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DIRECT MANUFACTURING

3D PRINTING & ADVANCED MANUFACTURING

3D PRINTING'S IMPACT ON THE VALUE CHAIN

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INTRODUCTION

3D printing, also known as additive manufacturing (AM), has been around now for several decades, expanding into new markets and industries in unique ways as innovators have embraced the technology.

It wasn't until the last few years, however, that its potential has been more broadly realized. During this awakening, there has been a rise in claims from influencers and skeptics that the technology has and will continue to disrupt traditional value chains.

The impact of additive manufacturing on the product life cycle is near-undeniable, but businesses who utilize 3D printing have seen their traditional supply chain remain relatively unchanged due to a slow moving shift in corporate leaders' understanding of the technology's business value.

Before 3D printing can impact operations on a broader scale, there are challenges that must be addressed, such as equipment and material costs. When these cost considerations are evaluated alongside the benefits of 3D printing, more companies will realize how 3D printing can give their business an edge.

Full adoption of additive manufacturing is steadily growing as the 3D printing perspective is evolving. In the early 80's and 90's, 3D printing was just emerging and developing beyond Stereolithography (SL), the first additive technology widely used commercially and positioned for producing fast prototypes and first iterations. By the mid-2000's, commercial 3D printing reached a new maturity as consumer 3D printers hit the market. The idea of "a printer in every home" emerged, sparking the maker movement and expanding the idea of 3D printing beyond the manufacturing world and into the hands of 3D designers and the general public. During this time, very few AM processes were adopted for production. Now, 3D printing is experiencing a new stride, one that is more realistic about the technologies' capabilities and their place in production.

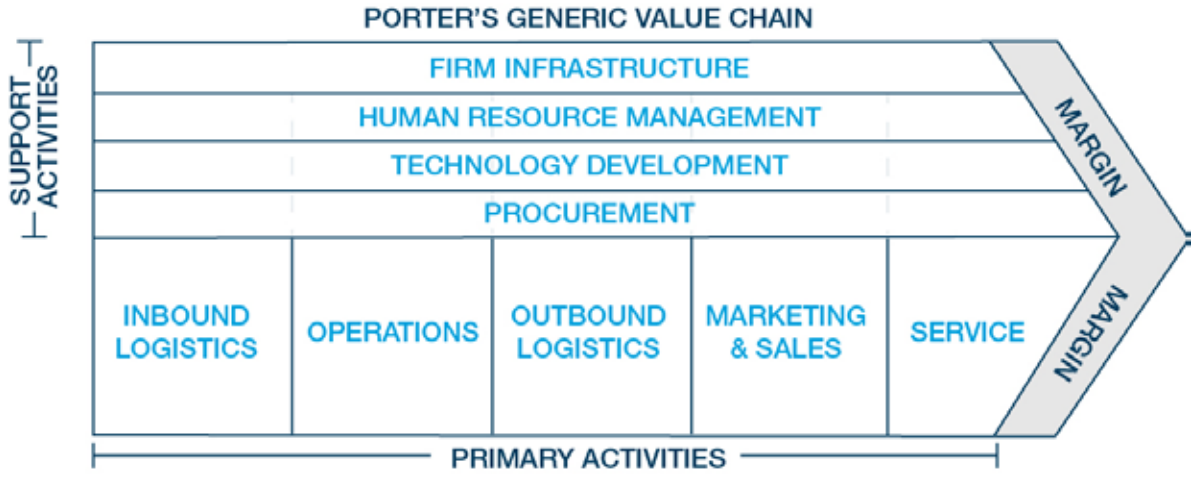
AM is cementing its status as a powerful method capable of being used throughout the value chain and as a complement to traditional manufacturing.

In this new era of 3D printing, we are driving towards a production revolution – an Industry 4.0 where smart, digital production ecosystems communicate, interpret, evaluate, and augment behaviors to drive better manufacturing.

Looking towards the future, 3D printing aids in the advancement of this vision by acting as a key physical manufacturing component utilizing the digital thread as a part of the industrial "Internet of Things", or the inter-network of physical devices and buildings with the objects that collect data.

This concept is driven by the advancement of three key areas: software, equipment and people. Next generation software will serve as the conduit for Industry 4.0's interconnectedness, analysis and adaptive decision-making processes. Stratasys is already advancing toward this with the Stratasys Continuous Build 3D Demonstrator which utilizes a central cloud-based architecture. The machines utilized throughout the design, manufacturing and related operations must be able to communicate and react in real-time with future software. The real-time communication will result in fast, reactive manufacturing. Most importantly, the software and hardware of Industry 4.0 are powered by the innovation of people pushing the envelope of what's possible today.

Early, yet substantial, progress has been made, and these improved production processes will translate into competitive advantages for businesses adopting AM throughout their organization. As we drive toward the smart factory of the future, there are key ways you can implement 3D printing today, as expanded upon below.



Porter's Generic Value Chain illustrates the typical set of activities that businesses perform to deliver products to market.

PRODUCT AND TECHNOLOGY DEVELOPMENT

Businesses that embrace 3D printing leverage unparalleled speed in product development. These businesses can iterate faster with 3D printing's tool-less manufacturing and reduced production times. Integration of 3D printed production components enables users to incorporate components or features too costly or impossible to manufacture.

The real benefits of additive manufacturing are not fully realized until companies shift their approach to product design. Instead of viewing AM as a replacement manufacturing method for components that were designed with another process, businesses should embrace new designs with the features and capabilities of 3D printing in mind. Part consolidation is the first step toward product design with AM in mind, but the ultimate shift occurs when engineers look at the whole system and redesign with functional efficiency in mind.

Part performance can be improved through 3D printing due to benefits like part consolidation, which can significantly reduce weight. Other light-weighting methods, the inclusion of conformal features and topology optimization are also benefits that result from 3D printing parts.

SALES AND MARKETING

A significant benefit from AM's speed of production is having an effective sales and marketing model quickly. Garner initial sales by illustrating true product functionality with prototypes and sales models to secure orders before the product or service is completed.

Recently, Olympia Entertainment used 3D printing to build an ambitious scale-model of The District Detroit. In a bid to drum up support for the project and illustrate their grand vision, Olympia Entertainment and local architectural design agency Zoyes Creative Group teamed up with Stratasys Direct Manufacturing to create a preview center featuring the 50-block miniature.

Zoyes Creative Group outsourced a majority of the 3D printing to Stratasys Direct, including parts up to 36 to 40 inches in length and 20,000 individual people to fill the seats of the Little Caesars Arena. Because of the speed and flexibility that comes with 3D printing, Stratasys Direct Manufacturing was able to print pieces, review them, make changes when needed and then reprint without affecting Zoyes and Olympia's project timeline. With an expectation that they would sell all of the new stadium's suites within 6 months, the resulting model helped sell out the suites in 40 days.

The FDM model included 20,000 people in the stands

How 3D Printing Shrinks the Supply Chain

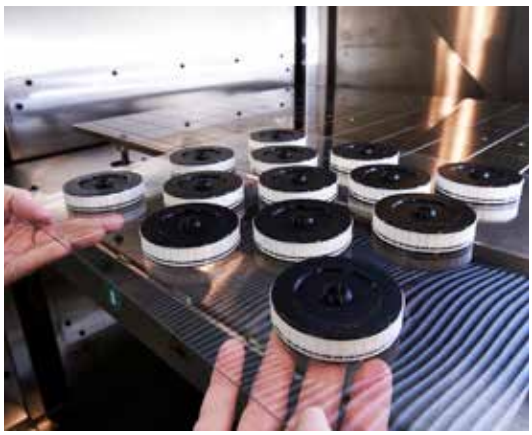
So how does AM adoption shorten the typical supply chain? To start, you have fewer suppliers to work with, many of them offering local production with lower labor units. There's no need to follow cheap labor rates overseas, and there are minimal or no tooling costs. With the fast responsiveness of AM service bureaus, your team can address issues effectively and rapidly. With made-to-order parts, there are no warehousing costs, and parts can be delivered faster.

REDUCED INVENTORY WITH ON-DEMAND MANUFACTURING

Digital design files allow for a "virtual" inventory of parts available for print on demand. This transition can lead to significant costs savings with less storage requirements and the ability to quickly edit designs and produce new iterations. This added agility enables unparalleled responsiveness to market needs.

SUPPLIER CONSOLIDATION

Currently, manufacturers may source tens to hundreds to thousands of parts from a variety of suppliers. Looking forward, the model for procurement may look very different. Manufacturers will be able to acquire a range of parts from a much smaller group of suppliers armed with a fleet of 3D printers. A byproduct of this capability is the added advantage of supplier redundancy. Experienced service bureaus offer reliable service with the knowledge of which technology works best for your applications and the quality requirements to meet expectations.



Local suppliers 3D print designs on-demand

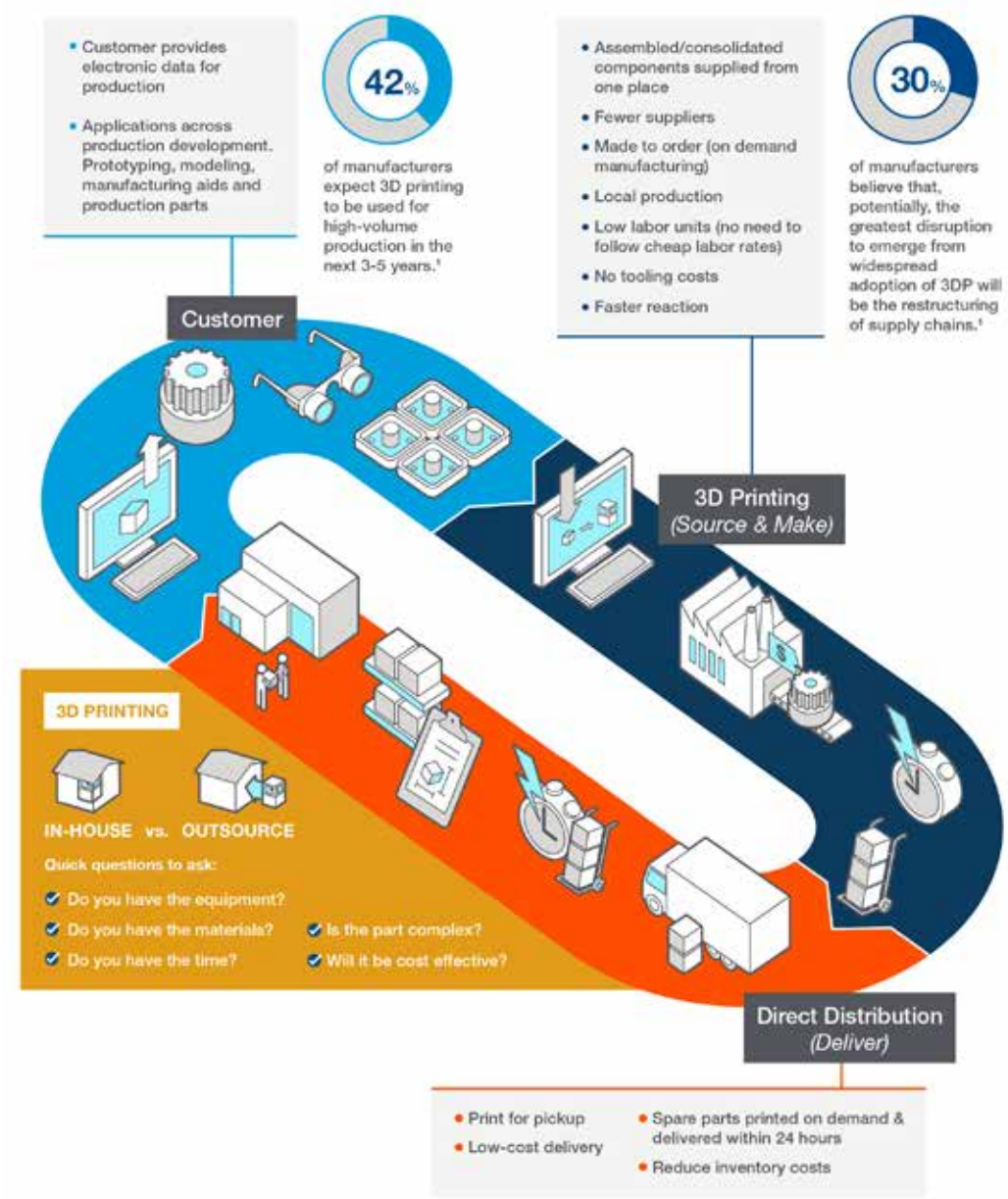
DISTRIBUTED MANUFACTURING

Specific facilities can locally 3D print designs on-demand from files sent securely across the globe, or they can print from a nearby supplier that provides needed capabilities. The ease of a local build opens the potential for significant transportation cost reductions, giving businesses the control to print parts when they're needed, where they're needed.

INCREASED RESPONSIVENESS

A halt in the production line results in compounded production problems down the line. Long lead times are a thing of the past when businesses embrace 3D printing for expeditious tool-less manufacturing. In some cases, parts can be made within hours or days instead of weeks, significantly reducing manufacturing downtime.

For example, the Oreck Corporation recognized an opportunity to utilize 3D printed customized fixtures for inspection of first articles for their vacuum cleaners. It took Oreck thirty days to complete its first article inspections of twenty to thirty components with the modular aluminum clamp fixtures. With 3D printed fixtures, the QA team was able to do the same amount of work in a single day at 32% of the costs.



3D printing's impact on the supply chain is a simplified, optimized flow from customer to manufacturing.

SERVICE

Replacement parts represent a multi-billion dollar industry ripe for 3D printing. Reduce your reliance on costly inventory management of spare or obsolete parts, and enable customers to access parts instantly. They can choose to have them printed on-site or delivered within days.

For example, Jay Leno used Stratasys Direct Manufacturing's services to reverse engineer a broken, obsolete pilot light to restore one of his White Steam cars. An INCONEL® 718 burner was produced with Direct Metal Laser Sintering. Leno was enthused by the technology, calling it a "revelation" for antique car collectors and restorers. The ability to build new iterations of obsolete parts is one way that 3D printing has increased customer satisfaction and expanded the ability to creatively solve maintenance, repair, and operational challenges.

PwC's Strategy& released survey results regarding the 3D printing of spare parts in 2014. The survey consisted of respondents from 38 German industrial companies. The results showed that:

- Companies that invest in printing spares today will gain a competitive advantage
- Over half of companies fear losing marketing share to third-party suppliers
- Lack of expertise in 3D printing is seen as the main challenge
- Partnering with experts will be key

Companies that invest in printing spares will gain a competitive advantage.

Some businesses may be dipping their toes into the additive manufacturing world with hope of leveraging its benefits. However, simply using 3D printing for some projects does not mean actualizing its full potential. The following highlights key areas that businesses can examine for further implementation.

RANGE OF APPLICATIONS

The advances of 3D printing have made applications possible from prototypes to marketing tools to manufacturing aids to production parts. Businesses who aren't utilizing AM throughout the full product development cycle are likely missing out on cost-savings, lead time reductions, and improved product performance.

DESIGN FOR MANUFACTURABILITY

Businesses that adopt AM open up new possibilities with an incredible freedom of design. Parts can be designed for function rather than manufacturability. With benefits like part consolidation, organic cellular structures, and the ability to easily build tough features like undercuts, conformal structures and living hinges, 3D printing offers a new opportunity to design and produce geometries and assemblies previously thought impossible. Let 3D printing enable the next wave of innovation in your company.

MATERIAL/PROCESS SELECTION AND TECHNOLOGY INTEGRATION

There is no one-size-fits-all process when it comes to manufacturing, even with additive manufacturing. By trying different 3D printing technologies and subsequent materials, new possibilities and applications are born. Each process has its own benefits and detractors, but by experimenting beyond what's comfortable and known, a company could reap huge rewards.

Furthermore, it's important to acknowledge additive technology as a complementary method to conventional manufacturing. 3D printed jigs and fixtures on the manufacturing floor, bridge-to-production applications for mass-produced products, and assembly components all demonstrate the technology working in conjunction with traditional manufacturing. Sometimes 3D printing's biggest impact may not be in the final product; rather, it may be used to produce manufacturing tools that streamline the production floor. Specifically, 3D printed jigs and fixtures provide a light-weight, cost effective and customized solution for traditional production floor processes.

The future of manufacturing will depend on this complementary view of additive and conventional manufacturing technologies. Traditional methods are being considerably challenged and advanced as a result of additive manufacturing's capabilities.

INFRASTRUCTURE

A lack of trained personnel, limited space for industrial printers or wait times to use the machines can restrict the effectiveness of 3D printing in your organization. To avoid limiting a project's potential, businesses may consider buying additional printers or hiring supplementary employees. By performing a make vs. buy analysis, businesses may turn to another solution – outsourcing to businesses who are experts on technologies and materials.

Recognizing the value of service providers and educational partners is key to utilizing 3D printing to its full potential. Experienced suppliers know the machines, their capabilities and the materials that will benefit your project. They can provide insight into your design and how to secure your project's success. They also act as helpful suppliers when your own 3D printing capacity becomes insufficient for your job needs.

INTERNAL SUPPORT

A vital element of taking full advantage of additive manufacturing for businesses is having a 3D printing champion or group in the organization. This person or team will take on the responsibilities of learning the key elements of the technology's impact on the organization, and they will in turn learn to communicate its financial, business and engineering value.

The 3D printing champion(s) can take the time to educate the organization on 3D printing's potential and identify key areas that it can improve upon. By facilitating training they can help cultivate an organization whose employees are knowledgeable about the technologies and are able to bring about additional use of the machines

Identifying internal 3D printing champions for your business is a key step of taking full advantage of 3D printing.

CUSTOMER STORIES

Two Stratasys Direct Manufacturing customers took full advantage of 3D printing in key areas along their value chain, resulting in incredible illustrations of how strategic use of 3D printing reaps incredible rewards.

BELL HELICOPTER

Bell Helicopter Textron Inc., a leading developer of military and commercial helicopters, frequently explores additive manufacturing for the creation of functional hardware. Bell turned to Stratasys Direct for the production of several components of ECS (environmental control systems) ducting because of their expertise, breadth of technologies and commitment to quality with AS9100 and ISO 9001 certifications.

The ECS components were complex in design, with multiple geometrical intricacies and internal features – an endeavor perfect for AM. The parts had to meet aerospace quality standards and Bell's rigorous testing processes.

To fulfill these requirements, Stratasys Direct Manufacturing recommended Laser Sintering (LS) technology because of its ability to build tough and geometrically intricate components without the need for support structures. Perfectly suited to Bell's quality requirements, Stratasys Direct performed several inspections and tests to confirm LS produced parts adhering to specification and product quality requirements.

Elliott Schulte, engineer III at Bell said the "technology produces a robust and highly repeatable process. We often discovered that the production cost per piece is reduced compared to conventional manufacturing methods when producibility is a factor."

The AM process yielded high rewards for Bell Helicopter. For their 429 helicopter program, there was a 24% part-count reduction when designs were converted to Laser Sintering, with six materials reduced and rework eliminated. Overall, the most crucial savings for the 429 program was in weight. Bell measured an overall weight savings of 2/3 lb. for every 1 lb. of laser sintered weight.

By using LS to manufacture a defog duct nozzle component for their 412 helicopter program, Bell realized a weight savings of 13% and a lead time compression of 75%. Employing design consolidation reduced the part count by three part numbers. They estimated a cost avoidance of $120K because of the elimination of conventional tooling and rework.

Delivered quicker, with a repeatable process and at a competitive cost per piece, AM proved to be a perfect solution for Bell's ECS ducting.

DEFOG DUCT NOZZLE	
WEIGHT SAVINGS	13%
LEAD TIME COMPRESSIONS	75%
COST AVOIDANCE	$120K

429 HELICOPTER PROGRAM	
WEIGHT REDUCTION	2/3lb for every 1lb of LS weight
PART-COUNT REDUCTION	75%

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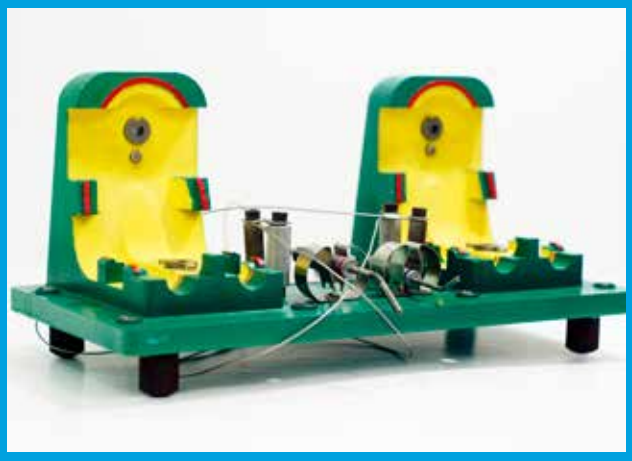
TS TECH

TS Tech Co., Ltd, the world's sixth-largest interior component manufacturer with assembly plants in 13 countries across the globe and $3.6 billion in sales, is the number one seat supplier for an international automotive company. Engineers at TS Tech are constantly evolving and perfecting the tools they use to validate parts. Stephen Mollett, a tooling engineer that oversees the fixtures and tools used to inspect seat frames, was interested in improving the solid aluminum check fixture used to inspect a back seat hinge. Because of his previous working knowledge of 3D printing applications, he understood the potential benefits.



Latest iteration built with FDM and CNC machined metal parts

TS Tech utilizes an in-house FDM (Fused Deposition Modeling) 3D printer to create components for their customers. This machine can have "an unbelievable waiting list" for part production during new model development activities and is essentially working 24/7. A great deal was riding on the success of this fixture, so turning to Stratasys Direct Manufacturing for its fleet of 3D printers and decades of 3D printing expertise made sense. Stratasys Direct quickly went to work to optimize and produce a 3D printed check fixture that weighs less, costs less and saves time.

Associates at TS Tech's metal stamping plant, as well as their suppliers, use check fixtures early in the production process to inspect seating frames and other componentry for the car seat systems. Using the check fixture, workers can visually, aesthetically and mechanically validate hole placement and depth, part width, dimension and form. Associates use the fixture to check a statistical sampling of parts at the inspection station next to the stamping press. The fixture itself is designed to check around 42,000 parts in its life. The check fixtures are typically heavy and stored on shelves in the stamping facility, and employees often carry them by hand or small cart across the facility to the press for parts inspection. This walk could be a long trip for an employee carrying a 40-pound tool.

The most recent check fixture iteration is a 3D printed check fixture with clamp-on assemblies. Even with its smaller profile, it ensures better alignment, with greater accuracy, for use across the assembly plant. And most importantly, it weighs just 4 pounds – that's only one-tenth the weight of the aluminum fixture previously used. This significant reduction in weight is a great benefit to each one of TS Tech's associates.

It also costs significantly less to build the new assembly line check fixture. In total, the Stratasys Direct Manufacturing 3D printed check fixture is only 69% of the cost of the old aluminum check fixture. That results in a 31% direct cost savings, along with a noteworthy cost avoidance with the elimination of the prototype fixture.

IMPACTFUL ACROSS THE VALUE CHAIN

3D printing is not an “all or nothing” approach. It holds real impact across the value chain. Businesses that embrace 3D printing iterate faster, accelerate time to market, garner more sales and condense the typical supply chain. Using 3D printing across the production lifecycle allows companies to provide unique services to their customers, expand their ability to creatively solve production challenges and increase customer satisfaction.

Ultimately, the future of manufacturing includes integrating additive manufacturing into the traditional value chain in order to fully optimize and streamline your production. Any company that doesn’t embrace it may be left behind.

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