Analysis

Production Printing & Media

June 2013

3D Printing

Technologies, Markets, and Opportunities

Service Areas

Wide Format Printing

Functional & Industrial Printing

Comments or Questions?

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Executive Summary

The rapid growth in 3D printing technology represents a key area of opportunity for service providers and vendors looking to expand their offerings into new markets. According to a March 2013 article in the Fiscal Times, the 3D printing market is expected to grow to over USD $3.7 billion by 2015. With many market players—including large corporations, such as Stratasys, and start-up based 3D print manufacturers developing new 3D printers each day—the technology is quickly advancing. Through the use of desk research and discussions with 3D printing service providers, InfoTrends was able to develop an overview of the technologies used as well as the markets, applications, materials, cost, and opportunities.

The trends surrounding 3D printing and its impact on the manufacturing and machining markets are similar to those that occurred with the introduction of digital printing to the conventional printing market. 3D printing allows for faster turnaround, short runs production of objects, improved processes, and supply chain. More importantly, 3D printing also allows for the ability to customize objects and produce a "one-off" product. For example, in vertical markets such as medical, this is seen as a revolutionary solution for prostheses, hearing aids, and other equipment that must be adjusted for an individual.

When thinking of 3D printing versus inkjet printing, it is important to remember that the only true commonality between the two is the word "printing" or deposition of material. Unlike inkjet printing, most 3D printers do not deposit a liquid; rather, they convert a solid into a deposited layer. Most 3D solutions use phase change deposition technology, where by material is heated to its melting point and then moved in a horizontal or vertical fashion to be deposited in the right location. The material hardens right after it leaves the nozzle of the printer and the object is produced by the layering of the material.

3D equipment manufacturers are present in key geographies and—according to information collected by 3Ders.org—North America represents 44% of 3D print manufacturing, while Europe has 37% of the market. North America and Europe have the most active markets in 3D printing development. Manufacturing of 3D printing materials is also concentrated in North America with 37% development and Europe with 40%.

As the popularity and public awareness grows around 3D printing, it is expected that there will be major developments, improvements in the current technology, as well as vendor consolidation. Those service providers looking to integrate 3D printing as a service should look to their current clientele to see if entrance into the 3D printing space is an applicable business move given their customer needs. Improvements in speed, resolution, and the ability to deposit different materials will have a huge impact moving forward. In addition, 3D printing has the ability to change supply chain as we have come to know them, and it is during this current development stage that users will figure out new applications beyond prototyping that will open up new opportunities.

Key Findings

- It is a rapidly/explosively growing market worth $1.7 billion USD dollars in 2011 and expected to grow to $3.7 billion USD by 2015, according to the *Fiscal Times*.

- There are many active markets that use 3D printing. Nevertheless, InfoTrends sees the most activity and potential in the following verticals: architecture services, footwear manufacturing, engineering (aerospace and automotive), and medical.

- Revolutionize production processes, supply chain, and prototyping—3D printing lends itself to short run production or prototyping. Its impact on production cost is similar to that of digital printing as compared with conventional printing methods. The break-even point on 3D printing, compared to traditional manufacturing, depends upon the quaintly being printed.

- The concentration of vendors developing 3D printers can currently be found in North America, with 44% and Europe with 37% and (According to 3Ders.org).

- The most frequently used material for 3D printing is Acrylonitrile Butadiene Styrene (ABS) and is currently found in 51% of 3D printers. The most popular deposition technique is fused filament fabrication (FFF), a technology that can be found in 82% of machines. (According to 3Ders.org).

- 3D printing vendors are not only developing 3D print technology, but are manufacturing their own printheads for use on these machines.

Recommendations

Due to the wide range of industries and markets that 3D printing effects, InfoTrends has divided recommendations into four critical areas: Equipment and material manufacturers, in-house production and fabrication, print service providers, and educators.

Equipment & Material Manufacturers

- Vendors should consider the material science behind 3D printing to decide whether or not entering this product segment fits with their core competencies. Such things to consider include overall material science and material deposition technologies, as well as intellectual property positioning.

- InfoTrends believes that understanding the complexity of the 3D printing go-to-market business model is key for their success. Vendors must decide whether they can adopt a business strategy needed for successful development, marketing, and selling of 3D solutions.

- If 3D printing technology is developed or obtained from a merger or acquisition, vendors must determine if they have the proper go-to-market distribution channels to bring a product to market successfully. Furthermore, the support of the channel of distribution is key to maintaining a name in the 3D printing market.

In-house Production & Fabrication

- Those that are producing and fabricating products must consider what impact 3D printing will have on prototyping or short-run production orders compared to their current manufacturing processes.

- It must be determined if the skill set needed for in-house 3D production and fabrication is within reach to bring a prototype or short-runs from concept to finished product.

- In-house production and fabrication companies must determine if the investment and overall cost of 3D printing is more cost-effective than current methods of prototyping, manufacturing, and outsourcing.

Print Service Providers

- It is important to have a clear business plan when implementing 3D printing; taking into consideration a PSP's current client mix and the local market will help to highlight possible opportunities.

- InfoTrends recommends that PSPs look to invest in an entry level machine that allows for the skills needed for 3D printing to be developed before expanding 3D offerings.

- Learning the 3D Printing Workflow will take time. PSPs need to learn the technology, material science, and have an understanding of Computer Aided Design (CAD) fundamentals. This will require an investment in staff training, and possibly recruiting someone with a manufacturing background.

Educators

- 3D printing can be used as a tool for education in a wide variety of subjects, including (but not limited to) fine arts, engineering, and the sciences. 3D printing provides opportunities to students for hands on experience with leading technologies.

- Leading fine arts and engineering, as well as secondary education schools, are equipping their production labs with 3D printers. Supporting this new generation of innovators and users is key for their future success.

Introduction

In February 2013, President Barack Obama in his State of the Union address said, "A once-shuttered warehouse is now a state-of-the art lab where new workers are mastering the 3D printing that has the potential to revolutionize the way we make almost everything." As the awareness of 3D printing grows, vendors and PSPs are taking notice of this process. 3D printing is a technology that can trace its development back to the 1980s, but it has only recently become visible on the public's radar. 3D printing awareness allows print service providers to add a new service. Through the use of trade websites, such as 3ders.org; vertical market research through databases, like Hoovers.com; and interviews with 3D print users, InfoTrends was able to do top-level preliminary research on this topic. We were able to look into the markets, applications, materials, cost, and opportunities of this market.

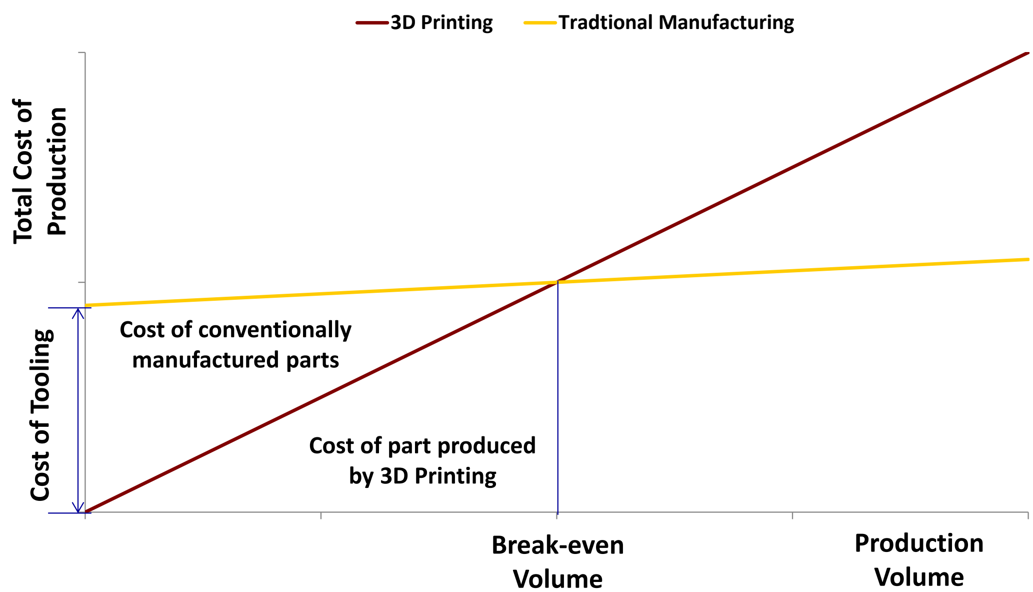
Value Proposition

3D printing has several advantages over the traditional processes of manufacturing. The use of 3D printing is especially effective when it comes to the application of rapid prototyping. Using 3D printing as a way to prototype lowers the product development time, the labor costs associated with human labor, and the materials in comparison to the traditional process of manufacture prototyping. When a 3D printer is purchased by an office or department that frequently requires on fabrication on demand, turnaround time is also reduced.

Offering a 3D printing service also acts as way to be a customization leader. Objects printed via the 3D printer can now cater to an individual's wants and needs in a product instead of providing an object based on mass consumption. The ability to customize products for individuals also allows for new design possibilities to be developed; this is especially true in markets that serve many unique individuals, such as prosthesis services. Eliminating the traditional constraints of the manufacturing process allows for complex designs to develop without producing multiple parts that have to be assembled; instead, objects can be produced with complex working parts already assembled.

3D printing has the ability to lower the barrier to entry for new business looking to become fabricators. It should be noted that, like all printing processes, there is a break-even point for the cost of production when using a 3D printer compared to traditional prototyping processes. The break-even point between 3D printings as a production tool versus traditional methods depends upon the quantity of an item that needs to be produced. For short runs, however, there is a break-even point for 3D printers and traditional manufacturing processes.

Figure 1: Break-even Cost of 3D Printing vs. Traditional Manufacturing

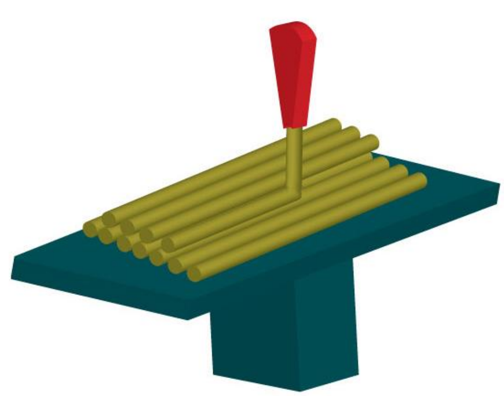


Technology

Deposition Technology

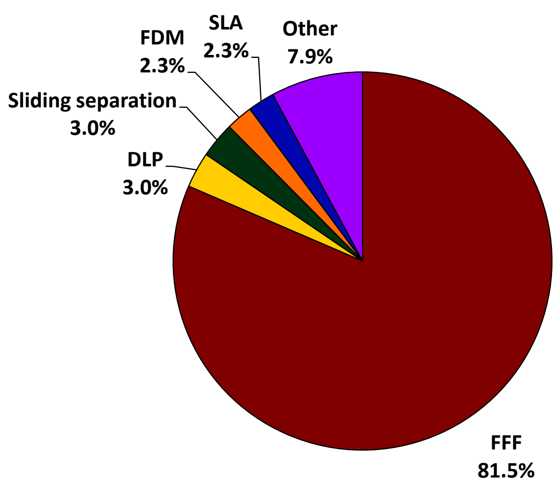
The most common method for 3D printing is deposition technology. When compared to other printing technologies, especially inkjet printing, it is important to understand that the methods in which deposition technology produces a 3D object are not the same as a conventional inkjet printer. The type of technology used in deposition technology is not a jetting technology, which is the technology currently found in inkjet printers. In deposition technology, a material is heated to its respective melting point and pushed out a printhead in a vertical or horizontal direction. The material hardens as soon as it is laid down, allowing for another layer to be printed on top of it. These multiple layers then create the object being "printed."

Figure 2: Deposition Technology Visualization



The deposition technology and technique for 3D printing can vary depending upon the manufacturers and materials used to produce an object. Some methods are preferred over others. According to the trade reference site 3Ders.org, the most popular technology being used today is fused filament fabrication (also known as Fused Deposition Modeling or FDM). This technology can be found in 84% of machines. The FFF process uses the same deposition technology process as described in the previous paragraph in which a material—it is plastic for the FFF process—is heated to its melting point and moved directionally to produce an object. FFF does this deposition process repetitively and the object is built up to size. This process is also known as “additive” 3D printing.

Figure 3: 3D Printers by Technology According



N = 129 printers
Source: 3Ders.org

Other technologies that make up the market are Digital Light Processing (DLP) sliding separation or stereolithography (SLA); however, each of these make up less than 5% of the market. (For further explanations of these technologies, please see the Appendix at the end of this piece.) Making up the other 8% are other technologies that vary from printer to printer. The reason for such a mix amount of other technologies is due to the large amount of startup 3D printer companies that make their own printers and then put them to market on a smaller scale.

Jetting Technology in 3D Printing

As explained in the previous section, the 3D printing process that is most commonly used is based on deposition technology. Nevertheless, it should be noted that there are some jetting systems similar to an inkjet process that are used to print with liquid polymer based materials. In the jetting process for polymer based materials, a liquid polymer is jetted out of a printhead onto a build tray. As the layers are completed, they are immediately hardened by contact with UV light. The layers produced in this jetting process are thinner and finer than those of the deposition process, so detail on an object printed using the jetted technology are far better. Detail comes at a cost, however, as the 3D printers utilizing jetted technologies are slower than those using Fused Deposition Modeling.

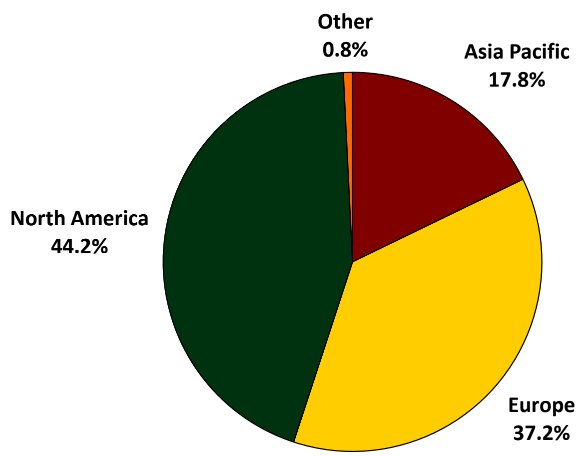
Table 1: Comparison of Deposition and Jetting Technologies

Deposition Technology		Jetting Technology	
Benefits	*Drawbacks*	*Benefits*	*Drawbacks*
• High speed • Many applications for finished products including industrial and consumers • Suitable for small production runs & prototyping	• Strong odor due to plastic melting and material composition • Lower resolutions compared with Jetting; is not suitable for fine details production	• High resolution for fine details (under 20 microns) • Smooth surface production • Many market applications with the need for detailed and finished looking prototypes	• High resolution results in slow production speed resulting in longer production time • Prototype only due to jetted material composition

Vendors

In terms of vendors and manufacturers of production-ready machines, the development is happening mainly in North America and Europe. According to 3ders.org, over 44% of development and manufacturing of 3D printers is happening in North America and approximately 37% is occurring in Europe. There are a range of print systems available, from a sub USD $800 personal desk top printer to a $100,000+ full size production printer that creates fully functional prosthetics and automotive parts.

Figure 4: Manufacturers/Vendors or 3D Printers by Country



N = 129 Manufacturers
Source: 3Ders.org

Major American and European vendors are 3D Systems and Stratasys. They produce a range of 3D printers for prototyping and production applications. It is important to note that there is a lot of acquisition activity, with larger 3D printer vendors buying up smaller companies. For example, Stratasys now manufacturers the Objet, Mojo, uPrint, Dimension, and the Fortus series printers—all of which were technologies and vendors that had operated independently of Stratasys prior to acquisition.

Other European and North American companies are MakerBot, Bits from Bytes, and Formlabs Inc. These companies are all 3D printing system manufacturers with a focus on smaller printers for prototyping and educational purposes. These printers can be used in any industry for prototyping. They are more affordable than larger production model 3D printers.

While Asia Pacific does hold 17% of the market on manufacturing, relatively little has come from China, Japan, or India. These countries appear to have an active interest in 3D printing, but have yet to produce production-sized machines for the market. There is an opportunity for vendors and manufactures outside of Asia Pacific to find country partners for 3D printing to help them bring production machines into this market.

Table 2: Vendors in 3D Printing Market

Vendor	Device	Max Build Size (in)	Material
3D Systems/Zcorp	ZPrinter 150	9.3 X 7.3 X 5	High Performance Composite
	ZPrinter 250	9.3 X 7.3 X 5	High Performance Composite
	ZPrinter 350	8 X 10 X 8	High Performance Composite
	ZPrinter 450	8 X 10 X 8	High Performance Composite
	ZPrinter 650	10 X 15 X 8	High Performance Composite
	ZPrinter 850	20 X 15 X 9	High Performance Composite
Stratasys	Mojo	5 X 5 X 5	P430 ABSplus in ivory
	uPrint SE Plus	8 x 6 x 6	ABSplus
	Objet 24	9.21 x 7.55 x 5.85	VeroWhitePlus Opaque material
	Objet 30 Pro	32.28 × 24.4 × 23.22	Vero material, non-toxic photopolymer
	Objet 30 Scholar	11.57 x 7.55 x 5.85	Vero material, non-toxic photopolymer
	Objet Eden 260/350/500	13.39 x 13.39 x 7.87	Vero material, non-toxic photopolymer
	Objet Connex 260/350/500/1000	39.3×31.4×19.6	Vero and Tango materials
	Dimension SST/BST 1200es	10 x 10 x 12	P430 ABSplus
	Dimension Elite	8 x 8 x 12	P430 ABSplus
	Fortus 250mc	10 x 10 x 12	P430 ABSplus
	Fortus 360mc	16 x 14 x 16	ABSplus -P430
	Fortus 400mc	16 x 14 x 16	ABSplus -P431
	Fortus 900mc	36 x 24 x 36	ABSplus -P432
MakerBot	Replicator 2X	9.7 x 6.0 x 6.1	Plastic Spools
	Replicator 2	8.9 x 5.7 x 5.9	Plastic Spools
	The Replicator	8.9 x 5.7 x 5.9	ABS, PLA
Bits from Byes	3D Touch	7.3 x 10.75 x 7.9	ABS, PLA
	RapMan 3.2 3D	10.5 x 8 x 8.75	ABS, PLA
PP3DP	Up! Plus	5 x 5 x 5	ABS, PLA
	Up! Mini	4.7 x 4.7 x 4.7	ABS
Formlabs Inc.	The FormOne	4.9 x 4.9 x 6.5	Acrylic Resin

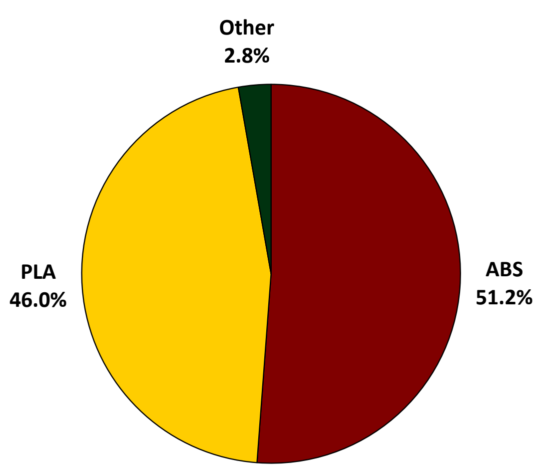
Materials

3D printing can be executed in a number of ways. Depending on what type of object is being a printed will effect what type of material is used for that print job. One of the most popular materials is Acrylonitrile Butadiene Styrene (ABS) and is currently found in 51% of 3D printers[1]. With a high heat tolerance, ABS is a very strong plastic that allows for slight flexibility once dried. ABS is an easily moldable plastic that allows for further sanding and shaping once printed; when printing, ABS plastic can give off a burning smell while printing that could be undesirable for some users. Due to its strength and machinability, it is a preferred plastic for engineering and industrial applications.

Another popular plastic is Polylactic Acid (PLA), which is used 46% of the time by 3D print manufacturers. PLA is biodegradable and does not give off fumes when printing. PLA plastic is also harder than ABS plastics, but is also more brittle in the sense it will snap rather than bend. Nevertheless, PLA is a better choice for larger objects as ABA can warp or crack when printed too large.

Both of these plastics come in a spool that looks like thread. They are referred to as filament material. The spool is plugged into printer head and then layers the melted plastic.

Figure 5: Materials for 3D Printing by Type



N = 856 manufacturers
Source: 3Ders.org

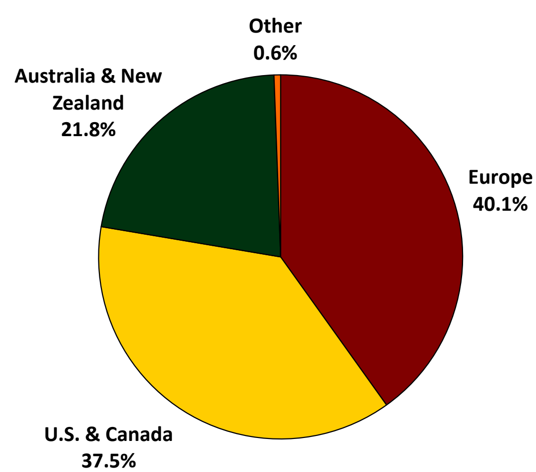
[1] "Price compare - 3D printing materials - Filament." *3Ders.org*. 3Ders.org, n.d. Web. 5 May 2013.

Figure 6: Filament Material for 3D Printer from MakerBot Online Store

Resins and metals can also be used as materials, but the way in which they are melted to be pushed through the printhead is different. In many cases, when printing metal, a laser is used to melt the metal. After the metal reaches its melting point, it is deposited out layer by layer just like any other substance. Another way of using metals via 3D printing is to use a 3D printer to print a complex mold out of plastic and then poor liquefied metal into the mold. In this scenario, the metal is not being pushed through the head of the printer, but rather is applied in a second step.

The bulk of 3D printing materials can currently be found in Europe, with 40% of material production occurring there. The U.S. and Canada produce 37%, while Australia and New Zealand produce 22% of materials currently used. The Asian market—a market that a strong presence in the manufacture of conventional digital materials—has not made a clear market presence in the production of 3D printing materials. This is most likely due to these countries' low production of natively manufactured 3D print machines in the Asian market. Without the high demand for 3D printers, the materials would then be produced less domestically. Nevertheless, as the growth of 3D printing increases and this technology more widely spreads, it is likely that there will be growth in other regions.

Figure 7: Materials for 3D printing by Country



N = 856 manufacturers
Source: 3Ders.org

Cost and Performance

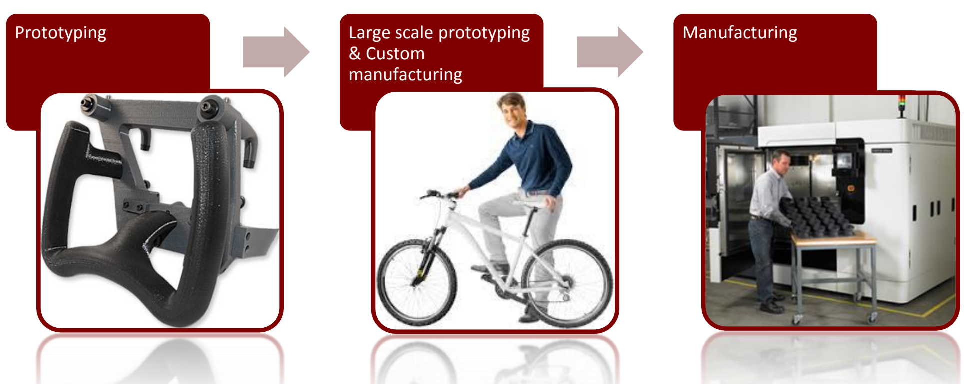
The initial investment costs of 3D printing are very accessible to even the average consumer. Those looking for an entry-level machine that can fit on a desk or work station can chose from many varieties of moderately priced machines. For example, the Up! Mini 3D printer by Bytes to Bits costs only $899 before tax.

Due to the wide use of hobbyist printers and educational printers, there are more affordable options available that provide the same functionality of an industrial printer model with the only change being the maximum size of the object that can be produced. The cost of a machine relates heavily to its capabilities and performance. A higher-end machine can serve a wider segment than a smaller desk top machine. It should also be noted that material cost also varies depending upon the type of machine purchased for use and application. A high quality ABS plastic can range in price from $20 to $120, depending on weight (kg), color, and type. PLA, on the other hand, ranges from $40 to $150, depending on weight, color, and type.

Markets and Opportunities

Implementation of 3D printing ranges across many different markets and applications. 3D printing allows for rapid prototyping in many fields, but with the right materials it can also be used to create industrial-strength parts for machinery, apparel, and even medical devices. This section will cover examples of prominent market sectors using industrial printing for specific applications.

Figure 8: Market Segments

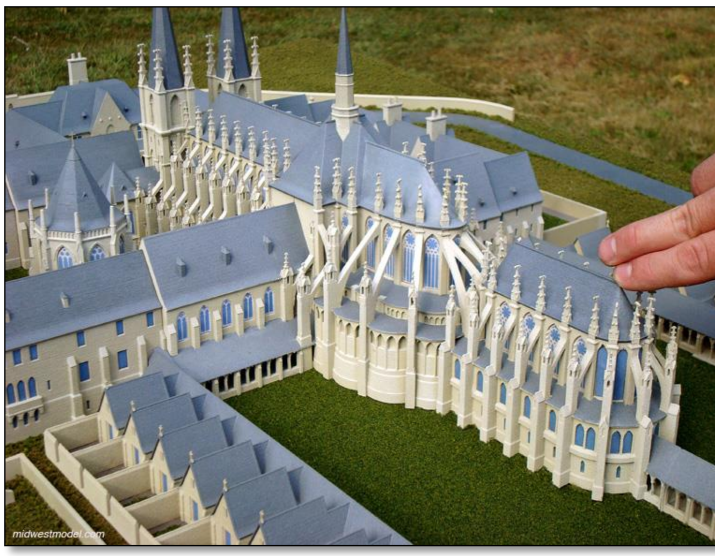


Source: Stratasys

Architecture Services

In the recent economic slowdown, architecture and architectural services (i.e., those who design spaces for private or public use) have seen a downturn. There are approximately 30,000 architectural design firms in the U.S. that represent an industry with combined annual revenue of $30 billion[2] as of 2012. Architecture can benefit greatly from the use of 3D printing. In the past, creating models or pieces for architectural use consisted of assembling complicated models by hand. A 3D printer can produce a model in a few hours, removing the requirement for a lot of time and manpower. Workers in architectural services are heavy computer users already, and are well acquainted with computer-aided design (CAD) software—the main software application used in the design of 3D printed files.

Figure 9: 3D Printed House Model



Source: Midwest Model

[2] "Industry Description." *Architecture Services* (2013): n.pag. Hoover's. Web. 6 May 2013.

Footwear Manufacturing

With approximately 250 companies with sales of 2 billion dollars annually, the U.S. footwear manufacturing industry represents a formidable sector of the apparel industry. Over 50% of the shoes produced and sold are men's footwear, while women's footwear account for 20% of the overall market, with the rest of the market filled by athletic shoes[3]. The changeover of the market is seasonal and follows the fashion industry when items are placed in stores. This constant change-over also requires heavy prototyping for footwear design that requires the ability to quickly change designs.

An example of 3D printing applied to footwear manufacturing can be found in a case study on the 3D print manufacturer ZCorp's website. In ZCorp's case study, the footwear manufacturer Timberland has to send out for prototypes of soles for boots that would take weeks and thousands of dollars to manufacture. After installing the Spectrum Z510 printer, designers were able to rapid prototype the soles created at less than 50 dollars a prototype. In the case study, it was also stated that Timberland's profits increased due to faster turnaround time of prototyping.

Figure 10: Timberland 3D Printed Shoe Bottom Printed with ABS Plastic

Source: Stratasys

[3] "Industry Description and Products, Operations, and Technology." *Footwear Manufacturing* (2013): n.pag. Hoover's. Web. 6 May 2013.

Medical

Medicine is one of the markets that stands to benefit the most from 3D printing. The medical industry, specifically medical equipment and supplies manufacturing, develops "medical equipment and supplies, including surgical and medical instruments, dental equipment, and surgical appliances."[4] The worldwide value of the medical equipment and supplies manufacturing industry is approximately $350 billion. In the U.S., there are 11,000 companies that have combined annual revenue of $90 billion. Manufacturing for medical tools is only expected to increase as the world's population lives longer and requires more medical attention. Allowing for medical tools and equipment, such as prostheses, dental, and other tools, to be customized to the patient will only benefit overall healthcare.

Customization via 3D printing can fit many applications in the medical industry. It could be used as a means to develop better prosthetics, braces, or implants for patients. There have been successful transplants done in the past year that have involved 3D printed bones and developments in improved customizable prosthetics that have been printed for patients and can be updated and adapted as the patient changes or grows. Finally, organ transplants are also seeing the effects of 3D printing. Currently, in research labs, there has been development on using modified 3D printers to print human tissue to produce fully functional organs; however, it should be noted that this technology is far from ready for use in the mass market.

Figure 11: A Child with a Custom 3D Printed Exoskeleton

Source: Stratasys

[4] "Industry Description." *Medical Equipment and Supplies Manufacturing* (2013): n.pag. Hoover's. Web. 6 May 2013.

Engineering

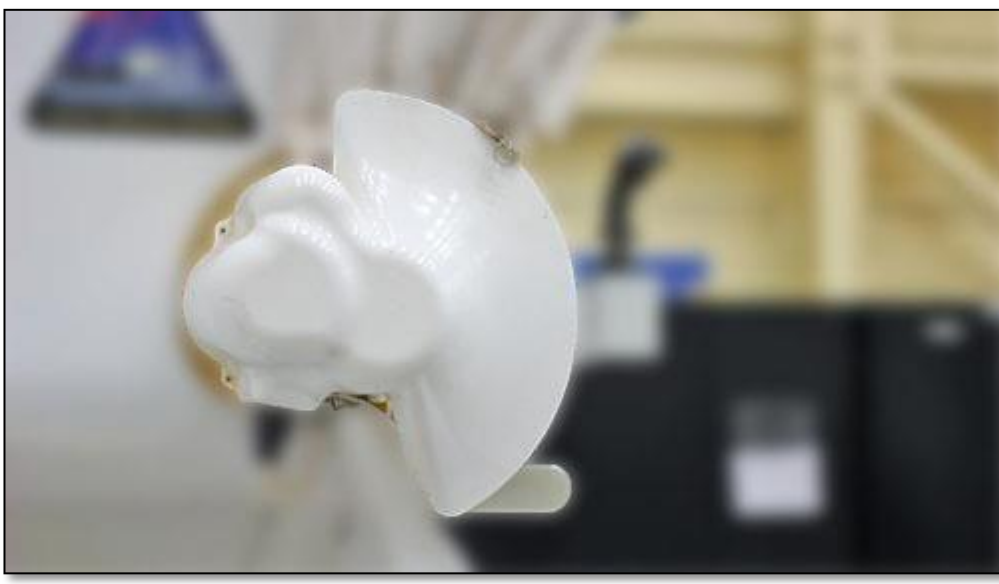
There are many vertical markets in engineering that can benefit from 3D printing. Nevertheless, aerospace and automotive engineering are actively using and participating in the development of 3D printing and its applications.

Aerospace

In the U.S., there are 1,300 companies that manufacture for the aerospace industry. Combined, these companies have annual revenue of $185 billion with moderate growth[5]. The cost of manufacturing in aerospace is highly dependent on the cost of materials and supplies. These include expensive raw materials, such as aluminum, titanium, carbon fiber, and special steel alloys.

3D printing is being actively used in research and development as a way to produce lighter and more material-efficient parts for airplanes and space-related applications. For example, the Kelly Manufacturing Company based in Kansas is using 3D print systems to manufacture altitude gyros, engine gauges, and voltage systems for airplanes. Taking it a step further, NASA recently became interested in 3D printing and uses 3D printed parts on a rover that is being tested with the intention of being sent to Mars.

Figure 12: 3D Printed Piece from NASA Machine



Source: Stratasys

[5] "Industry Description." *Aerospace* (2013): n.pag. Hoover's. Web. 6 May 2013.

Automotive

While the international auto industry has an annual worth over USD $2 trillion, the U.S. market has an annual revenue of about $220 billion dollars with 200 active companies in the field[6]. With the recent struggles of the American auto industry to remain competitive in a global market, 3D printing represents an opportunity for auto makers to remain relevant. 3D printing can offer more effective prototyping to the auto industry, but can also fill the demand for hard to find parts on discontinued car models. In one case, KOR EcoLogic, an engineering firm, was able to create a fully-functional 3D printed car that runs on ethanol and can reach speeds of up to 70 mph.

Figure 13: The Urbee First Fully-functional 3D Printed Car

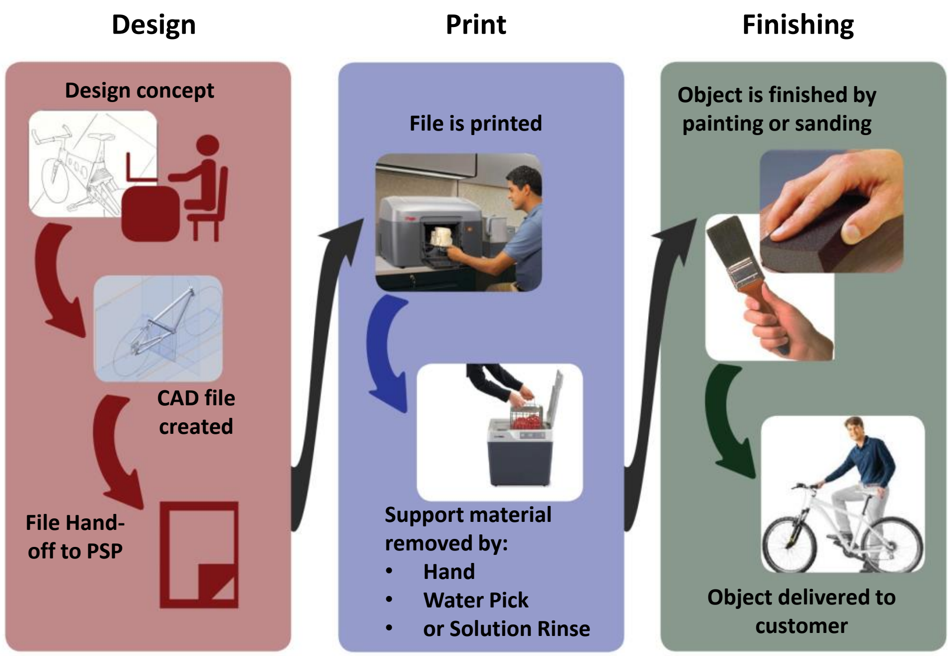
Source: Stratasys

[6] "Industry Description." *Automotive Engineering* (2013): n.pag. Hoover's. Web. 6 May 2013.

3D Print Workflow

3D printing follows a logical workflow. The 3D printing process contains three to four different key players to complete the full 3D printing workflow. A 3D object begins its life as a concept or idea that is then modeled using CAD software by the client or an industrial designer. From the creation of the CAD file, the design is then printed internally or sent to a service provider. Finishing or painting of the printed piece may be handled by the service provider or another firm.

Figure 14: 3D Printing Workflow

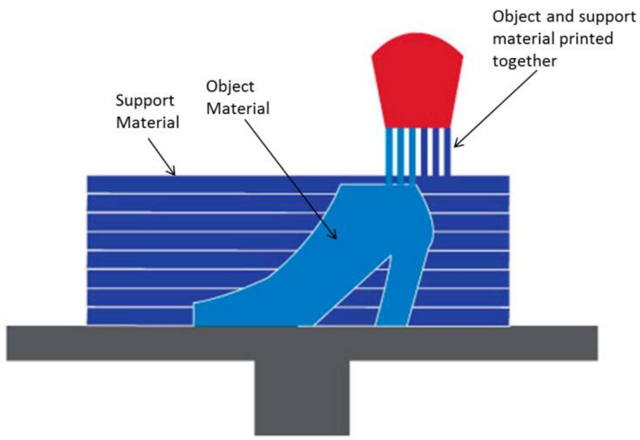


Note: Each step can be completed by the industrial designer, PSP, or be outsourced.

Many of the production 3D printers have the some sort of proprietary pre-flight software that allows AutoCAD files to be processed by the printer. Should a file be rejected by the preflight process, the file is returned for adjustment by the customer. Should a PSP have someone trained in AutoCAD, minor adjustments could be made on site at the PSP.

Once approved by a preflight or approval process, the object is then printed by the PSP. Depending on the type of material and 3D printing technology used, a support material is printed to encase the printed object. The reason for support material is that it allows the printer to from complex shapes when printing in directional environment.

Figure 15: Example of Support Material



Some support materials are able to be dissolved when using a special cleaning solution, removed by hand, or in some cases can also require sand-blasting with a water pick. These removal methods require that staff working with these materials are trained on how to remove support material properly without damaging the printed object. Should an object be damaged during the support removal process, another must be printed. It should also be noted that support material does come with some costs, but is not as expensive as the plastics used to print an object.

Figure 16: Before and After with Support Material

Source: Stratasys

When moving into finishing of a 3D printed object, a PSP must make the decision on whether to contract out such things as sanding (by hand or with a machine), painting, or other finishing requirements. Should such finishing be done in-house, it is important that the PSPs have staff that has the skill level to complete required finishing tasks.

Finally, once an object is finished, it is presented to the client. Should a client not approve of the finished output, the rest of the workflow must be looked at to see where the dissatisfaction began. In some extreme cases, reprinting of the object may occur. If the customer is satisfied with the object, it is then delivered to the client.

Print Service Providers and 3D Printing

InfoTrends recommends that PSPs look into lower beginner models to get themselves acquainted with the current technology and markets that they would be serving before investing in a production quality device.

The 3D printing workflow, as mentioned in the previous section, allows a PSP to get clearer idea of the requirements of implementing a 3D printer into their current offerings. 3D printing will require that workers have a different knowledge and set of skills to properly move an object/file through the workflow. Depending on how involved a PSP wants to be on the front end, a worker with deep knowledge of AutoCAD is needed. Rendering software requires training and, in many cases, a strong background in industrial design. While there are simpler programs for the hobbyist, such as Tinkercad (an online instructional rendering software tool), they do not come with the full capabilities to design or adjust detailed objects as software like AutoCAD would. Finally, if a PSP would like to become full service on the finishing side of the workflow, they again require workers with a knowledge base for 3D finishing techniques.

InfoTrends' Opinion

As the market for 3D printing expands, equipment and material manufacturers, in-house production and fabrication, PSPs, and educators must be aware of the requirements for successful application and use of these devices. Vendors should look to develop partnerships where there are opportunities for manufacturing, application of, and the interest in 3D printing is high. PSPs should look to their local markets and current clients to determine the feasibility of adding 3D printing to their service offering. As the 3D printing market continues to mature and develop, those on the front lines of innovation stand to benefit greatly by exploring their options for development today.

Appendix

Process	Abbreviation	Definition	Materials Used
Fused Filament Fabrication[7]	FFF	Material is fed into the print head nozzle via a coil. The nozzle then heats up reaching the material's melting point. The material then leaves the nozzle in a liquid form and is layered directionally (vertical and horizontal) across the printing bed. The material hardens immediately after it is laid on the bed, allowing for the next layer to be placed on top of it.	Thermoplastics (ABS, PVA), Waxes, Metals
Digital Light Processing	DLP	As the polymer based material leaves the print nozzle, a UV or visible light source is exposed to it. The exposure to light causes the material to immediately harden. This laying down of material and light exposure occurs for each layer and builds the object.	Polymer based material - Resin
Sliding Separation		In this method the polymer based material is found at the bottom of the machine. It is not jetted onto a surface. Instead an LED light source moves in an upward motion attracting the selected hardened layers to a head that is moving up. This is currently a proprietary process by the vendor Asiga.	Photo polymer plastic
Stereo-lithography	SLA	Similar to Digital Light Processing, a polymer based material leaves the print nozzle and a UV laser exposes the material and then hardens it. Unlike, DLP the laser exposes cross sections to the material to harden it instead of the whole material layer. The process is repeated until the object is built up.	Polymer based material - Resin

7 Can also be known as Fused Deposition Modeling or FDM

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Comments or Questions?