



Revolutionizing Healthcare: How 3D Printing is Creating New Business Opportunities

A SMARTECH WHITE PAPER

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This White Paper is based on market research and industry analysis carried out for **SmarTech's** report "3D Printing in Medical Markets 2015: An opportunity Analysis and Ten-Year Forecast" More information on this report can be found at: <http://smartechpublishing.com/reports/3D-Printing-in-Medical-Markets-2015-An-Opportunity-Analysis-and-Ten-Year-F>

The Growing Influence of 3D Printing in Medicine

SmarTech envisions an impressive future for 3D printing providers specializing in the medical sector. Exhibit 1 provides our projections for revenues of printers, print materials, and software for printers installed in medical environments. Note that the software revenues in Exhibit 1 are not related to advanced medical solutions such as surgical planning software, but rather printer control software and build chamber prep software sold in excess of standard hardware costs.

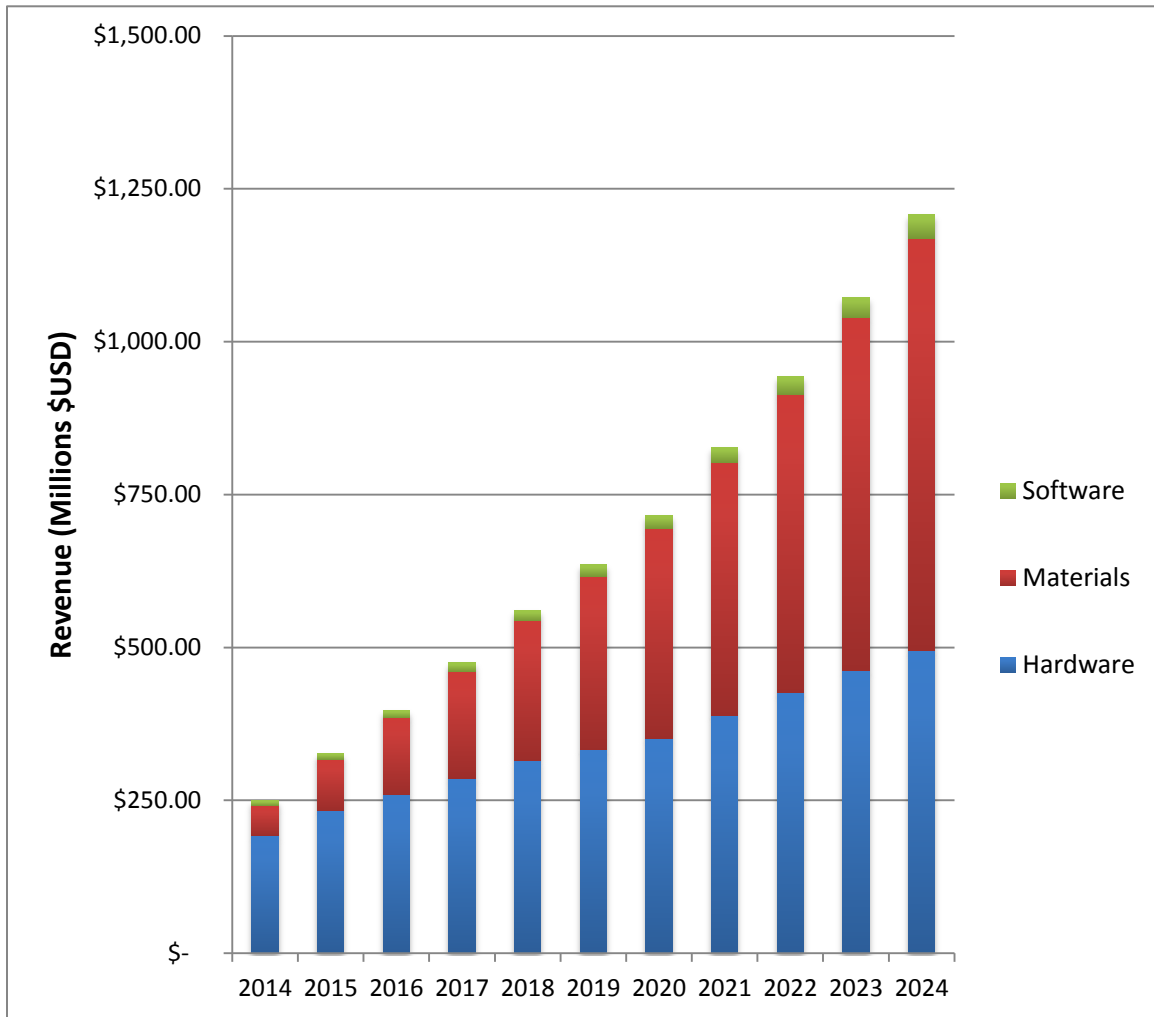
Nonetheless, the predicted revenues shown in the Exhibit are quite large and we expect these revenues to be attained because of the ability of 3D printing to fill gaps that currently exist in conventional treatments, as well as its ability to open up entirely new markets. Thanks to a group of increasingly popular technologies that are better enabled by additive fabrication, the future of healthcare is being enhanced in ways both familiar and totally new.

As **SmarTech** sees things, 3D printing in the area of medical applications is unique when compared to other popular industries such as aerospace, automotive, and others, where 3D printing is already being used. In medical applications cost becomes a secondary concern to a successful outcome, which may save a life or greatly improve the quality of one. This cost factor clearly distinguishes the economics of medical 3DP from other kinds of additive manufacturing.

In the medical sector, 3D printing has also created entirely new solutions that could not exist with previous technologies. For example, the printing of advanced medical models for procedural planning, reference and training has progressed significantly over the past several years. In some areas, 3D printed models are quickly becoming absolute necessities for surgeons and doctors in order to increase success rates and reduce operating times.

3D printing can fabricate components with precise detail, complex shape, and in a variety of applicable materials. Combined with other well-known primary value drivers of additive fabrication -- such as rapid production of small volume parts, and the nearly total elimination of manufacturing complexity constraints -- 3D printing offers medical professionals and patients impressive new prospects for treatment.

Exhibit 1: Total Medical 3D Printing Market Value, 2014-2024



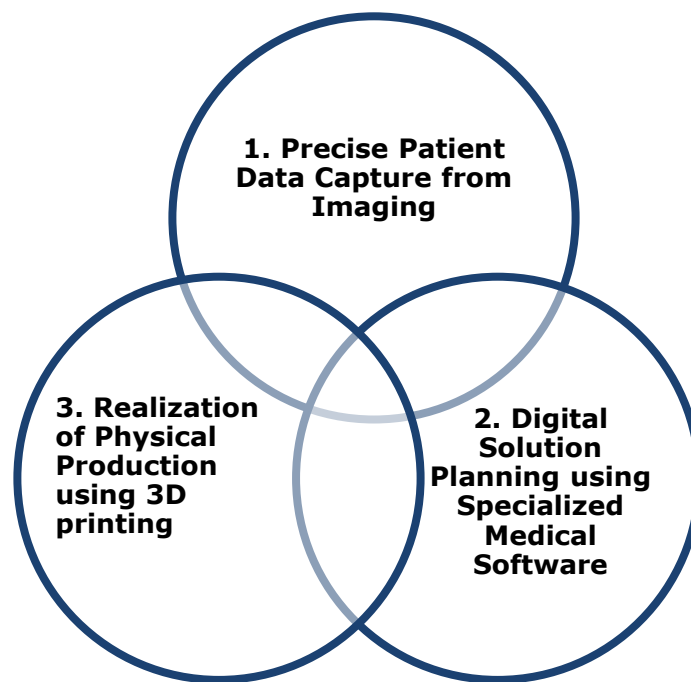
3D Printing-Enabled Medicine

Also unique to 3D printing in medical markets is the especially strong synergy in medical applications between (1) digital three-dimensional design, (2) medical imaging, and (3) 3D printing. These three technologies are beginning to form a trio of medical problem solvers, offering solutions where patient-specific data can be captured, manipulated, and ultimately applied to medical situations of all shapes and sizes through the use of 3D printing.

Exhibit 2 displays the relationship of 3D imaging, data collection and 3D printing. The emphasis is on the combined powers of all three technologies in 3D printing-enabled medicine:

- Current medical imaging technology allows for precise capture of patient specific data in a digital format
- Modern 3D printing medical software can translate medical imaging data into formats that can be manipulated by medical professionals so as to plan the most ideal solution in digital space
- Today's additive manufacturing technologies complete the system in a way not previously possible by allowing the physical actualization of these solutions. Prior to 3D printing being brought into the mix; 3D medicine was image-capable only

Exhibit 2: Interconnected Value of 3D Print-Enabled Medical Solutions



Source: SmarTech Markets Publishing

Matching 3D Print Technology to Market Needs

3D printing's future penetration of medical markets is dependent on (1) matching current capabilities to medical problems where traditional solutions

exist but can be improved upon, (2) and advancing print technology to increase capabilities in order to serve unmet medical needs.

These factors need to be seen against a background in which the new 3D printing technologies are already able to create medical products of comparable quality to conventionally manufactured parts and, in some cases, even exceed this quality. Furthermore, with 3D printing, parts are produced more efficiently, using fewer resources, and requiring fewer labor hours.

Most importantly, 3D printing brings to the medical industry the ability to provide customized medical products in a way that has not been possible before. Customized products have the ability to improve medical care, at the same time reducing healthcare costs by decreasing time spent under direct care and improving success rates, reducing the need for additional surgeries and malpractice lawsuits.

The different key users of printed medical parts often also have differing needs for the entire solution process and selection of print technology:

- Doctors and surgeons key motivation is patient outcome, so the entire process needs to be tuned to empower medical professionals to think about the best possible solution while leaving all other considerations (such as traditional constraints) out of the equation.
- A patient use part, however, shares some of the concerns of the patient as well including psychological effects of treatment and considerations for post-operative quality of life.

Finally, the market for 3D printing covers a broad range of products as shown in Exhibit 3. And the “golden rule” of 3D printing is especially relevant in medical markets –no single print technology can be applied market-wide to serve all primary applications.

Exhibit 3: Printed Medical Part Requirements by Group		
Medical Part Category	Typical Part Requirements	Print Technologies Capable of Meeting Requirements
Direct Patient Use Parts (DPU)	Strength-to-weight ratios, load bearing capability, durable, inertness	Selective Laser Melting and Sintering (both polymeric and metallic)
Medical Professional Assistance Parts (MPA)	High resolution, various material properties, visual accuracy, tap and drillable, etc.	Stereolithography, UV based material jetting, DLP photopolymerization,
Medical Manufacturing Parts	Economic, fast print speed, durable and good functional accuracy, thermal performance	UV based material jetting, fused deposition modeling, selective laser sintering
Biomedical Research Parts	High resolution, thin walls for scaffolding, biocompatible materials	Proprietary processes based on extrusion

Source: SmarTech Markets Publishing

Creating Medical Market Value with 3D Printing

Overall, **SmarTech** believes there are four primary value drivers for 3D printing across a wide variety of medical applications. Despite very different requirements and users of parts, the following points of value creation are generally universal across medical markets:

- Increasing the number of treatable patients with conditions previously considered untreatable due to low likelihood of success relative to risk or cost
- Improved outcomes for patients through use of specialty 3D-printed solutions with unique characteristics
- Less total time under direct care of medical professionals
- Decreasing costs of development of medical solutions through additive manufacturing.

Implants and Prosthetics: 3D Printing Leading to Improved Cost Effectiveness

In the areas of customizable 3D printed implants, as well as a growing number of non-load bearing prosthetic devices, 3D printing is allowing treatment of patients with non-life-threatening injuries or conditions where previously treatments weren't viable.

Implants of the hip, cranium, and spine can be customized for individual patients who have extensive damage where standard implants may have a low likelihood of success.

Prosthetics in children are often also neglected due to cost effectiveness. In older patients, the waiting period for prosthetics can be lengthy leaving patients impaired for long stretches of time.

Scaling Advantages

Whether its hearing aid shells, spinal implants, standard hip cups, or surgical guides, a lot the reason 3D printing has so much potential to revolutionize medical treatment is because of opportunities for scale production aligned with markets where high volumes of parts are required.

Although not all great medical uses of 3D printing need lots of parts produced regularly (such as medical models), the opportunity for scale production in medical is not typically a barrier for 3D printing the way it may be in other industries. By contrast, in other applications, the size and shape of parts prevent them from being easily stacked and organized within the build chamber of a 3D printer meaning even if there were higher demand that production capacity is not as easily achieved because each part takes longer to fabricate.

This is a generalization, of course, but, for example, aerospace parts require either more printers to achieve similar volume or larger printers. Medical parts are capable of being printed in high volume with today's printers that have relatively small print chambers.

Handling Variability

Looking at the vast number of applications for 3D printing in medical today we observe a very high degree of variability in parts printed, which leads to variations in requirements for printed parts and different value drivers for the use of AM technology. For example, the production of standard hip implants with AM is a rapidly growing area due to the ability to print advanced

texturing onto the surface of implants to enhance osseointegrative properties while eliminating the cost and time for traditional secondary processes for the same result.

In this way, AM is beneficial in a completely different way than in the use of the technology for the production of a 3D printed surgical guide which is only used once as an enhancement to existing medical procedures.

Better Outcomes Enable New Markets

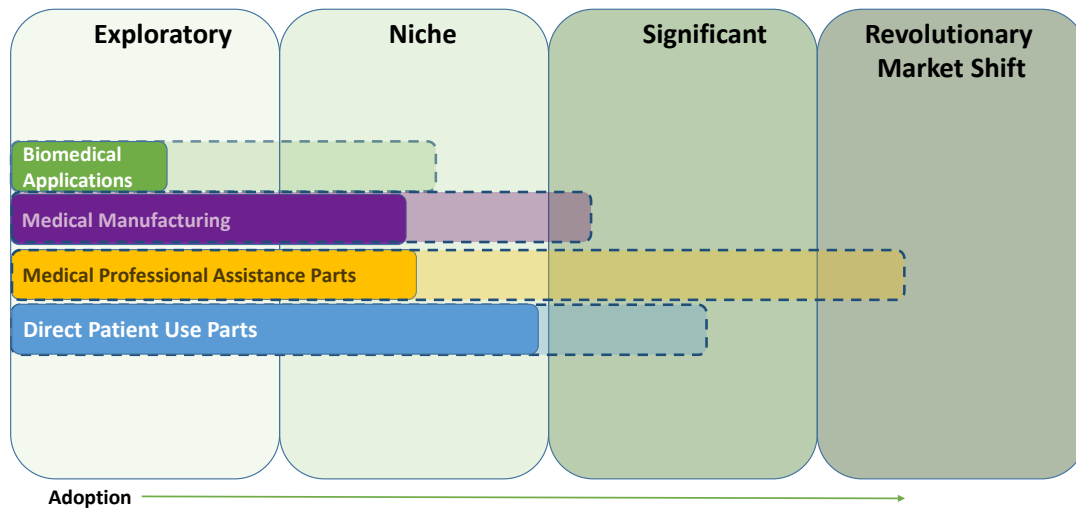
Through 3D printing, easy customization and the cost effectiveness and speed of production in certain scenarios are creating entirely new markets where traditional treatments aren't effective:

- Improved patient outcomes are also a key driver for a 3D printing in medicine. From medical models that reduce the chance of unforeseen complications during complex surgeries, to standard implants fabricated from high-performance materials with complex geometry to improve acceptance of the implant in a patient's body, 3D printing is enabling better outcomes for patients across many applications and areas of practice.
- As a result of these better outcomes and an increased ability for medical professionals to plan customized treatments ahead of surgery, the overall time patients may spend under the direct billable care of a specialist can often be reduced significantly. In some cases, this more than offsets costs associated with planning and production using 3D printing in one-off solutions, again creating better value.
- And finally, for manufacturers in the medical device industry, additive manufacturing continues to provide large timesavings in product development. This is especially important as regulatory environments have gotten more complex, increasing lead times for new products that can improve patient procedures and care. These benefits have been well documented in a variety of manufacturing industries, but certain uses of 3D printing are new to the area of medical device manufacturing; printed injection molding and tooling, for example

A Revolutionary Future for Medicine: The Road Ahead

Exhibit 4 below previews **SmarTech**'s overall expectation for penetration of 3D printing technology across the four primary categories of medical printed parts identified above in Exhibit 3.

Exhibit 4: Current versus Potential Adoption of Major Medical Components by Group



Source: SmarTech Markets Publishing

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Leading 3D printer companies such as 3D Systems, Arcam, Materialise, and others have already capitalized on applying both 3D printing technology and services to medical applications. **SmarTech** analysis of the overall market for non-dental medical applications in 3D printing reveals an exciting future ahead for the segment, where printers, imaging technology, and modeling all come together to create a value greater than the sum of these individual parts.

*In **SmarTech**'s report, "[3D Printing in Medical Markets 2015](#)," we further break down AM in non-dental medical into its most basic elements. Available equipment, industry makeup, component supply chain, key players, benefits, applications, and processes are all explored to arm our clients with the information needed to drive meaningful business decisions.*

About SmarTech Markets Publishing

SmarTech Markets Publishing delivers industry analysis and market forecasts for the 3D printing industry. Our coverage provides insight for those companies offering 3D printing equipment, materials, services, and software, as well as companies who operate in industries where 3D printing will begin to play a role in the near future.

When a company purchases a report from SmarTech Markets Publishing or engages us for custom consulting, it receives:

- Comprehensive analysis that reflects today's 3D printing market realities and tomorrow's profitable possibilities
- Detailed forecasts that provide our clients with compelling evidence to support important strategic decisions and give them an edge over the competition.
- Actionable recommendations identifying where money will be made and where it will be lost.
- Candid market assessments based on today's best strategic thinking, not just data dumps from the Internet.

SmarTech offerings complement internal product planning technology road-mapping, as well as provide low-cost knowledge enhancement for firms in the 3D printing industry.

Our mission is to identify business opportunities in the areas of additive manufacturing (AM)/3D printing and other advanced manufacturing technologies, while generating ideas that aid in growing adoption of additive manufacturing in ways that benefit global industry.

We use a proven market analysis process with roots that stretch back 30 years in the telecommunications industry.

Our reports are focused on providing granular, comprehensive ten-year forecasts of revenue generation and market size for sectors of the AM industry. Our reports include forecasts of hardware, software, services, and materials, along with market size for potential applications.

SmarTech Markets Publishing's reports are intended as key strategic inputs for all senior executives planning 3D printing product/market strategies and for investors who are looking to take equity positions in 3D printing firms

SmarTech also offers customized consulting and due diligence analysis.

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