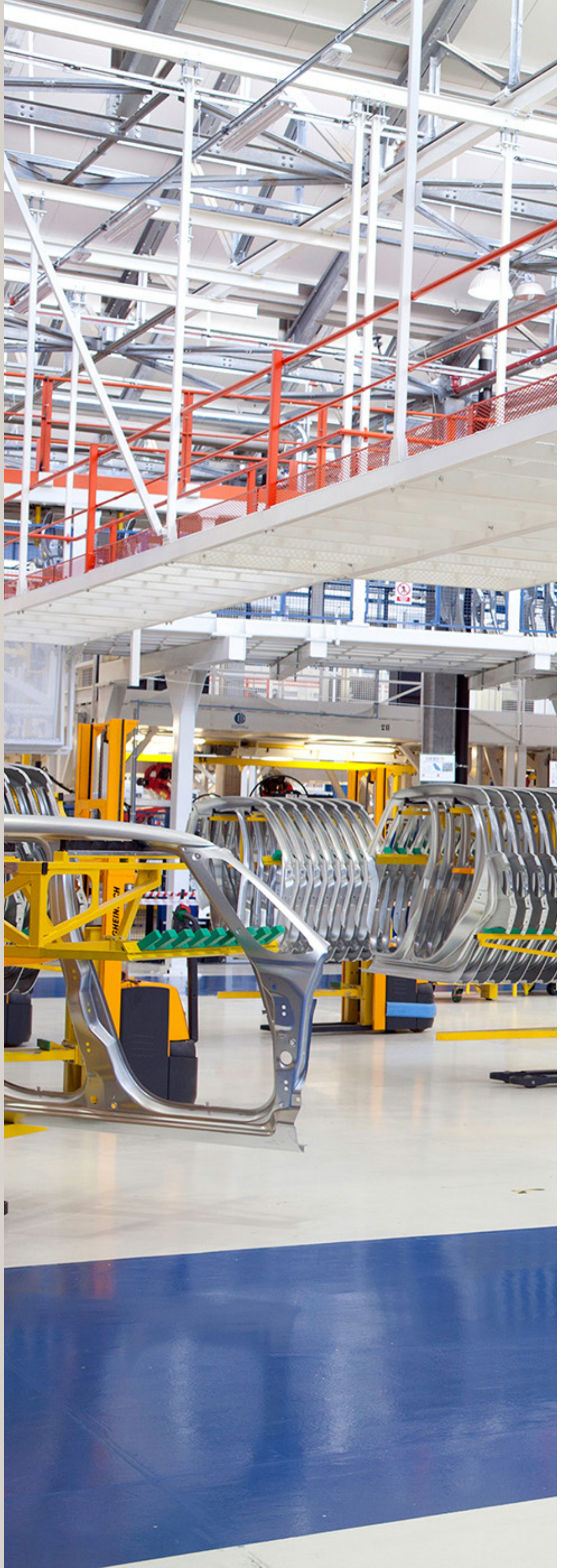
stratasys

3D Printing: The Disruption is Real

E-Book



What is Disruption

The term disruption is often viewed negatively. But "disruption" combined with innovation is often what's needed to take something to the next level. The Manufacturers Alliance for Productivity and Innovation (MAP) says that **disruptive innovation in manufacturing has created a new normal for manufacturers**.

So, is this disruption a good thing? Well if you're a manufacturer and you're looking to reduce costs, decrease waste and/or increase productivity, it's a good thing. Thanks to cloud-based computing and the Internet of Things (IoT), we are all better connected with each other and our devices.

What's this mean for manufacturing? It means "IoT has the power to transform manufacturing by changing the types of products companies will make and how they will be made, all while reducing costs. **Disruptive technologies are good for business**," according to information industry analyst Steve Beard.

Enter
3D printing

While 3D printing began nearly 30 years ago, there are still many who are unaware of not only its capabilities but its capacity to disrupt. And the digital proliferation during that time has only served to propel this additive technology into new territory.

So what exactly is 3D printing? Another term for 3D printing is additive manufacturing (AM). Routinely used for rapid prototyping across many industries, 3D printing is now finding its place on the manufacturing floor, as well.

AM uses a layer-by-layer or particle-by-particle approach to manufacturing. With additive manufacturing, **it's possible to go directly from digital design data to a final part with no intermediate production steps**. Information is gathered either from a scan or from Computer Aided Design (CAD) files, and communicated directly to a 3D printer. From these digital files, the 3D printer starts building, from the bottom up, to create a three-dimensional representation of the object.

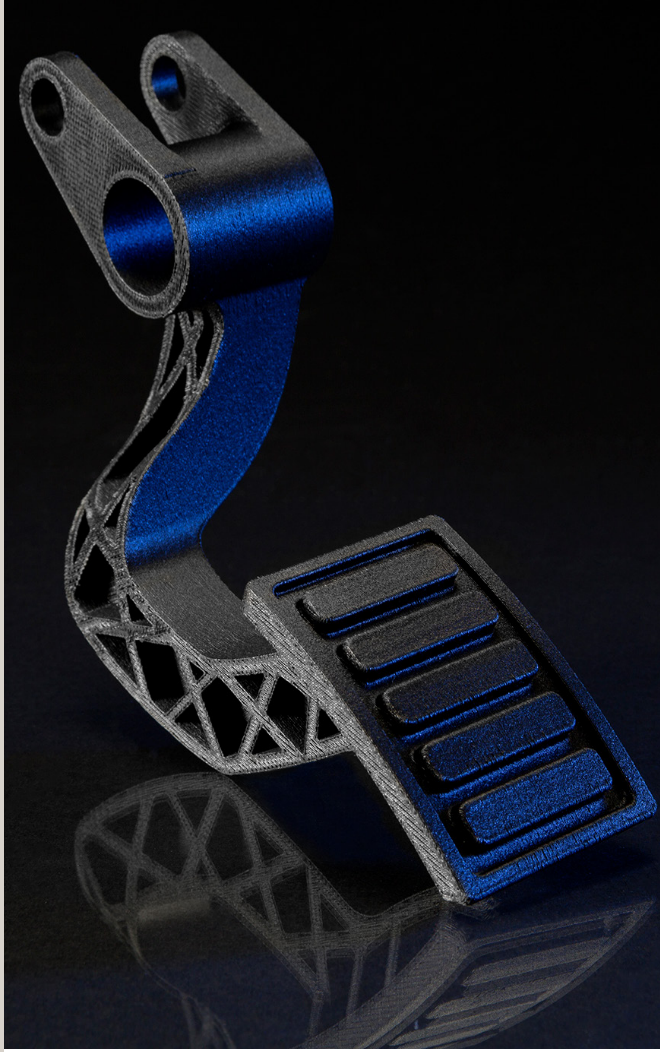
There are many 3D printing processes and even more materials but they all have one thing in common: digitization. Without digital technology, there could be no 3D printing. It's a way to design on screen and seamlessly print using a completely digital workflow.

3D printing began with hobbyists and quickly gathered steam for use in the rapid prototyping (RP) of items that can, through additive manufacturing, be made quicker and for less cost. RP is still the most heavily-weighted arm of 3D printing but new production-grade printers and materials that can replace metal and glass-reinforced parts have burst on the scene to add a whole new dimension to 3D in manufacturing.

Why additive vs. subtractive technology

Additive technology deposits materials layer-by-layer, and in subtractive or CNC and other machined manufacturing, parts are made by successively cutting material away from a solid block of material. Subtractive technology, while time-tested, is slow, wasteful, costly, and optimal only for large-volume runs.

From its inception, there have been those who've claimed 3D printing would replace traditional machining in its entirety. This has not, and probably won't, come to pass. Instead, **within manufacturing today there's a place for both traditional machining and additive manufacturing**. Often, these two processes can and do complement one another on the same production floor.



Low-volume production

The ability to quickly and economically 3D print one-off or low-volume production runs is one of the greatest attributes of AM. Design engineers in all disciplines have come to rely on 3D printing for the rapid prototyping of their designs, with iteration becoming possible on a daily rather than a monthly, or more, basis. Many designers set-up their design files then let the part print overnight, arriving in the morning to a newly-realized 3D design.

With low-volume part production, products can be customized to local markets or even to individual customer tastes, driving adoption within industries as diverse as fashion, health care and automotive.

Also, with the ability to print-on-demand, businesses also have the opportunity to **eliminate inventory and cut aftermarket lead times** by providing digital spare-parts catalogues that can be printed when needed.

AM can disrupt the traditional economies of scale by allowing cost-effective production of single-unit or low-volume parts.

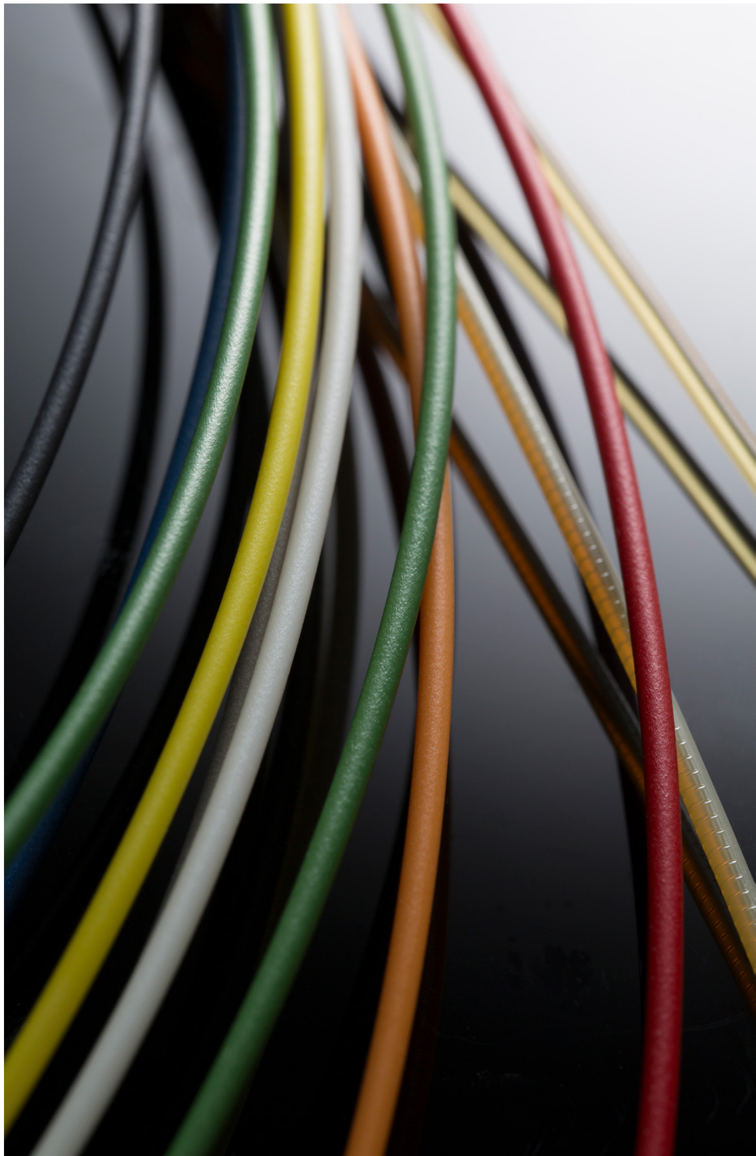
Life cycle sustainability

Another way to think of the life cycle sustainability of a part is to think of its environmental impact. This begins within the factory that produces it and continues through its active usage and afterwards. **The environmental impact of a part can be substantially reduced when produced additively versus through traditional machining.**

How? AM is highly material-efficient. There is nearly no waste with 3D printing as only the material necessary for the design is used. Thanks to digital technology, the build of a part can be optimized by positioning material only where it's needed. This not only reduces the amount of scrap but also reduces the amount of energy needed to produce the part.

Taking this a step further, this ability to design a part with an optimized strength-to-weight ratio also has a life cycle environmental benefit. **Lightweight parts used on vehicles like aircraft and cars further reduces fuel consumption and the resulting emissions.**

The ability to disrupt shipping is another way additive technology has a positive effect on the environment. **Parts can be printed closer to the point of need, reducing or eliminating shipping and transport.** Also, the disposal of end-of-life parts will be eliminated because they need never have been printed in the first place. Finally, 3D scanning enables reverse engineering to support legacy products so parts can be printed long after the traditional stock becomes obsolete.



Increased part **functionality**

Of course, a part is more than just shape; it's also about function. The proliferation of strong, durable materials has made parts printed with **carbon fiber-reinforced materials** for strength and strong, flexible materials for parts with living hinges to multi-material parts. 3D printing with multi-materials can even simulate wood and leather and print in **500,000 colors**.

Even electro-static dissipative materials using PEKK (ESD) can be used with electrical components and in challenging environments such as deep space.

Multi-material AM can also produce parts with isotropic properties where parts resist loading in different ways in different directions.

Supply chain realignment

Positioning technology at the heart of a business is a growing trend. Shortening the distance from producer to buyer means the **supply chain models based on economies of scale are being challenged**. This enables a seamless integration between the customer and the factory or shop producing the product, through to the distribution business distributing and/or delivering the product. AM fits nicely within this paradigm.

Integrating additive into their existing supply chains is only the beginning, however. With in-house 3D printing, companies, business and medical facilities are using 3D scanning technologies at the front end of the supply chain, which allows customers to become product designers, recipients of personalized medical models and devices as well as driving lean and agile manufacturing. Patient-specific products derived from medical **scanning and imaging data means AM products can be fully customized**.

Spare parts on demand, whether through a hardware store or a large fulfillment center, are another way 3D printing is revolutionizing the way supply chains operate.

Finally, AM on-site or in geographic proximity to its end-use means parts can be made closer to the customer, point-of-sale or patient. All these factors contribute to reduced lead times, transportation costs and decreased environmental impact.

Personalization

Personalization is a 21st Century trend. From personalized device covers to personalized automotive plates, to medical devices 3D printed from a pathology-specific patient scan, personalized products are on the uptick.

Not only does 3D printing enable this trend, it defines it. No other manufacturing process is able to support personalization with no added cost.

Design Complexity

Additive manufacturing has another very important value-add over traditional manufacturing. 3D printing can produce parts that can't be produced any other way. Complex designs and objects-within-objects simply cannot be manufactured traditionally.

Taking part complexity to even a higher level, there's another huge benefit with AM. Part complexity is not associated with cost as it is in traditional manufacturing. The phrase **"complexity is free"** is frequently used when talking about the benefits of printing complex parts using AM.

In its most extreme form, parts designed for additive can be designed around lattice structures and honeycombs or using genetic algorithms – all producing parts that are **lightweight yet structurally sound and functional**.

Again, due to the additive nature of 3D printing, only the material needed to produce the design is used (along with some support material, depending on the design).

Volume of part also has no relation to its respective cost. Instead of needing to spend thousands to have a costly mold made to produce a low-volume part, 3D printing enables the economical rapid iteration of design. (Part cost and production volume, whether high or low, have no correlation.)

AM with its disassociation of volume and cost, is a customization-enabler.

How is 3D printing disruptive

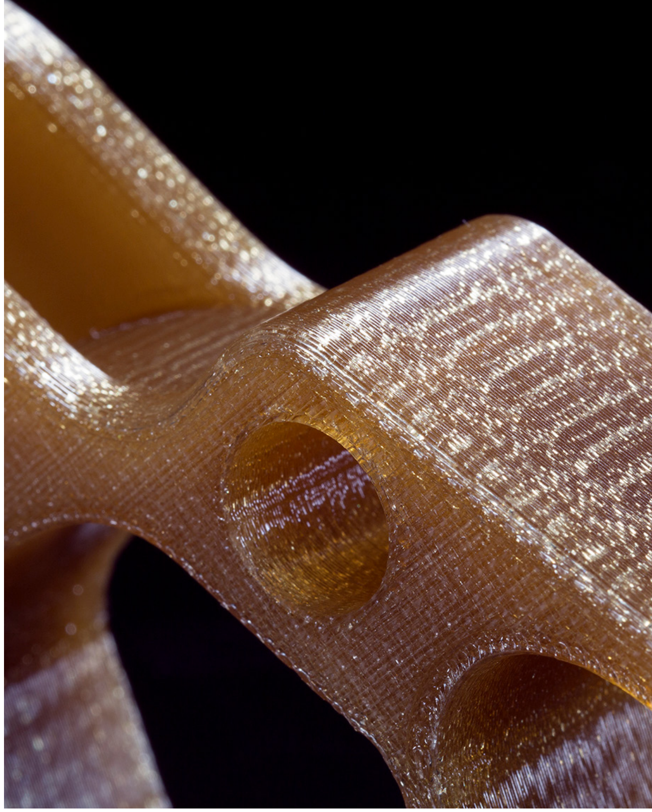
"The adoption of additive manufacturing as an engine for growth and innovation is reaching levels where the potential for disruption is becoming very real."

Dr. Phil Reeves
additive manufacturing expert

If we go back to the beginning of this eBook and revisit our working definition of "disruptive technology," we see disruption is often the function of not only meeting society's or an industry's needs but also anticipating future needs.

We've already seen how AM has disrupted production, sustainability, supply chains, personalization and design complexity. Now we'll turn to how this disruption supports various manufacturing sectors.

Aerospace



The aerospace industry is a prime adopter of AM due to the process's high strength-to weight properties and design freedom. Not only can parts be geometrically optimized to reduce aircraft weight and extend fuel consumption but they can also increase engine efficiency through component part design optimization.

Additive manufacturing also reduces the volume of raw material needed within the supply chain, decreasing costs and the associated lead times. **Spare parts on demand** for maintenance, repair and overhaul facilities is another way AM is helping aerospace.

Increased personalization on private jets and commercial jet interiors helps airline branding. Even fast, customized tooling for the shop floor aids in production fixes. New materials are even enabling 3D printed parts to travel to deep space.

Lockheed Martin Space (LM), prime contractor for the NASA's Orion program to deep space and Mars, uses 3D printing to ensure part consistency, material properties and the highest quality due to the fact there will be humans on board.

LM has seven 3D printers in its additive manufacturing lab due in part, to new materials capabilities on some of the printers. While **ULTEM™ 9085** material has been an industry standard, it lacked the electro-static dissipative properties of a new material called **Antero™ (ESD) PEKK**.

ESD PEKK "has enabled us to achieve very consistent builds that move beyond the realm of prototyping and into production in a manner that is consistent," says Brian Kaplun, manager, additive manufacturing at LM Space.

Kaplun sees something very special about a space mission that's going to have people on board. "There's that intimate connection when you can associate yourself with the astronauts going on the mission, and it's nice to be able to tie-in technological advancement [like 3D printing] to these missions."

Want to learn more about Lockheed Martin's use of additive in space?

LOCKHEED MARTIN

Aerospace

Even when a 3D printed part isn't going into deep space, there are a lot of material constraints around approved parts. **Stratasys**, the leader in 3D printing technology has qualified their **Aircraft Interiors Certification Process (AICS)**, providing a clear-cut path to certification for flight-worthy parts.

This AICS process encompasses a special configuration on its Fortus 900mc Production System 3D printer in combination with the establishment of design allowables for material that ensures certified parts.

Interested in learning how to develop flight-worthy parts?

AICS SOLUTION

Automotive

The **auto industry** was one of the early adopters of AM as a way of making rapid prototypes back in the 1980s.

The sector's use of AM has matured along with the technology itself and is now routinely used in the product development process, from concept design and early-stage prototyping, to making low-volume components used on demonstration and test models.

Some high-value, low-volume car markets are already starting to use the technology to make permanent metallic and polymeric component parts, from exhaust manifolds and turbochargers to personalized interior trim components.

Vehicle markings to support legacy vehicles with spare parts and within dealerships to add personalization value are another use of additive.

Audi, the luxury car brand, is using 3D printing for advanced prototyping thanks to the **Stratasys J750's** ability to produce prototypes that are as realistic as possible. In fact, says Tim Spiering, head of the 3D printing center in Ingolstadt, Germany, **"The J750 is the most versatile printer ever produced."**

The ability to 3D print up to six materials simultaneously, has enabled Audi to print tail light covers directly. "We can produce tail lights – both red and transparent – in a single piece," says Spiering. Audi updated to the Vivid Colors palette and can now print up to 500,000 colors.

But multi-material, multi-color 3D printing is not the only plus for Audi. **The ability to print overnight for results the next day, gives them the advantage of prototyping speed up to 50% faster than through traditional methods.**

See Audi's innovation and cost savings with 3D printing.

AUDI VIDEO

Consumer goods and fast moving consumer goods

The **consumer goods industry** is a prime adopter of 3D printing, especially for the **rapid iteration of design prototypes**. These prototypes are used not only to sell designs to stakeholders, but to provide them with something tangible to actually hold in their hands. It also gives them the design freedom to rapidly iterate to help speed their product to market.

Again, the cost effective production of low volume runs makes design iteration possible. Also, the advanced materials that allow multi-materials to be printed in a single print add functionality and value.

Brooks Running uses in-house 3D printing to speed design iteration and validation of their shoe designs amidst a highly competitive marketplace. With a minimum of five new shoe designs a season, the ability to design then print **saves untold outsourcing time as well as $500-$800 per shoe design**.

As for the ease-of-use in-house 3D printing provides, Kenny Krotzer, footwear developer at Brooks says their printer saves “untold time and headaches” during the design process. “We aim to build the best performance product on the market and now we have a new tool to help us get there.”

Learn how 3D printing has helped solve the prototyping dilemma for Brooks Running.

BROOKS

Consumer Electronics

AM is being used by some companies to produce personalized cases for smartphones and tablets, with other companies going one step further to use AM to produce the ergonomic bodies, housings and spare parts for devices such as electric razors and cell phones.

The ability to integrate AM with digital intellectual properties allows consumer electronics companies to create new revenue streams. AM also provides a higher level of product personalization which provides broader applications within consumer electronics. Also low volume packaging for limited market products and the manufacture of spare parts for legacy technology.

Medical

Patient-specific surgical cutting guides, implants and prosthetics along with other devices such as orthotic insoles and rehabilitation splints are being 3D printed. CT and MRI scan data can also be used to print patient-specific pathology for pre-surgical planning, education and physician training. Surgeons can use these models to plan complex procedures, reducing OR time and its associated costs and risks.

Medical device manufacturers also use 3D printing to add value to every stage of the product life cycle. From prototypes to models used for verification and validation to test rigs used to simulate the actual anatomy surrounding the pathology to help in preclinical trials.

In a surgical environment, 3D printing takes a whole other level of importance. It's about more than speed and cost, it's about lives. **The Hospital for Sick Children (SickKids)**, in Toronto, knows there's a direct correlation between the volume of practice a surgeon gets pre-surgery and the outcome, especially when it comes to difficult surgeries.

Dr. Glen Van Arsdell, head of cardiovascular surgery at SickKids and Dr. Shi-Joon Yoo, head of pediatric cardiac imagine at SickKids began 3D printing pediatric heart models a few years ago to enable education and training at the facility.

"The reality of training on anatomically accurate, realistic models finally became a reality. Advanced medical models are anatomically accurate, have the ability to mimic various pathologies, and provide true haptic feedback for surgeons-in-training," said Van Arsdell.

Learn how SickKids 3D prints pediatric hearts to save lives.

SICKKIDS

Medical

Medical devices developed and produced by original equipment manufacturers (OEMs), have a different set of challenges that 3D printing aides. The product lifecycle of a medical device can be extremely protracted and fraught with regulations. “With 3D printing, we can be very quick in our process by developing a prototype component one week and then gather feedback from physicians the next week,” said Will Besser, senior product development engineer at **Cardiovascular Systems, Inc.**, a med device company focused on treating peripheral and coronary artery disease.

“We take angiographic images and use 3D modeling to recreate the complex anatomy of different coronary vessels, 3D print a realistic model and stress test different situations to see where we can improve our device,” says Nick Ellering, product development engineering manager.

For Will Besser, senior product development engineer, the beauty of 3D printing is that “we can be very quick in our process by developing a prototype component one week and then gather feedback from physicians the next week.”

See how 3D printing paves the way in the medical device industry.

CSI

Process **industries**

AM has already established its place within the process industries and the power and utility sector. Using high performance polymers and metals, companies are producing heat exchangers, catalysts, filters and strainers, cutting tools, complex pipework and ducting along with a host of experimental devices and test rigs.

AM is also being used for the resupply of spare parts and as a way of making specialist tooling needed in remote locations.

Drivers for AM within these industries include low volume cost-effective production of component parts and responsive supply of high value spare parts and distributed manufacture of parts at remote locations. The manufacture of complex geometry parts and systems with added functionality are another use of AM within this sector.

Good Disruption

Although there are no exact numbers when it comes to predicting the growth of the AM market, one thing is sure: **The adoption of AM as an engine for growth and innovation is reaching levels where the potential for disruption is becoming very real.**

And this kind of disruption is a very good thing.

Learn more about 3D printing and the industry solutions it provides by visiting our website at www.stratasys.com.

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