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3D Printing Quarterly Report—Q1 2017

3D PRINTING–A FAST MOVING MARKET

Developments in 3D Printing

A Sector by Sector Overview

Overview

This report explores recent developments across a number of sectors as it relates to 3D printing and its impact on each sector. We've limited our scan to the last three months to demonstrate the pace and scope of activity in the market.

For more information, please contact:

Mark E. Avsec
(216) 363-4151
mavsec@beneschlaw.com

www.beneschlaw.com

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General

3D Printing Market to Reach Nearly $30B by 2020: IDC

IDC forecasts that worldwide spending on 3D printers, along with associated software, materials and services, will reach $28.9 billion in 2020, compared to an estimated $13.2 billion in 2016. It's expected that the manufacturing industry will control the market for the foreseeable future, responsible for more than two thirds of the revenues in the space. IDC believes, however, that medical companies in the U.S. and Western Europe will push healthcare into the number two spot by 2020 with revenues of more than $3.1 billion.

Education

Arizona State University Unveils 3D Printing Research Facility

Arizona State University has opened what is so far the largest 3D printing research facility in the Southwest region of the U.S. The new facility was made possible through a partnership between Arizona State University, Phoenix-based Honeywell Aerospace, Temple-based PADT and Grapevine, as well as Texas-based Concept Laser, a manufacturer of 3D printing machines. According to PADT principal Eric Miller, as more industries use 3D printers to produce everything from dental work, tools and engine parts, more students will need to know how to use these machines. The research center holds several different 3D printing machines of various sizes and uses, including equipment that manufactures products made of plastic, polymer and metal.

GE Pours $10M in Additive Education Program to Foster 3D Printing Talent

GE is investing a total of $10 million over the next five years in its GE Additive Education Program, which seeks to develop future talent in the field of additive manufacturing. GE investment will enable educational institutions to have access to 3D printers which will help accelerate the adoption of the technology worldwide. Specifically, a $2 million investment will be made over two years to subsidize desktop polymer printers for primary and secondary schools around the world. Priority will be given to institutions serving ages 8-18 with a strong commitment to STEM education. A second $8 million investment will be made over five years to subsidize up to 50 metal additive machines to colleges and universities around the world. Priority will be given to institutions with curriculum and/or research underway in the field of additive manufacturing.

Arts & Entertainment

Weta Workshop Turns to 3D Printing to Create Practical Effects for *Ghost in a Shell* movie

In a recent installment of his web series *Tested*, former *MythBusters* TV personality Adam Savage paid a visit to New Zealand's Weta Workshop, the practical effects studio behind the movie *Ghost in the Shell*, to get a sneak peek at how some of the props for the movie were built. Instead of going with the more commonly trodden path of CGI, Weta Workshop crafted the robot skeleton for the movie's main character using 300 interconnected, 3D-printed, laser-cut, and hand-modelled components. 3D printing the individual pieces took hundreds of hours and was based off a CAD file that was also made in-house. The robot geishas featured in the movie were also built with the help of 3D printing. Once the geisha masks were digitally modeled, the workshop used a combination of 3D printing, milling, and hand sculpting to bring the masks to life.

History Channel Hosts 3D Printing Giveaway During Fourth Season of *Vikings*

During the fourth season of *Vikings*, the History Channel hosted a giveaway contest dubbed the 3D Prophecy Challenge, a weekly contest that tested viewers' knowledge of the show and Viking history, while also putting a spotlight on the ways 3D printing technology can be used to recreate historic artifacts. To make this happen, the History Channel turned to the studio team at 3D Brooklyn to recreate a series of significant objects and props central to the season's storyline. Before every new episode, the network introduced a weekly object via teaser videos posted on Facebook. The viewer who correctly guessed what role the item would play within *the show* won the 3D-printed replica of the onset prop. The studio primarily used the Makerbot Replicator 2 printer to make objects in biodegradable plastics, but used Formlabs' Form 2 resin printer for objects requiring more surface detail. According to 3D Brooklyn co-founder Nate Kolbeck, the History Channel collaboration opened up the door for future collaborations with museums and cultural institutions.

Researchers Mix 3D Printing and Virtual Reality to Enhance Museum Experience

Researchers from Deakin University in Australia are using 3D printing and virtual reality to capture a paleontological dig in what used to be a Gondwanan riverbed. "We're looking at how we can use virtual reality and 3D printing to help with providing educational experiences in a museum context," said Ben Hornan, from Deakin's Virtual Reality Lab. The work will be displayed at Geelong's National Wool Museum in what researchers believe will be a world first. The centerpiece of the exhibition will be a 3D-printed dinosaur based on one of the most complete skeletons ever found in Australia.

Cybersecurity & 3D Printing

NYU Researchers Warn Against 3D Printer Cybersecurity Vulnerabilities

According to researchers at New York University's Tandon School of Engineering, 3D printing carries cybersecurity vulnerabilities that can lead to potentially dangerous, undetectable defects. NYU Tandon professor Nikhil Gupta said that through their research they've shown that 3D printers can either intentionally or inadvertently be instructed to create defects in products, meaning hackers could intentionally alter a print to ill effects. Everyone in the supply chain, he adds, from 3D printer manufacturers to design engineers that use them, will have to take some role in addressing potential cyber threats. For his part, Gupta co-founded a startup, called 3DP Security, which is focused on identifying and addressing cybersecurity threats associated with 3D printing. The startup emphasizes four key solution areas: embedded tracking to ensure CAD files are not stolen; automatic dimensional control to ensure optimized printing; CAD modeling strategies; and microstructure tagging.

Printing Techniques and Capabilities

3D Printing Could Lead to Advancements in Membrane Capabilities: Research

Researchers at the University of Bath's Centre for Advanced Separations Engineering suggest that through the use of novel 3D printing techniques it could be possible to offer novel produce membranes of different shapes, types and designs, which can be more precisely designed, fabricated and controlled than any other membrane fabrication method currently available. In an article published in *Journal of Membrane Science*, the research team claims that the increased membraned capabilities made possible by 3D printing could has significant implication for number of key industries, including the water industry. Membrane technology potentially offers lower energy, more sustainable molecular separations that can be applied to a wide range of gas and liquid separations, they note.

MIT Scientists Develop 3D Printing Technique that can Change Color, Shape of Printed Objects

Scientist at MIT have created a 3D printing technique, called living polymerization, which makes it possible to change the polymers in an object—its shape and colors—even after the object has been printed. Previously, through the use of the common 3D printing technique known as stereolithography, the polymers in a printed object were considered "dead"—they couldn't be extended to form new polymer chains, which would in turn alter the printed object. To overcome this limitation, the scientists designed new polymers that would react to light. These new polymers contain chemical groups known as TTCs, which are activated when turned on by light. For example, when blue light from an LED shines on the polymers, it attaches new monomers to the TTCs, which makes them stretch out. The group of scientists also found that they could make materials become bigger or smaller using different temperatures by adding a specific monomer. The limitation of this new technique, however, is that it requires an oxygen-free environment.

Mass. 3D Printing Company Unveils Metal Printing Technique using Metal Powder, Plastic Binders

Cambridge, Mass.-based Markforged unveiled a novel metal 3D printing technique called Atomic Diffusion Additive Manufacturing (ADAM) to produce metal parts for manufacturers in industrial, automotive, medical and aerospace industries. Through the ADAM technique, parts are printed, layer-by-layer, using a metal powder contained in a plastic binder. After the printing is done, the plastic binders are removed and the part sintered into customary engineering metals. By sintering the entire part at once, the technique allows metal crystals to grow through the bonded layers, erasing the layer-to-layer strength of many other 3D printing processes.

Israel 3D Company Embeds Electronic Components in 3D-Printed PCBs

Israel-based 3D printing company, Nano Dimension, successfully 3D-printed electrical circuits, in which it embedded electrical components, through placement, as an integral part of the printing process. The technique presents various advantages:

1. It improves the polychlorinated biphenyl (PCB) reliability by maintaining the electronic components internally and keeping them from being exposed to the external environment;
2. It makes obsolete the soldering process since the components are embedded within the printed board during printing; and
3. The process enables printing on electronic components without their complete packaging (printing directly on the dye), and consequently supports the creation of thinner, more protected PCBs.

Team of Researchers Mimick Cellular Architecture to 3D Print Materials with Ceramic Foam Ink

A team of researchers from Harvard John A. Paulson School of Engineering and Applied Sciences, the Wyss Institute for Biologically Inspired Engineering at Harvard University, and MIT, mimicking nature's cellular structure, developed a technique to 3D print materials with independently tunable macro-and microscale porosity using a ceramic foam ink. The ceramic foam ink contains alumina particles, water and air. As explained in their article published in the *Proceedings of the Natural Academy of Science*, by controlling the foam's microstructure, the researchers were able to tune the ink's properties and how it deformed on the microscale. Once optimized, the team printed lightweight hexagonal and triangular honeycombs, with tunable geometry, density and stiffness. They believe the approach could be used to fabricate lightweight structural materials, thermal insulation or tissue scaffolds.

Materials

Washington State University Team Comes Up with Novel Technique to Build Bio-Like Materials

As demonstrated in an article published in *Science Advances*, researchers at Washington State University have developed a 3D printing technique that can precisely control a material's architecture from nanoscale to centimeters, with results that closely mimic the architecture of natural materials like wood and bone. The research team used a 3D technique to create foglike microdroplets that contain nanoparticles of silver and to deposit them at specific locations. As the liquid in the fog evaporated, the nanoparticles remained, creating delicate structures. The tiny structures are porous, have an extremely large surface area and are very strong. The printing technique itself is similar to a rare, natural process in which tiny fog droplets that contain sulfur evaporate over the hot western Africa deserts and give rise to crystalline flower-like structures called "desert roses."

MIT Researchers Design 3D Form of Graphene Stronger but Lighter than Steel

A team of MIT researchers has developed a form of graphene with a density of just 5%, but that is 10 times stronger than steel. In a study published in *Science Advances*, the researchers show how by compressing and fusing together flakes of graphene they were able to make strong, lightweight sponge-like configurations. The team discovered that the strength and lightness of the new 3D form of graphene-had more to do with the unusual geometrical configuration than with the material itself, which suggests that similar strong, lightweight materials could be made from a variety of materials by creating similar geometric features.

Netherlands Scientists Use Bacteria to 3D Print Materials

Scientists at Delft University of Technology in the Netherlands developed a process that enables them to 3D print a variety of materials using bacteria. With a regular over-the-counter 3D printer, the team used bacteria to 3D print materials that resemble graphene, scratch-resistant mother-of-pearl and a bacterial based model of dental plaque that could be used to test future toothpastes. "One of the big advantages of using bacteria is that it's cheap, easy, and environmentally friendly," said Dr. Anne Meyer, a member of the research team, adding that using bacteria reduced chemical waste typically observed in traditional chemical approaches.

Dubai Startup Uses Industrial Waste to Create 'Green' Cement for 3D Printing

Renca, a startup enrolled in Dubai's Future Accelerators program, created a geopolymer cement from industrial waste that uses only a 10th of the energy compared with traditional Portland cement. The company is working with Dubai Municipality to develop its material for use in 3D printing projects in Dubai. The geopolymer cement and concrete produced from industrial by-products, such as pulverized fly ash and ground granulated blast slag, has greater thermal insulation properties than regular concrete, so is better in hot climates at resisting heat. Among the main benefit of geopolymer cement is that it is cheaper to use than Portland cement, which needs additives to work properly.

Military & Government

U.S. Army 3D-Printed a Grenade Launcher that Fires 3D-Printed Grenades

The U.S. Army's Research, Development and Engineering Center unveiled the Rapid Additively Manufactured Ballistics Ordnance, or R.A.M.B.O, a modified M203 grenade launcher that is made almost entirely from 3D-printed parts and fires 3D-printed grenades. R.A.M.B.O. consists of 50 individual parts, and all of them, with the exception of springs and fasteners, were made by 3D printing. The grenade launcher barrel and receiver took about 70 hours to print and then required five hours of post-print finishing. The U.S. Army believes the production of actual, useful heavy weapons has serious implications for defense manufacturing and that, in the future, it could be possible for soldiers at forward outposts to print their own weapons or critical replacement parts.

Finding the Process to be Efficient, U.S. Navy 3D Prints its First Aircraft Component

The U.S. Navy's Fleet Readiness Center Southeast based in Jacksonville, FL, successfully 3D-printed its first aircraft component, a replica of Ultum 1085 air duct tubing. Until now, the center had been using its 3D printer to make parts for support equipment. When it was found that Raytheon had exhausted its supply of a piece of air duct used to circulate air throughout the cockpit of a T-44 Pegasus, Randy Seeker, a tooling maker at the center, decided it could either develop a product similar to the part or 3D print it. Cost analysis demonstrated 3D printing would be more efficient and provide better quality as well.

Mergers and Acquisitions

3D Systems Gain Stronger Foothold in Digital Dental Industry with Acquisition of Vertex-Global

Rock Hill, SC-based 3D Systems acquired Vertex-Global Holding, a provider of dental materials under the Vertex and NextDent brands, for an undisclosed amount. Vertex Dental and NextDent are manufacturers of photopolymer, thermoplastic, polymer and monomer materials for traditional and 3D printing dental applications. 3D Systems will continue to offer Vertex Dental and NextDent's existing portfolios and will continue to sell to and serve all current customers.

Texas Engineering Company to Acquire California-based Additive Manufacturing for $14M

Texas-based engineering, manufacturing and product development company Galenfeha announced plans to acquire Additive Manufacturing, a 3D printing company based in San Juan Capistrano, CA, for $14 million in cash. Additive Manufacturing's clients include large companies such as Google, Honeywell, GE, Tesla, NASA, Cisco and more.

San Diego 3D Printing Startup Acquires Polish Software Company, Raises $100K Ahead of Seed Round

San-Diego-based automations technology and 3D printing company SD3D completed the acquisition of Polish software company Printelize.com for an undisclosed amount. The deal includes both Printelize Professional, a customizable web-based platform through which companies can offer their new clients auto-quoting solutions and manage their 3D printing orders, and Printelize Marketplace, a platform through which users with 3D models can connect with users who have 3D printers. In addition, SD3D raised $100,000 in bridge funding. The equity financing round was led and syndicated by TIG Investments, a venture capital group specializing in early stage tech companies. The investment will be used to expand operations in California and Texas, complete U.S. and international patent applications and to support strategic growth initiatives in preparation for a seed round later in 2017.

Money and Investment

GE Launches Financial Solutions to Spur Growth in 3D Printing Technology

GE Capital, the financial services division of General Electric, is developing a range of customized financial solutions, including leasing, to enable the purchase of 3D printing technology as part of an effort to stimulate growth in several industries such as healthcare, automotive and machining. The division will work with GE's recently formed additive manufacturing business unit to finance metal additive machines. GE has invested approximately $1.5 billion in 3D printing technologies in recent years, in addition to acquiring stakes in 3D printing businesses like German company Concept Laser and Swedish company Arcam.

Singapore Startup Secures $1M from Angel Investors

Healthcare and medical applications startup Supercraft3D raised $1 million from Flipkart cofounder Binny Bansal and four other angel investors. Founded in 2016, Supercraft3D makes additive manufactured customized body implants made of bio-compatible titanium alloy and offers implants specific to the patient's physiological or pathology needs. The company also offers patient-specific visualization solutions that help doctors, surgeons and academics gain greater perspective about the human anatomy.

France-based Groupe Gorgé Plans IPO for its Growing 3D Printing Division

Groupe Gorgé, an independent group located in France focused on high-tech industries, plans to launch an IPO on Euronext Paris for its 3D printing division, Prodways Group, to take it on what it describes as "the second phase of growth." Prodways saw its revenue rise from $100,000 in 2013 to more than $27 million in 2016, a growth the group credits to "a strategy combining organic growth, sustained by substantial capital expenditure, and targeted acquisitions in the B2B 3D printing segment."

Startup Obtains $1M in Seed Funding to Launch Chef3D, a Pizza 3D Printer

Beehex, a Columbus, OH startup that designs and builds commercial 3D food printers, raised $1 million in seed funding to launch its first product, a pizza printer called the Chef 3D. Beehex's 3D printers use pneumatic systems, rather than traditional additive manufacturing technologies, to move ingredients around. Long-term, the company wants to create a network of printers capable of producing snacks or meals on-the-spot, tailored to customers' needs. It hopes that one day customers will be able to select their food through an app, or the BeeHex printers could make food that correlates to their health needs, taking into consideration data transmitted from internet connected medical devices or fitness-related wearables.

L.A. 3D Printing Startup Raises $23M in Series A Financing Round, Sets Sights on Chinese Automakers

Los Angeles-based startup Divergent 3D raised $23 million in a Series A funding round led by technology venture capital fund Horizon Ventures. The company will use the money to commercialize its manufacturing platform, which produces 3D-printed joints that can be connected with carbon fiber structural materials to build a strong and light automobile chassis. The platform is designed to reduce the cost, time-to-market and environmental impact of building automobiles. According to Divergent 3D CEO Kevin Czinger, the investment will help the company bring its technology to as many automakers as possible, especially in China.

Desktop Metal Receives Venture Capital from BMW, Alphabet and Lowe's

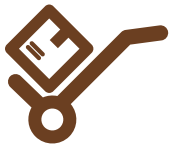
3D metal printing startup Desktop Metal, which is based in Burlington, MA, raised $45 million in venture funding from the venture arms of Alphabet, BMW and Lowe's. These new investors are also potential customers. *FORTUNE* reports that the round values Desktop Metal at $305 million pre-money, up from its valuation of $100 million in April 2016. The company has so far raised a total of $97 million. Other investors include NEA, Kleiner Perkins Caufield & Byers, Lux Capital, GE Ventures, Saudi Aramco and 3D printing company Stratasys. Desktop Metal co-founder Ric Fulop said the capital raised in this round will enable the company to enter mass production.

Voodoo Manufacturing Secures $1.4M in Funding from KPCB Edge and Angel Investors

Brooklyn-based 3D printing manufacturing company Voodoo Manufacturing raised $1.4 million in funding from KPCB Edge, with participation from various angels including Tumblr founder and CEO David Karp. The company is also expanding its operations, growing its team to 18 members and adding 50 new printers to its printer cluster, bringing the total number of machines to 160. To further accelerate its growth, the company has joined Y Combinator's Winter 2017 batch of participants. The seed accelerator has funded more than 1,000 startups, including Reddit, Airbnb, Dropbox and more.

Chinese 3D Printing Startup Secures $5M in Funding Amid Stellar Growth in Revenue

Shanghai-based 3D printing startup Polymaker raised $5 million in a second round of funding led by a Chinese venture capital firm. This follows a round led by LegendStar, an affiliate of IT company Lenovo, which was held in early 2015. Polymaker reported healthy market-driven growth in 2016, with an increase of over 200% in revenue compared to the previous year. The newly raised funding will be used to expand the company's manufacturing capacity and fuel the development of next-generation products and applications. Headquartered in Shanghai, Polymaker also has global offices in New York City, Utrecht (Netherlands) and Tokyo (Japan).



Transportation and Logistics

Yamato Installs 3D Printers in Fulfillment Center to Quicken Supply of Goods to Clients

Japanese logistics company Yamato Holdings has installed 3D printers at its Haneda Chronogate fulfillment center in Tokyo's Ota Ward. The company hopes to offer clients a faster solution for ordering industrial and medical 3D-printed supplies. The minifactory will receive the necessary patient data online and deliver the complete products to medical institutions in about three days, compared with 7-10 days for specialty manufacturers, according to Yamato. The company aims to expand the service to industrial and other goods and reached $87.2 million in annual sales in fiscal 2025.

Healthcare

Stratasys Teams Up with Veterans Affairs to Create Customized Prosthetics for Patients

Stratasys is partnering with the U.S. Department of Veterans Affairs to create the first 3D printing hospital network in the country. Under the partnership, Stratasys will donate industrial 3D printers, materials and training that will allow doctors to make customized prosthetic and orthotic devices for veterans. The 3D printers are also meant to help doctors create precise anatomical models of body parts that can be used to teach medical students or to help surgical teams practice complicated surgeries. The first hospitals receiving the 3D printers are located in Seattle, San Antonio, Albuquerque, Orlando and Boston. Doctors who come up with new designs for a medical training model or prosthetic device will be able to share best practices across hospitals, where the CAD files can also be customized.

Ottawa Hospital Launches First Medical 3D Printing Program in Canada

With the goal of improving surgical planning and enhancing education and research, the Ottawa Hospital, in collaboration with the University of Ottawa, has launched the first multi-departmental Medical 3D Printing Program in Canada. Ottawa Hospital hopes the new 3D printing program will allow doctors to produce models for the planning and practice of complex surgeries, develop prosthetics for patients, and create new research opportunities. The hospital also believes the 3D printing program will position its medical imaging department at the forefront of international developments in radiology.

Spanish Researchers Unveil Prototype of 3D Bioprinter that Can Print Human Skin

Researchers at Universidad Carlos III de Madrid in Spain presented a prototype for a 3D bioprinter capable of mass-producing human skin. The bio-ink-based 'skin' replicates the structure of actual human skin—complete with the same layer of epidermis to act as protection against the environment, with a thicker, deeper dermis that produces the collagen to give the skin its elasticity and strength. Bioengineering professor José Luis Jorcano explains that there are two main possible applications for 3D printed skin: testing new compounds, as many fields can no longer use animals for testing; and, providing skin transplants for patients who have suffered burns or have severe skin problems.

Texas' TriFusion Devices Partners with Standard Cyborg to Produce Orthotics, Prosthetics

3D printing company TriFusion Devices is teaming up with San Francisco-based Standard Cyborg to create orthotics and prosthetics for the biomedical industry. Through this partnership, TriFusion hopes to combine its 3D printing capabilities with Standard Cyborg's software platform, Design Studio. Those in need of prosthetics or orthotics will have their limbs scanned by a certified clinician, equipped with an iPad-mounted scanner. Using Standard Cyborg's scanning and design technology, the clinician will then be able to create a custom-fit geometry, tailored to the individual patient's needs.

U.K. Surgeons Successfully Implant Patient with 3D-Printed Titanium Sternum and Ribs

A team at the Birmingham Heartlands Hospital in England has successfully implanted a patient with a custom-built 3D-printed titanium sternum and ribs to replace those that were removed following a rare bone infection. Birmingham Heartlands Hospital is only the second medical institution in the world to successfully complete the procedure. The hospital collaborated with Australia-based medical device company Anatomics. The team used high-resolution CT scans of the patient's chest to recreate the defect so that the implant would precisely fit. This data was then fed into a 3D printer that uses an electron beam, to melt and fuse metal powder into a 3D object. Cardiothoracic surgeon Ehab Bishay explained that they opted for titanium as it is "more resistant to infection, lightweight, tough, and, since it exactly replicates the defect, it means that the operative time is reduced as it slots in."

University of Cincinnati Students Build Low-Cost 3D-Printed Prosthetic Hands for Patients

Inspired by the global organization e-Nable, biomedical engineering students at the University of Cincinnati started Enable UC, an organization that builds custom, functional 3D-printed hand prosthetics for less than $20 and delivers them to patients in about a week's time. Prosthetics for pediatric patients are built and delivered free of charge. The artificial hands are made of plastic and don't use electrical sensors or robotics. This method of making them reduces the cost of supplying multiple prostheses when kids grow out of them and can be easily replaced if they break. To build the prosthetic hands, UC students find the appropriate 3D design files from e-Nable—a global open source organization and volunteer network that provides free prosthetic hands to kids in need around the world.

Physicians in France Implant 3D-Printed Tracheobronchial Prosthesis in Patient

A team of physicians at a university hospital in Toulouse, France (Centre Hospitalier Universitaire de Toulouse) have successfully implanted a 3D- printed custom tracheobronchial prosthesis into a patient. The implant was designed and additively manufactured in partnership with Anatomik Modeling, a Toulouse-based startup that specializes in custom-made 3D implants. To make the implant, Anatomik Modeling worked with the university hospital to model the implant based on a scan of the patient's bronchus. From there, a mold of the 3D implant was 3D printed, which allowed for the silicone elastomer prosthesis to be cast. Anatomik Modeling and the physicians at the university hospital believe the 3D implants, while still in an experimental stage, could be ready for commercialization by 2018.

Patient Regains Mobility After Receiving 3D-Printed Talus Implant at Hong Kong Hospital

Doctors at the Pamela Youde Nethersole Eastern Hospital have used 3D printing to create a replica of a talus—a small bone connecting the lower leg and foot—for a patient. To reproduce the talus on the patient's left foot, doctors first performed a computerized tomography scan on the right foot. A metal implant was then made with 3D printing based on the converted image from the scan. After the successful procedure, mobility was restored to the patient's leg and he could bend his ankle at an angle of 15 degrees, walking with the help of a support stick.

Manufacturing and Construction

Swiss Company Expands Additive Manufacturing Business in U.S. with Facility in North Carolina

Swiss company Oerlikon is expanding its global additive manufacturing business in the U.S. with an R&D and production facility in Charlotte, NC. Oerlikon will invest about $56 million in the facility in 2017 and 2018 and expects to create more than 100 new jobs at this site over the long term. The new facility in Charlotte will offer U.S. industrial customers a single source for a full suite of integrated services for end-to-end advanced component manufacturing—from R&D, design, applications engineering and series production to post-processing, the company announced.

SAP Launches Early Access Program to its Distributed Manufacturing Application

SAP, which partnered with UPS last year to set up an on-demand 3D printing network, has launched an early access program for its SAP Distributed Manufacturing application. The early access program, which will give new customers a taste of SAP and UPS's digital manufacturing solution, has the goal of establishing and promoting 3D printing and on-demand manufacturing as "an integral part of the digital manufacturing landscape." The Distributed Manufacturing early access program will be offered to a range of business types, including discrete manufacturers, industrial 3D printing companies, suppliers of materials, global logistics networks, postal companies and more.

San Francisco Startup Builds House in 24 Hours for Just Over $10K Using 3D Printing Robot

San Francisco-based startup Apis Cor was able to build a house in one day by using a 3D printing robot. Working with the Russian home-building company PIK Group, Apis Cor built the house at its test facility in Stupino, south of Moscow. Apis Cor programmed the 3D printer to construct a rounded house. The machine applied cement in layers to form the shape of the house, but left a gap between the interior and exterior walls in which the team then placed fiberglass reinforcements and sprayed a polyurethane-based mixture for insulation. The company says building homes with the bot is more efficient and less expensive than relying on humans. The cost of the home's materials—including the foundation, walls, insulation, finishings and wiring—came to $10,134.

France-based XtreeE, VINCI Construction Partner to Apply 3D Printing to Construction Industry

French large scale 3D printing company XtreeE has partnered with French construction company VINCI Construction, which also acquired a stake in the 3D printing company. Through the partnership, XtreeE hopes to continue to advance its additive manufacturing technology as both companies will explore potential applications for 3D printing in the construction industry. XtreeE has also been working on creating construction-grade 3D printing concrete materials.

3D Printing Construction Startup to Build High Rises with 'Crane Printing' Technique

Dubai-based 3D printing construction company Cazza has made public plans to build the world's first 3D-printed skyscraper. The firm said it will 3D print high rise structures of 80 meters and more using a new construction technique called 'crane printing.' Cazza's crane printing process includes all major structural components required for tall buildings, including reinforcement with steel rebar, the company said, adding that the cranes will 3D print specific parts of buildings, with the rest of construction undertaken through existing methods. Cazza CEO, Chris Kelsey, said the first 3D-printed high rise would be constructed in the United Arab Emirates, although the height of the structure and start of the work were not revealed.

Heavy Equipment Manufacturer Caterpillar Teams Up with German Additive Manufacturing Company

Construction and mining equipment manufacturer Caterpillar has entered into a strategic partnership with German prototyping and additive manufacturing solutions company FIT. Under the agreement, FIT and Caterpillar will focus on designing and 3D printing aluminum and titanium parts. Caterpillar will bring product-specific knowledge and FIT will bring the knowledge for additive design. This relationship will complement the ongoing work in Caterpillar's Additive Manufacturing Factory. The strategic alliance will have an initial three-year term, but will evolve to the next step based on its success, the companies said.

Clothing and Wearables

Adidas Opens "Speedfactory" Powered by 3D Printers, Robots to Bring Shoes to Market Faster

German sportswear manufacturer Adidas is launching a "Speedfactory" in collaboration with local manufacturing firm Oechsler Motion to produce and distribute high-standard running shoes at a faster pace using robots and 3D printing technologies. Production at the Ansbach facility is due to begin in mid-2017, slowly at first and then ramping up to 500,000 pairs of trainers a year. Adidas is building a second Speedfactory near Atlanta for the American market, *The Economist* reports. The Speedfactory's main strength, Adidas claims, is to shorten the supply chain, and so the time it takes to have the shoes in shops, to less than a week, perhaps even to a day, once the trainer design is complete. In addition, the Speedfactory will replace thousands of human workers with robots, to automate some of the manual processes in the manufacturing phase. In comparison to its Asian factories, which house thousands of human workers, the Speedfactory will be run by around 160 employees.

Missouri University Research Test New Process to Produce Stretchable Electronics

Although stretchable electronics are often faced with mismatches between the flexible elastomer base and the electronic conductors, researchers at Missouri University of Science and Technology have developed a type of conductor that can be built or set into the surface of the elastomer using 3D printing. The researchers believe stretchable electronics could replace the brittle circuit board that powers many electronics devices, adding that stretchable material could also create new options for wearable sensors that adhere to the skin to monitor heart rate or brain activity, or sensors in clothing or thin solar panels. As demonstrated in an article published in *Micromachines*, the researchers tested a process called "direct aerosol printing," which involved spraying a conductive material and integrating it with a stretchable substrate to develop sensors that can be placed on the skin.

Auto Industry

Ford Tests 3D Printing for Prototyping and Production of Vehicles

As part of a pilot project that uses a Stratasys 3D printer, Ford is looking at how large-scale one-piece auto parts, like spoilers, can be 3D printed for prototyping and future production vehicles. The 3D printer will be located at the Ford Research and Innovation Center in Dearborn, MI, and will be used to develop more efficient, affordable ways to create tooling, prototype part and components for low-volume vehicles.

Renault Truck Turns to 3D Printing to Build Lighter, More Compact Engines

A team of engineers and designers at Renault Truck is working on a metal 3D printing process to boost the performance of engines. A prototype DTI 5 4- cylinder Euro 6 step C engine has been designed exclusively using 3D printing. The company said metal additive manufacturing opens up new development opportunities for thermal engines as the printing process can be used to create complex organic forms, optimize the sizing of parts and reduce the number of assembly operations and therefore the number of components in an engine.

McLaren Racing Turns to Stratasys' 3D Printing Solutions to Improve Performance, Productivity

Minnesota-based 3D printing company Stratasys signed a four-year partnership agreement with McLaren Racing, the Surrey, England company that competes on the Formula 1 racing circuit with the McLaren Honda team. Under the partnership, Stratasys will supply McLaren with a suite of additive manufacturing solutions, such as the latest FDM and PolyJet-based 3D printing solutions and materials for visual and functional prototyping, production tooling including composite tooling, and customized production parts. The goal, from the perspective of McLaren, is to accelerate delivery while increasing performance and productivity in design and manufacturing operations. For branding purposes, Stratasys will become McLaren's official supplier of 3D printing solutions.

Ferrari Turning to 3D Printing to Improve Race Car Engine for 2017 F-1 Season

A week after McLaren Racing partnered with Stratasys, its Formula 1 rival Ferrari announced that it would also take advantage of 3D printing technology to improve its engine for the 2017 season. Ferrari is set to replace aluminum alloys, with 3D-printed heavier steel alloys. The rationale being that heavier alloys will be able to resist deformation and breakage in extreme temperatures. The 3D printing technology allows engineers to build up thin layers on material one at a time, so it is possible to create complex shapes that have not been possible before using traditional casting and machining methods.

NASCAR, IndyCar Racing Team Partners with Stratasys

As part of multi-year agreement, 3D printing company Stratasys will provide equipment and support services to assist Team Penske in its engineering and manufacturing efforts across its NASCAR and IndyCar racing platforms. As an official partner, Stratasys will furnish 3D printing solutions to create manufacturing tooling and car parts as well as rapidly generate engineering prototypes. Stratasys plans to highlight its new partnership with Team Penske by engaging with its customers through tours of the team's facility, technical talks, and product demonstrations designed to showcase the company's solutions and offerings.

Audi Forms Development Partnership with AM Solutions Provider EOS

German automaker Audi has agreed to a development partnership with EOS, a provider of additive manufacturing solutions that has also recently formed an automotive 3D printing partnership with UK-based GNK Metallurgy. The partnership with Audi will see EOS' consulting division "Additive Minds" support the automaker in the implementation of industrial 3D printing technology and the establishment of a corresponding 3D printing center. "The aim is to not only supply Audi with the right additive systems and processes but to also support them during applications development, when building up internal AM knowledge and training their engineers to become in-house AM experts," said Güngör Kara, Director of Global Application and Consulting at EOS.

Aviation and Aerospace

3D Printing Company Partners with Axiom Space to Manufacture Parts in Space

Made in Space, a company that produces 3D-printed parts for use in outer space, and Axiom Space, a developer of a privately-owned commercial space station, have struck an agreement to manufacture products in Low Earth Orbit. The companies are currently working out the logistical elements of in-space manufacturing, outfitting the in-space factory with equipment, utilities, power and thermal management to answer customers' growing demand. Made in Space's technology, operating aboard Axiom's modules, aims to service and expand satellites and station capabilities.

Aerospace Giant Boeing Turns to 3D Printing Company to Supply Part for Space Taxis

Boeing hired privately held company Oxford Performance Materials to make about 600 3D-printed parts for its Starliner space taxis. Oxford Performance Materials, which closed a $10-million round of strategic investment from Hexcel Corporation on the same day as the Boeing announcement, will provide parts that will allow Boeing to reduce the costs and lower the weight of the seven-seat Starliner capsules, which they're building under a $4.2-billion NASA contract. While Oxford Performance Materials has already shipped parts for the capsules, Boeing has so far declined to say how much of the capsule will consist of parts supplied by Oxford Performance Materials.

NASA, University of Central Florida Looking at 3D Printing to Build Shelters on Mars

Researchers from NASA and the University of Central Florida are studying a process called molten regolith electrolysis to build structures on Mars. The loose Martian soil, known as regolith, could be placed inside a chamber and heated to almost 3,000°F, before electrolysis melts down the metals. As a bonus, the process would also produce much-needed oxygen. The molten metal can then be used in a 3D printer to create parts to build a shelter, like the igloo concept. For NASA, the less there is a need to cart resources from Earth to Mars, the better, with the agency saying that finding ways to live off the land could save over $100,000 per kilogram (2.2 lb) per launch. It's known as in situ resource utilization, and that's the goal of this new project.

South Africa's Aeroswift Wants to Supply Airbus, Boeing with 3D-Printed Parts

South Africa's government-backed 3D printing company called Aeroswift is in talks with Airbus and Boeing to produce aircraft parts using lasers to melt powdered titanium. South Africa's Council for Scientific and Industrial Research, in partnership with local aerospace firm Aerosud Innovation Centre, say access to vast titanium reserves as well as pioneering the world's largest titanium powder-based 3D printing machine should give them a competitive edge. During proof of concept trials, the 3D printing machine developed by Aeroswift achieved production speeds up to 10 times faster than currently available commercial laser melting machines.

Boeing to Use 3D Printing, Less Workers to Build Satellites More Quickly

The Wall Street Journal reports Boeing plans to build satellites more quickly by adopting new production practices that will rely more heavily on 3D printing. The company said fewer workers would be involved in the production process. The effort to rely more on additive manufacturing is part of Boeing's attempt to become more competitive in an evolving industry. Some of the new manufacturing processes, including 3D printing, have been implemented in Boeing's facility in Los Angeles, while others are still in the planning stages. The change is expected to take a few years, and will require buy-in from satellite customers, before it starts to yield substantial results. Paul Rusnock, head of Boeing's satellite business, told *The Wall Street Journal* that the new manufacturing processes are expected to lower acquisition costs for operators while providing them with better opportunities to launch upgraded technology before hardware becomes outdated in orbit.

Abu Dhabi 3D Printing Company Partners with Siemens on Development of Aircraft Parts

Abu Dhabi's Strata Manufacturing has teamed up with Siemens and Etihad Airways as part of a pilot project to develop 3D-printed aircraft interior parts. Siemens will provide consultation on material selection, testing and process preparation, while the parts will be manufactured at Strata's facilities in Al Ain and certified by the design team of Etihad Engineering. If successful, the project will be expanded into the development of a three-year joint road map between Siemens and Strata for the further industrialization of 3D printing to produce complex airline parts for customers in the wider Mena region, including training opportunities for United Arab Emirates citizens.

Energy

Siemens Builds 3D-Printed Operating Part for Slovenia Nuclear Power Plant

Siemens achieved the first successful commercial installation and continuing safe operation of a 3D-printed part in a nuclear power plant. The replacement part produced for the Krško nuclear power plant in Slovenia is a metallic, 108mm diameter impeller for a fire protection pump that is in constant rotating operation. Meeting the Krško nuclear power plant's stringent quality and safety assurance requirements required extensive testing that was performed jointly with the Krško operations team over several months, ensuring the 3D-printed part would perform safely and reliably. Further material testing at an independent institute as well as a CT scan, showed that the material properties of the 3D-printed part were superior to those of the original part.

Siemens Successfully Tests Power Generating 3D-Printed Gas Turbine Blades

German engineering group Siemens achieved what it calls a "breakthrough" by successfully testing power generating gas turbine blades produced using 3D printing technology through its UK subsidiary Materials Solutions, which it acquired in 2016. The company tested the blades under full-load engine conditions at 13,000 revolutions per minutes and temperatures above 1,250°C. The blades were made from a powder of high-performing polycrystalline nickel superalloy. The 3D technology made possible a new design with improved internal cooling geometry. With the 3D printing technology, Siemens was able to reduce the design-to-testing time to two months from two years. "This is a breakthrough success for the use of additive manufacturing in the power generation field, which is one of the most challenging applications for this technology," Willi Meixner, head of Siemens' Power and Gas division, said.

Russian Scientists Build Expansion Turbine for Electric Generator Using Additive Manufacturing

Scientists at Peter the Great St. Petersburg Polytechnic University have used a 3D printer to develop an expansion turbine for a turboexpander electric generator that produces electricity from high-pressure natural gas. The turbine is capable of triggering significant pressure drop at a low volume flow of natural gas with an electrical power of 1 kW, and is made from 3D-printed plastic parts. The scientists found that by using abutting contact shoulders to supplement a 3D-printed plastic disc in the turbine's main wheel, they could reduce the stress inflicted upon the disc by 25%. Published in the *International Journal of Environmental and Science Education*, the findings are considered by the researchers as a huge step toward sustainable energy in Russia.

Food

WASP Creates 3D Printer for People with Celiac Disease

Italian company WASP is expanding its 3D printing technology into the field of food engineering. More specifically, the company wants to 3D print gluten-free food. The initiative is being undertaken in collaboration with chef Francesco Favorito, who specializes in creating pastry mixtures for those with food intolerances. WASP's first gluten-free 3D food printer was made public at Sigep Rimini 2017, a dessert and sweet trade show. The modified DeltaWASP 2040 machine 3D-printed a number of gluten-free edibles made from a pastry mixture. According to the company, by heating the printer's extruder to between 70 and 80°C, the pastry mixture was pre-cooked as it was extruded, giving it some rigidity. Once printed, the pastry was then cooked in an oven until ready.

Researchers in Ireland Compare 3D-Printed and Regular Processed Cheese

In a study published in the *Journal of Food Engineering*, researchers from the School of Food and Nutritional Services at University College Cork in Ireland 3D-printed cheese and conducted a series of tests evaluating its texture, resilience and "meltability," to see how this cheese would compare—on a structural level—against regular processed cheese. The research team found that the 3D-printed cheese was 45% to 49% softer than the untreated processed cheese. They also discovered that 3D-printed cheese was a little darker in color, a bit springier, and more fluid when melted—though it melted at approximately the same temperature as untreated cheese.