – has been touted as an enabling platform for applications ranging from lighter, more efficient aircraft and advanced prosthetics to homemade firearms and lab-grown organs. Among all the hype, the true impact of 3D printing is uncertain: Some believe the technology will eventually be more disruptive than the Internet and printing press combined, while others consider its impact to go little beyond hobbyists and artists with too much free time.

Today, there are a plethora of 3D printing technologies, which have enabled the on-demand production of physical objects of virtually any shape, directly from digital models. Rapid prototyping – making single, unique parts for testing of novel designs – rapid mold making, and rapid tooling remain the primary industrial application for the technology. Producing a traditional machined mold or other tooling for a single prototype can require tens of thousands of dollars and weeks to months of time, but 3D printing enables production of the same part, often overnight, for only the cost of materials. This accelerated production cycle means engineers and designers can test more ideas, and pursue more design iterations to ultimately develop superior parts.

In the next few years 3D printers will continue to decline in cost as resolution, materials selection, and mechanical properties improve. These advances will gradually shift 3D printing from a prototyping tool to a



production one.

However, in order for 3D printing to expand beyond the laboratory and become a viable production tool, a number of challenges need to be overcome, both technical, such as the performance and selection of printable materials, and the throughput of printing equipment), and commercial, including the basic structure of the industry value chain.

2 METHODOLOGY

We built a detailed model to assess the growth of the markets for 3D printable materials, 3D printers, and 3D printed parts through 2025. To support our analysis, we spoke with technology developers as well as potential users of 3D printing technology – including researchers, material companies, printer manufacturers, service bureaus, OEMs, artists, and consumers – to identify what factors affect adoption. These include materials cost and selection, performance characteristics such as resolution and throughput, printer and process costs, and regulatory issues. Our model incorporates industry-specific material and market requirements, historical adoption rates of new materials, and inputs from interviews with nearly 100 entities throughout the 3D printing value chain.

3 RESULTS

Overall, the market for 3D printed parts will grow from $2.2 billion in 2013 to $12.1 billion in 2025. The 2025 market will include $2.0 billion in material sales, $3.2 billion in printer sales, and $7.0 billion in added value from the use of those printers and materials to produce prototypes, molds, tooling, and end parts.

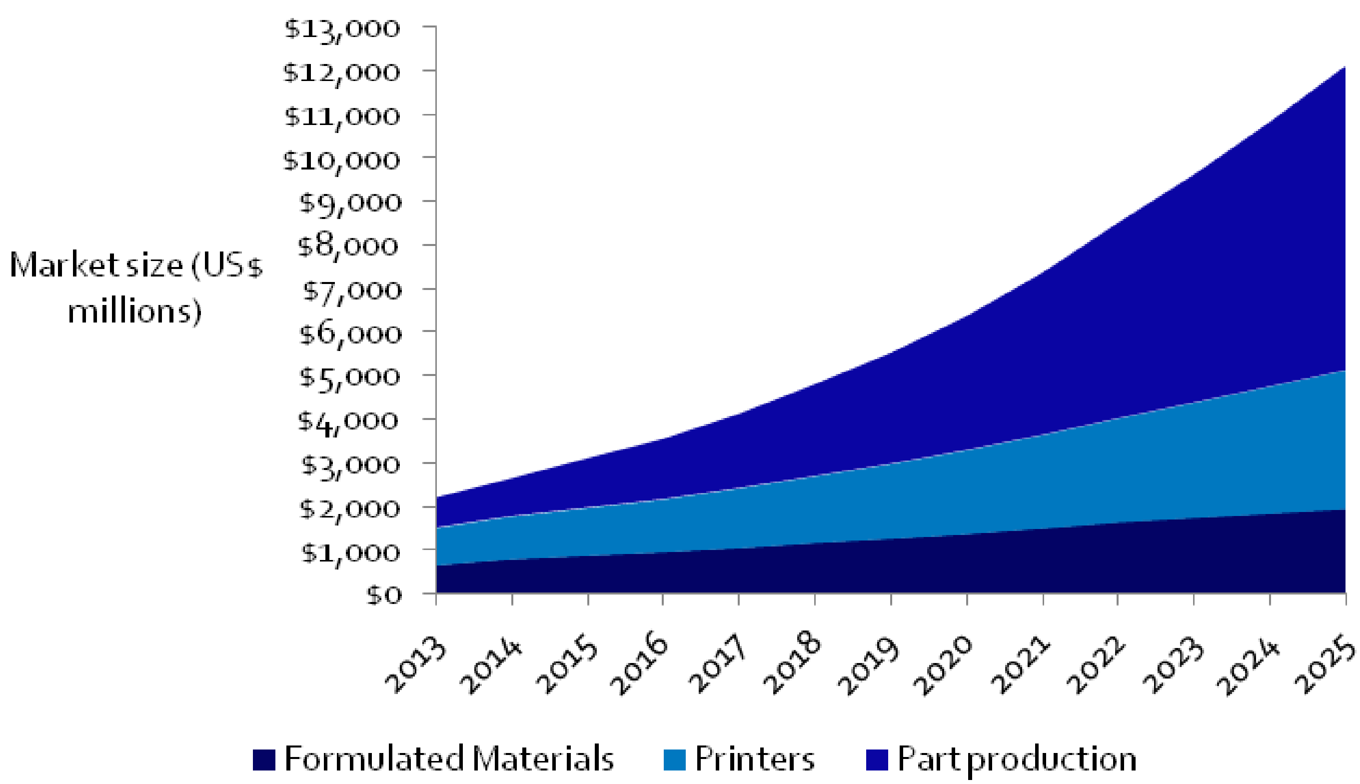
4 DISCUSSION

Today, leading printer companies – like 3D Systems, Stratasys, and EOS – were built around a closed, vertically integrated razor/blade model. Today they continue to capture outsized value from selling materials at high mark-ups to go along with equipment. Prices as high as $80/kg to $100/kg for nylon powder or ABS filament, or $120/kg for stainless steel powder, are common – a 10x to 100x markup. This strategy arose in part as a result of the nature of the prototyping market; the increased speed and reduced cost achieved by printing overshadowed the high materials prices, and the need for materials and software that worked reliably with a single piece of equipment outweighed the disadvantages of reliance on a single supplier.

However, printer companies focused on prototyping materials and applications will find their profit margins challenged by falling prices and rising competition, particularly from hundreds of suppliers of sub-$3,000 desktop printers with capabilities comparable to the $20,000 prototyping printers of just 5 to 10 years ago. Maintaining growth will require expansion into high-value, low-volume manufacturing applications in aerospace, medical, automotive, and consumer markets.

Yet as 3D printing expands into manufacturing , there is rising tension as end users demand a more open system with multiple available suppliers, to meet the specific needs of divergent applications. The razor/blade model is the central obstacle to an innovation ecosystem to encourage open collaboration among material, printer, and complementary technology developers.

Even the largest printer companies lack the same



bandwidth and materials expertise possessed by large chemical and material companies for material development, and as large industrial customers place bigger and bigger bets on 3D printing, they are going to demand security of supply, and thus demand availability and compatibility of third party materials. Consequently, moving forward greater revenue opportunity will flow upstream from printer companies to material suppliers.

Some printer companies, like Arcam, are just beginning adopt a more open model, sacrificing some materials revenue in order to expand their potential application scope. Others, such as Arburg, EnvisionTEC, and Syseng have announced printing methods that can accommodate conventional injection molding grade thermoplastic pellet feedstocks. If such methods produce sufficiently high quality parts, they could quickly upend the current materials supply model.

While increased competition will reduce the margins that make supplying what are otherwise commodity materials to this market so attractive, margins will remain high longer for developers, startups, and laboratories that provide printed materials with greater functionality. For example, Oak Ridge National Laboratory is loading thermoplastic filament with carbon nanofiber, startup File2Part is inkjet printing additives such asplasticizers and adhesion promoters during deposition between successive polymer layers, and startup LUXeXceL has developed variations on conventional photopolymer printing to produce optical-quality surfaces. NASA has even 3D printed prototype rocket components out of high performance alloys, and simple tools out of simulated lunar soil; it plans to launch a 3D printer in 2014 to produce tools for astronauts on demand, and is working on a food printer as well.

While not all of these emerging initiatives will pan out, and those that do will need years of additional research and development to reach commercial maturity, there will certainly be others we haven't even dreamed of yet.

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