Benesch

3D Printing Quarterly Report—Q4 2018

3D PRINTING–A FAST MOVING MARKET

Developments in 3D Printing

A Sector by Sector Overview

Overview

This report explores developments in 3D printing across several sectors and categories for the quarterly period of October 10, 2018 to January 10, 2019.

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General

Mass manufacturing set to be next step in 3D printing, experts say

There is a sense mass production is the next big thing in 3D printing and Christoph Schell, President 3D Printing & Digital Manufacturing at HP, lent credence to that when he said 2019 will be the year additive manufacturing moves from prototyping into full production in the automotive industry. HP aims to play a prominent role in this evolution with its Multi Jet Fusion and Metal Jet 3D printing technologies, both of which are designed for large batch production. Startups like Evolve Additive and Origin are using their own technologies for 3D printing large runs of plastic parts. Most companies working toward mass metal manufacturing, including HP, have developed binder jet platforms for mass printing parts. Boston-based Digital Alloys has a novel approach to fusing metal parts called Joule Printing.

Researchers discover 3D printers have 'fingerprints,' which could help trace 3D-printed guns, counterfeit goods

A University at Buffalo-led study describes what's believed to be the first accurate method for tracing a 3D-printed object to the machine that made it. The advancement, which the research team calls "PrinTracker," could help law enforcement and intelligence agencies track the origin of 3D-printed guns, counterfeit products and other goods. To test PrinTracker, the team created five door keys each from 14 common 3D printers. With a scanner, the researchers created digital images of each key. They then developed an algorithm to align and calculate the variations of each key to verify the authenticity of the fingerprint. The researchers were able to match the key to its printer 99.8% of the time. The team also ran experiments involving keys damaged to obscure their identity, it was 92% accurate in these tests.

Researchers find unsafe emissions from 3D printers

Research between scientists from the not-for-profit research lab UL Chemical Safety and the Georgia Institute of Technology examined what is being emitted by 3D printers. It discovered several desktop 3D printers generate ultrafine particles, which are known to cause a health risk when they are inhaled and penetrate deep into the pulmonary system. The researchers also identified emissions of more than 200 volatile organic compounds, several are known or suspected irritants and carcinogens. Rodney Weber, Georgia Tech's primary investigator of the research, explained the safety of 3D printers depends on several factors and what makes it difficult to label methods and materials safe or unsafe is that there are variations of printers and filaments on the market. Weber suggested operating in well-ventilated areas, setting nozzle temperatures at the lower end of the temperature range for filament materials, standing away from operating machines and only using machines and filaments that have been verified to have low emissions.

Arkema launches commercial platform for 3D printing materials

Arkema launched a commercial platform dedicated to 3D printing materials products. It will release new resins into North America and Asia through the next three years. PEKK resins will be launched in USA this year, photocure resins in China in 2019 and polyamide 11 biosourced resins will be available in Asia by 2021. The company already provides photocure resins and high-performance thermoplastic polymers through its N3xtDimension resins, Rilsan biosourced polyamides, and ultra-high performance Kepstan PEKK polymers brands, offering materials for the photocuring, powder bed fusion, and filament extrusion processes.

Researchers merge origami with 3D printing to create complex structures

By merging origami with 21st century technology, researchers created a one-step approach to fabricating complex structures whose light weight, expandability and strength could have applications in everything from biomedical devices to equipment used in space exploration. The researchers used Digital Light Processing (DLP) to create origami structures that are not only capable of holding significant weight but can be folded repeatedly in an action similar to the slow push and pull of an accordion. When Paulino first reported these “zippered tubes,” in 2015, they were made of paper and required gluing. In the current work, the zippered tubes—and complex structures made from them—are composed of a polymer and do not require assembly. The team used DLP to create several origami structures which showed they weren’t only capable of carrying about 100 times the weight of the origami structure, but also could be repeatedly folded and unfolded without breaking.

Simplify3D launched software update to improve print quality, customization options for control over the printing process

Simplify3D version 4.1 supports up to six simultaneously printing materials, with automatic handling between material changes. With this support comes improved inter-layer priming, namely “Prime Pillar” and “Ooze Shield”, which have been added to improve the definition of layers and multiple materials. Sequential printing enhancements have been made for 3D printing multiple objects on a single build plate. Automatic Collision Avoidance identifies potential part collisions to prevent them. And Sequential Raft Construction has been added to improve adhesion and reduce failures. Another update allows the software to deal with larger and more complex builds, inclusive of improved print time estimation. The post-processing scripting engine also facilitates rapid modifications to the build files prior to export.

Lockheed Martin, DoD partner to improve automation of 3D printing

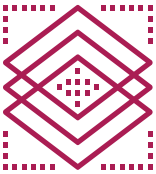
Lockheed Martin and the U.S. Department of Defense's (DoD) executive branch, the Office of Naval Research (ONR) partnered to accelerate the automation of industrial additive manufacturing systems. In a two-year, $5.8 million contract, the partners, led by Lockheed Martin's Advanced Technology Center, will apply software and sensor modifications to multi-axis 3D printing robots, to develop artificially intelligent additive manufacturing machinery. Lockheed Martin's research will help such systems identify the optimal structures based on verified analysis. The researchers will measure the performance attributes of systems parameters as well as a part's microstructures and align them to material properties before integrating this information into a working system.

MIT launches additive manufacturing consortium which aims to scale next-generation manufacturing technology

MIT launched an industry-facing consortium, the Center for Additive and Digital Advanced Production Technologies (aptly named ADAPT). With a core focus on additive and advanced manufacturing, ADAPT focuses on four things: visionary research, scalable education platforms, actionable strategic insights and an academic-industry ecosystem-based at MIT. The final goal of ADAPT is to combine the resources and efforts of several key AM industry stakeholders to leverage MIT's unique research and development experience and capabilities.

Xerox will participate in 3D printing, CEO reveals

On a call to report Q3 2018 financial results, CEO John Visentin announced Xerox is, "developing a roadmap to participate in 3D printing." Some in the traditional 2D printing market have remained cautious about entering the additive manufacturing industry. In 2014, HP was one of the first among a group that includes Ricoh, Canon and Epson, to announce plans for a 3D printer. While it is possible that 2019 sees a 3D printer launched by Xerox, a more likely timeline is a gradual feed of information. Whether that is enough to provide comfort to investors is another prospect.



Materials

Springy, crack-resistant cement created by 3D printing at Purdue

By investigating current weaknesses (such as non-uniformity in microstructure) present in 3D printed cement structures, a team from the Lyles School of Civil Engineering and School of Materials Engineering employs micro CT imaging to identify the weaknesses of 3D printed cement structures in order to improve their designs. The vision of Purdue University's cement 3D printing research is to apply these structural designs for the construction of stronger buildings.

3DXTech sign 3D printing materials distribution agreement with M. Holland Company

The deal will give M. Holland's industrial manufacturing clients access to an expanded team of commercial and technical support resources and an additional 24 materials. These materials include carbon fibre grades, electrostatic discharge-safe products, as well as materials with fire-retardant capabilities.

Research project will develop metal 3D printed parts for automotive, other applications

Liberty Powder Metals, which is owned by Liberty House Group, was granted £4.6 million to research alloy metal powders to be used in the 3D printing of automotive parts and other components. Liberty Powder Metals will have access to an atomizer at the facility, which will allow for collaborative research projects.

3D printed biosensors offer wearable glucose monitoring for diabetes patients

Researchers from Washington State University created a 3D-printed glucose biosensor that could be used in wearable monitors, leading to customizable glucose monitors for individual diabetes patient's biology. The team had been working to develop new wearable, flexible electronics that conform to patients' skin and monitor the glucose levels in bodily fluids like sweat.

Canadian webstore releases fully food safe PLA for 3D printing

Sourced from bioplastic manufacturer NatureWorks, the True Food Safe PLA is created using raw materials and colour pigments that follow the pharmaceutical industry manufacturing standard GMP (Good Manufacturing Practice). To double-check the feasibility of the filament, each batch is given a tracking serial number and spools are individually tested before being vacuum sealed in food contact safe bags for protection.

Michigan Tech researchers recycle wood furniture waste into composite 3D printing material

Researchers from Michigan Technological University published a paper that looks to see how viable a solution it is to use wood furniture waste, upcycled into a wood polymer composite material, as a 3D printing feedstock for building furniture. While a lot of wood is wasted by burning it, it may be better to upcycle it into WPCs, which contain a wood component in particle form inside a polymer matrix. These materials can help lower costs and environmental impact, as well as offer a greater performance.

Siemens targets 3D printing industrialization with €30M Materials Solutions facility

The main highlight of the facility is a machine park consisting of about 50 EOS 3D printers capable of processing various types of metal, from aluminum to titanium. The 3D printing-oriented production line is the result of a long-standing partnership between Siemens and EOS. With a printing area of 300 x 300 x 400 mm, four 400-watt lasers and scanners, EOS M 300-4 can significantly increase productivity.

Ultimaker and partners enable new 3D printing materials

Ultimaker and its partners are enabling a range of new materials to fit on Ultimaker 3D printers. The new material print profiles, released with companies like Clariant, DSM, and DuPont, are available via the latest version of the free print preparation software, Ultimaker Cura 3.6. The material profiles are fully optimized for Ultimaker 3D printers, with no need to manually input parameters before printing.

ORNL develops lignin-based composite 3D printing material

Researchers reportedly combined a melt-stable hardwood lignin with conventional plastic, a low-melting nylon and carbon fiber to create a composite with the right characteristics for extrusion and weld strength between layers during the printing process, as well as good mechanical properties. While lignin chars easily and can only be heated to a certain temperature for softening and extrusion from a 3D-printing nozzle, the researchers found that combining lignin with nylon increased the composite's room temperature stiffness and decreased its melt viscosity.

MakerBot launches Method, the first performance 3D printer

MakerBot introduces a new category for the professional segment with the launch of Method, the first performance 3D printer. Performance 3D Printing bridges the gap between desktop and industrial 3D printing by bringing features that were previously only available on industrial 3D printers to professionals at a significantly lower cost.

Canon introduces ceramic 3D printing technology, materials

Canon's latest technology is demonstrated through the presentation of a range of proprietary materials, made to be used with selective laser melting. Made to match the properties of conventional ceramics, e.g. heat and corrosion resistance, high insulation, Canon compares its material's properties to those achieved through injection molding. It also tackles challenges related to the shrinkage of typical ceramic materials that occurs in the post annealing/baking process.

DSM adds four 3D printing material grades to Digimat simulation solution

Royal DSM has announced the addition of four additive manufacturing (AM) grades into e-Xstream's Digimat-AM simulation solution. In the upcoming release, the digital twins of these materials will be available as Digimat material models to allow end-users to perform FFF process simulation and part performance prediction in the Digimat Additive Manufacturing Solution. The combination of DSM's high-performance AM grades with e-Xstream's printing process simulation, which also includes profiles for Solvay filaments, will allow manufacturers to identify manufacturing issues before printing.

Henkel launches portfolio of 3D printing resins and hardware under Loctite brand

The materials include two silicone grades, as well as high impact, transparent, and high temperature products. The Silicone Elastomeric 5010 and 5015 materials boast viscosity of 550-600 mPas, a 190% elongation at break, and Shore A Hardness of 60 and 80 respectively. Although these materials are yet to be medically approved, Henkel does eye the healthcare sector as there most fruitful vertical for these options, while there has been interest from companies in the sports consumer goods and automotive markets. The Ultra Clear material meanwhile has a print appearance transparency of 80-90%, a viscosity of 800-900 mPas, and a tensile strength at break of 20-30 MPa.

XJet releases ceramic support and materials

XJet introduced alumina, a conductive ceramic material. Alumina offers good electric and thermal resistance and is known for chemical stability. However, compared to zirconia, another ceramic material offered by XJet, alumina is mechanically less strong, and its application is not as wide as the zirconia, which has biomedical, electrical and even luxury applications.

Markforged introduces H13 tool steel for metal X 3D printer

A hot work tool steel, the H13 filament is made for use on the Markforged desktop-sized Metal X 3D printer. The material is ideal for making molds for plastic injection. Markforged's VP of product is calling H13 "a game changer" for manufacturers of high-volume plastic parts.

MIT researchers are now 3D-printing glass

MIT's system, called G3DP2, is a new AM platform for molten glass that combines digitally integrated three-zone thermal control system with four-axis motion control system, introducing industrial-scale production capabilities with enhanced production rate and reliability while ensuring product accuracy and repeatability, all previously unattainable for glass.

BASF presents 3D printing materials, alliances

BASF debuted a new range of photopolymer and laser sintering materials as well as several strategic partnerships at Formnext. Such partnerships include Origin, a silicon valley additive manufacturing startup, Photocentric, a U.K.-based manufacturer of photopolymers, and Xunshi Technology, a Chinese 3D printer manufacturer.

Turning metal replacement parts into composite 3D printed material

The Dutch 3D service bureau Visual First used a Stratasys 3D printer to produce a replacement part for The Chocolate Factory's packaging operation. Visual First used the Stratasys FDM Nylon 12CF carbon-filled thermoplastic to replace a metal machine part. The ability to create 3D-printed machinery replacement parts on-demand can significantly reduce machine downtime for manufacturers.

Fraunhofer IKTS adapts FFF 3D printing for hard materials processing

The Fraunhofer Institute for Ceramic Technologies and Systems IKTS in Dresden, Germany, developed a metal filament that, reportedly, can be 3D printed in "standard printers." The filaments can be used as semi-finished products in standard printers and, for the first time, make it possible to print hardmetals with a very low metal binder content. FDM Nylon 12CF thermoplastic contains 35% chopped carbon-fiber and provides the level of strength and tolerance required to replace metal parts. Also, the replacement time for replacing this broken machine part was reduced from one month to one week by using additive manufacturing compared to the traditional handmade metal process.

Carbon lowers cost of resins for production-scale applications

Carbon, a Silicon Valley-based 3D printing company, announced a further set of price reductions for its most widely-used resins, expanding upon the bulk discount program introduced last year. EPX 82 (epoxy), EPU 41 (elastomeric polyurethane), and RPU 70 (rigid polyurethane) will be offered in bulk volumes at $50 per liter. This move will increase the total addressable market for large-scale digitally manufactured parts across industries and continue to drive down costs and spur growth for the implementation of Carbon's digital manufacturing solution globally.

Stratasys reveals details about upcoming LPM metal printing technology

The LPM process utilizes Powder Metallurgy alloys (PM) and a unique binder approach to increase the efficiency of short-run metal parts production, in terms of operations and cost. The technique, which has been in development for several years at Stratasys, is based on the company's proprietary PolyJet jetting technology and uses readily available metallurgy powders.

Printing Techniques & Capabilities

3D concrete printing could dramatically increase construction productivity

While other industries have advanced in their productivity through significant progress in the use of digital, sensing and automation technologies, construction remains largely manual. 3D-printed concrete is one possible solution to the issue, giving architects more flexibility in how they design projects. There are also difficulties in quality control at construction sites, high levels of waste and carbon emissions, cost blow-outs and challenges in managing large worksites with a vanishing skilled workforce. The benefits of 3D concrete printing include free-form construction without the use of formwork, which reduces costs, and the elimination of secondary materials like timber. 3D-printing with concrete could be used for houses, bridges and intricate structures. The development of this research remains in early stages.

Researchers at Purdue University improve 3D-printing with use of ultrasonic vibrations

The viscosity of typical 3D-printing materials is one of the challenges in the process because of material build-up. A team of Purdue University researchers is looking at the application of ultrasonic to reduce friction and thus allowing the material to flow smoothly. They patented their discovery through the Purdue Office of Technology Commercialization and plan to market it to various government agencies. Their ultrasonic extrusion method can be performed remotely and doesn't require dangerous solvents, making the method much cheaper and safer. The research could be especially applicable to making rockets and missiles.

3D-printing with synthetic materials relies on AI advancements

Rather than using concrete and steel, a more advanced wave of materials design has emerged uses a nanoscale process. This new paradigm in engineering is enabling scientists and engineers to design a new class of materials that are stronger, lighter, more flexible and less expensive to manufacture. 3D-printing also for the rigorous testing of new materials to validate and eliminate choices and AI advancements are a key component to redefining the industry.

3D-printing technique allows engineers to streamline energetic materials production

Researchers are finding technological advancements to produce energetic materials, such as explosives or pyrotechnics, more quickly and safely, with less environmental impact and more cost-effectively. A Purdue University research team came up with a technique that essentially allows the printer to produce clay-like materials with a thick and sticky consistency. The team was also to produce the materials without the use of solvents for obtaining viscous results, which is an overall safer means of production.

M&A and Investments

Siemens builds EUR30M materials solutions facility, looks to industrialize 3D-printing

Siemens' 3D-printing facility features 3D printing systems, post-production machines, state-of-the-art 3D scanners and fully automated robots. The highlight of the facility is a machine park consisting of about 50 EOS 3D printers capable of processing various types of metal, from aluminum to titanium. Aerospace is one key target markets for Siemens' new digital facility, which will place a focus on the creation of turbine components. Another is automotive tooling, such as restoring an old vehicle by 3D-printing parts no longer in manufacture. The factory is yet to enter its full operations, but that's expected soon.

BASF Venture Capital GmbH reported an undisclosed investment in Chinese 3D-printing OEM, Prismlab

Prismlab is expected to continue the development of products and expansion into the global 3D-printing market and currently has five machines which are all based on stereolithography. A representative from BASF Venture Capital GmbH said the investment was the first of the company in a Chinese company.

Sumitomo invests in metal additive manufacturer Sintavia

Sumitomo Corporation of Americas invested in Sintavia, a manufacturer of 3D-printed parts for the aerospace, defense and oil and gas industries. the partnership is expected to produce solutions in the aerospace industry using AM technology.

PERI Group acquires minority stake in 3D-printing company COBOD

PERI Group, a manufacturer of formwork and scaffolding systems, acquired a minority stake in construction 3D printing company COBOD International. PERI will offer the company's BOD construction 3D printing technology to its own clients around the globe. COBOD was the first company to make a 3D-printed house in Copenhagen. Details of the investment were not disclosed.

Lockheed Martin contract marries 3D-printing with machine learning for parts manufacturing

Lockheed Martin and the U.S. Office of Naval Research are exploring how to apply artificial intelligence to train robots to independently oversee and optimize 3-D printing of parts, reducing the need for constant monitoring by people. The two-year, $5.8 million contract stipulates for the study and customization of multi-axis robots that use laser beams to deposit material, using machine learning as part of the additive manufacturing so variables can be monitored and controlled by the robot during fabrication. Lockheed Martin's research will help machines make decisions about how to optimize structures based on previously verified analysis. 3D-printing will align microstructures to material properties before integrating this knowledge into a working system. With this complete set of information, machines will be able to make decisions about how to print a part that ensures good performance.

3D Systems expands 3D-printing capabilities into casting market

3D Systems' 3D printing solution, ProJet MJP 2500 IC works for metal bridge manufacturing and low volume production of metal cast components. The majority of 3D Systems customers are shifting from prototyping to end use production, using 3D-printing technology. The company is looking to take a larger share of the metal cast market with its recent products.

Optomec acquires metal 3D-printing company Huffman, moves into commercial aviation market

Optomec will benefit from the acquisition of Huffman as the latter is at home in the gas turbine market, which is part of the aviation industry with large expenditures into parts repairs each year. Huffman and Optomec both offer a metal 3D-printing process known as Directed Energy Deposition (DED), or LENS, which has several advantages over more well-known methods like selective laser melting or powder bed fusion. Huffman's software and metal additive repair equipment are used by nearly all of the world's major aircraft engine and industrial gas turbine manufacturers. The company's metal deposition capabilities are used to help restore damaged or worn components, which costs a lot less money obtaining spare parts. Both businesses could benefit from the deal, given their complimentary portfolios.

Miscellaneous Partnerships

GE Additive, University of Sydney partner to drive 3D printing industry in Australia

GE Additive signed a Memorandum of Understanding with the University of Sydney, which includes a master research agreement stating the company will help the university create the first metal 3D printing ecosystem in Australia. GE will invest a maximum of $1 million in research and development efforts annually over the next ten years to speed up 3D printing adoption and set up the necessary people and technology to drive the 3D printing industry in the region. The two parties will also cooperate on developing new applications, as well as potentially new 3D printing industries, to drive positive economic and commercial impact.

BASF, Materialise partner with Essentium to advance industrial additive manufacturing

BASF Venture Capital and Materialise participated in a Series A investment round in Essentium, a Texas- based developer of industrial additive manufacturing solutions. BASF and Essentium have been working together on advanced FFF solutions using Essentium's FlashFuse technology for high mechanical strength in the build direction for extrusion printed parts. The two companies are now extending their strategic partnership to establish a consistent global materials supply chain supportive of Essentium's new HSE additive manufacturing platform. Materialise will enter the strategic partnership to develop 3D printing software for the Essentium technology.

GE Healthcare, VA partner to speed up 3D printing for radiologists

As part of the research agreement, GE Healthcare will provide software and work stations and VA Puget Sound Health Care System will provide input on its use of the technology. Building on its 3D printing network, VA Puget Sound and the Veterans Health Administration Innovators Network will integrate GE's visualization AW VolumeShare workstations with 3D printing software across its facilities in Seattle, San Francisco, Minneapolis, Cleveland and Salt Lake City. VA radiologists will be able to produce models of normal and pathological anatomy using automation techniques that will speed up the pre-3D printing preparation work and the diagnostic process.

3D Systems, Amann Girrbach to collaborate on dental 3D printing

Austria-based dental company Amann Girrbach will be integrating 3D Systems' NextDent 5100 3D printing solution into its Ceramill workflow. Through the partnership, the companies hope to accelerate the production of orthodontic splints and crowns at a lower total cost of operation by letting Amann Girrbach customers print their own models without moving out of Ceramill workflow.

Gillette partners with 3D printing startup to offer customized razor handles

Gillette worked with Formlabs to pilot a 3D-printed razor handle program. The products start at $19 and go up to $45, depending on the materials used. Users can design their custom handle using the Razor Maker site. The handles are then printed on Formlabs machines at Gillette's Boston headquarters.

Patents & Copyright

U.S. copyright law amended to reduce barriers to 3D printing innovation

Amendments to the Digital Millennium Copyright Act permits access to 3D-printing computer programs that could be used in the repair of automobile and farm machinery, reducing the possibility of manufacturers monopolizing the repair market. A second amendment relates to goods that are subject to oversight. In those cases, users won't be restricted as to what filament is used and can source feedstocks and controls from any third party. Production grade products will still need to be compliant with all relevant regulations

Apple granted patent for 3D printing technology that uses triangular print head motions

The patent is for a 3D printing method employing triangular tessellation. With this process, the printer head moves in a triangular pattern instead of in a circle. The idea is that it provides the underlying superstructure with more support, enabling faster print speeds while reducing the amount of material needed. The triangles produced by the tessellation process can also vary in size and density, depending on design parameters.

Auto & Transportation

Ford center uses 3D printer to produce parts for iconic sports car

The Ford Shelby Mustang GT500 will include brake line brackets produced by a 3D printer at its Advanced Manufacturing Center in Detroit. The center also incorporates collaborative robots (cobots), digital manufacturing and augmented reality into the manufacturing process. Augmented reality trains workers to assemble complex parts, using VR goggles to "see" a 3D representation of the component. The center is part of Ford's five-year, $4.5-billion advanced manufacturing strategy.

GE unit produces titanium automobile wheel with 3D technology

GE Additive and HRE Wheels teamed up to prototype a titanium wheel formed using the Arcam Q20plus process, normally employed in the production of aerospace components. The concept melts titanium powder using electric beams and is said to be more efficient and cost-effective than traditional wheel manufacture. The partners explain that instead of having to use a titanium block five times the mass of the wheel that's produced, just 5% of the metal is lost during the printing process.

BMW nears milestone on 3D printing journey with its 200,000th automotive part

Automaker BMW began using 3D printing for parts in 2010, using the process to create lightweight versions of parts without sacrificing strength or performance. Among the uses for the technology through the years:

- A lightweight water pump pulley for its DTM race car;
- Fibre-optic guide fixtures for the Rolls-Royce Dawn;
- Custom turn signal inlays and dashboard trim on the Mini;
- Roof mechanism and window guard of the BMW i8 Roadster; and
- Hard-to-find replicates of parts for a restored BMW 507 once owned by Elvis.

VW opening toolmaking center, expects to begin making 3D printed auto parts in three years

With other players in the auto sector like BMW, Ford and Porsche already building vehicles incorporating parts made by a 3D printing process, VW is taking its first steps in advanced manufacturing. The company opened a toolmaker center at its main production facility in Germany and is collaborating with HP to incorporate 3D printing into the process. VW's main focus will be metal and plastic components for primary installation and not spare parts. The company expects to begin producing 3D printed parts in two to three years.

Bugatti 3D printed titanium brake part ready for limited production in luxury automobiles

After a year of development, French luxury automobile manufacturer Bugatti produced a titanium brake caliper using 3D print technology. The part is designed for high-speed models and will be manufactured in limited quantities for the company's more expensive models as it takes 45 hours to produce a single caliper. Bugatti posted a video showing the part stopping a wheel spinning at 249 mph in which the temperature of the caliper reached 1,877 degrees.

Prof.: Auto dealers not likely to jump on 3D printed parts production bandwagon

A mechanical engineering professor at New York University admits the potential exists for auto retailers to begin manufacturing their own replacement parts for vehicles they service. However, several pitfalls stand in the way of this becoming a reality, he says. The cost of 3D printing technology is prohibitive for most auto dealers, he notes, particularly for high-quality, durable components, for which a single printer could cost upwards of $1 million. He adds that dealers could leave themselves liable should a 3D printed part they manufacture fails. Finally, dealers typically aren't in the business of manufacturing parts, so a move to 3D printed parts would require a change in business models from one that's been lucrative for decades.

Honda employs 3D printing technology in car assembly process in India; reduces weight, cost

Honda claims the introduction of 3D printing to the welding shop of both of its manufacturing units in India reduced the weight of the parts assembled by the method by 70% over traditional manufacturing. As well, 3D printing reduced the cost of welding for those components by 60%. The automaker says the goal is to take the technology out of the welding shop and onto the main production floor.

Singapore to set up world's first dockside 3D printing facility

Through an agreement between the Maritime and Port Authority of Singapore, additive manufacturing firm 3D Metal Forge, Singapore's additive manufacturing cluster NAMIC and Singapore's ocean freight terminal operator PSA, a 3D printing facility will be constructed at the Port of Singapore. The machine shop will manufacture spare parts for vessels make ports of call at Singapore. Along with the technology, the partners will set up a blockchain-enabled, cloud-based system for secure file transfers of parts' specifications.

U.K. passenger rail company to test 3D printed parts designed for the interior cabins

Angel Trains, which operates a passenger rail service in the U.K., says it'll pilot four parts that were manufactured be a 3D printing process. The components that'll be tested on board its trains this year are an arm rest, a grab handle, electrical connection covers and a seat back table. The parts, built by Stratasys, are meant to be robust to deal with normal wear-and-tear on passenger trains, as well as adhering to rail industry standard for fire resistance.

LM Industries' autonomous shuttle ready for deployment in Phoenix, Sacramento, D.C.

Local Motors produced a 3D printed car in 2009 called the Strati. Last year, it combined with design collaborative Launch Forth and rebranded as LM Industries. The new entity creates transportation, accessibility and mobility products for customers like Allianz Group, Airbus and the U.S. Marine Corps, and claims to be able to bring products from conception to completion in less than a year, manufacturing small batches at micro-factories. LM Industries also produced a 3D printed autonomous shuttle in 2016, using carbon fiber as a key component. Those vehicles, dubbed Olli, should begin to be deployed in limited areas this year.

Aviation & Aerospace

GE Addictive and GE Aviation 3D-printed engine bracket receives FAA approval

The FAA gave GE approval to replace a conventionally manufactured PDOS bracket for commercial airlines with an additively manufactured bracket. The 3D-printed brackets will be produced at GE Aviation's Auburn, Alabama facility using Concept Laser's M2 Cusing machines. The original PDOS brackets were milled from a solid block of metal, which resulted in about 50% of the material being wasted. Using additive manufacturing, GE will be able to reduce waste by about 90% and reduce the bracket's weight by about 10%, thanks to an improved design made possible by 3D printing.

GKN Aerospace opens U.K. additive manufacturing facility to make aircraft more sustainable

The 10,000 square meter facility will open in 2020 and house 300 engineers for the Airbus "Wing of Tomorrow" and additive manufacturing programs. GKN will collaborate with a wealth of manufacturing technology companies and research institutes, including the AMRC, Additive Industries, Ansys UK, Kuka Industries UK, the MTC, Materialise, the University of Bristol and the University of Sheffield, among others.

GE Aviation marks 30K 3D-printed fuel nozzle tip

The GE Aviation plant in Auburn, Ala., noted the 30,000th 3D printed fuel nozzle tip shipped. Installed within GE's LEAP jet engine, the nozzle has been made at the facility since 2018. The fuel nozzle is qualified for manufacturing on an EOS M 250 DMLS 3D-printer.

3D-printing having transformative effect on the aviation industry

Aerospace firms are increasing their use of 3D printers in order to speed up the manufacturing process, save money and make aircraft that burn less fuel. The International Air Transport Association is expecting the number of passengers to double over the next two decades to 8.2 billion in 2037, 3D-printing can help meet the challenge. Airbus had an order backlog of 7,337 aircraft at the end of November, or nine years of production at current rates. Boeing's commercial aircraft backlog was 5,849 at the end of September.

FDM Digital Solutions sees opportunity in visually pleasing 3D-printed aircraft interiors

Despite the size limitations of the 3D-printers available today, airframers such as Boeing are confident that larger aerospace parts will be able to be manufactured in an aesthetically pleasing manner in the future. One challenge preventing this innovation at present is that machines large enough to print parts this way do not exist yet. FDM Digital Solutions expects high-demand from private jet and maintenance, repair and overhaul (MRO) markets once the possibility becomes reality. The advantage of additive manufacturing for MRO companies is that spare parts can be printed on demand, reducing the need to store large numbers of pre-fabricated items in warehouses.

Rolls-Royce looks to 3D-print Advance3 aircraft demonstrator engine

The engine demonstrator integrates 3D-printed components as well as parts made from ceramic matrix composites. The Advance3 engine, to be available starting in 2025, is made up of around 20,000 parts, a significant number of which have been 3D printed. The Advance3 demonstrator integrates an engine core which is expected to provide fuel efficiency and low emissions.

Mubadala Aerospace looks to invest in 3D-printing and AI

Badr Al Olama, Head of Mubalada Aerospace, indicated his firm is looking at 3D-printing and robotics, advanced materials and predictive maintenance using AI as areas of strategic investment. Al Olama also said he expects those technologies to create rather than eliminate jobs, but there is a skills gap to overcome in order to reap the benefits.

Etihad Airways Engineering works toward vision of 3D-printed aircraft cabin interior

Etihad Airways is working with EOS and BigRep One to help with additive aircraft parts manufacture and tooling at its Abu Dhabi facility. EOS' polymer 3D-printing technology and systems will be harnessed to produce suitable cabin interior components. The partnership may extend to include their metal technology further down the road. The installation of the BigRep One is the first phase of an agreement with Etihad Airways, and will be followed next year by the delivery of a BigRep Edge system, launched recently at Formnext alongside the BigRep Pro.

Health & Life Sciences

3D printing slated to disrupt healthcare

More than 100 medical devices and one drug manufactured using 3D printers have reached the market, with FDA commissioner Scott Gottlieb dubbing 3D printing a transformative technology that could disrupt medical practice. The FDA is trying to keep pace with the emerging technology, which is presenting new regulatory challenges. New medical and dental technologies accounted for 11% of the $7.3-billion additive manufacturing market in 2017 as a number of medical device companies bet on the technology's ability to improve manufacturing and product quality, including Stryker, Medtronic and Smith & Nephew. While companies typically outsource their 3D printing, in medical more companies are making that investment internally. Rady Children's Hospital in San Diego, for instance, is among a growing number of hospitals investing in 3D printing by developing a 3D printing hub to serve all its departments. Rady views the lab as a potential revenue stream that will help build return on investment.

Wyss Institute applies 'try before you buy' initiative to 3D printed heart valves

A team of researchers at Harvard University's Wyss Institute for Biologically Inspired Engineering created a 3D printing workflow to predict the performance of artificial heart valves. Taking a "try before you buy" approach, the team developed software that simulates a valve's reaction with a patient's native tissue in order to provide accurate medical models specific to each patient. They also created a custom 3D printed "sizer" for a physical demonstration of a valve's fit. By identifying seven key points that show up in a CT scan, the software can accurately restructure a patient's heart valve in its entirety. This allows for a medical model of a patient's heart to be 3D printed using a mutli-material system, which surgeons can then use to apply the adjustable 3D printed sizer device to determine how an artificial valve would fit inside the natural tissue. To test their model, the team compared predictions from the 3D printed workflow to data from 30 patients who had previously undergone transcatheter aortic valve replacement (TVAR) operations. By applying the sizer and modeling software, the team was able to predict the rate of leakage in these cases with 60% to 73% accuracy.

3D printing offers helping hand to patients with arthritis

A Michigan Tech researcher and a team of students assessed how 20 3D printed adaptive aids could provide cost savings for arthritic patients while meeting or exceeding the standards for existing products. Joshua Pearce, the Richard Witte Endowed Professor of Materials Science and Engineering at Michigan Tech, and a group of students 3D printed adaptive aids, which range in price from a cheap pop can opener for $5.99 to pill splitter for $23.75 to a phone holder for $49.99. Doing so, they were able to reduce the costs by 45 cents to a pop can opener, $1.27 for a pill splitter and 79 cents plus a rubber band to hold a phone. The 3D printed versions of the aids not only cost less but are also customizable. "We printed and analyzed 20 different products and each one has a great return on investment, even for people who can use insurance to purchase adaptive aids with a co-pay, and a printer pays for itself easily," Pearce said, though he added that concerns remain about how people can access 3D printers, particularly older patients. Pearce sees nursing homes, doctor's offices and physical therapy clinics as the ideal hubs for 3-D printed adaptive aids.

MSF-run hospital offers 3D-printed prostheses to war wounded

The Doctors Without Borders (known by their French acronym MSF) reconstructive surgery hospital in Amman, Jordan, is offering amputee war victims from across the region 3D printed prostheses in an attempt to help patients regain partial functionality of their missing upper limbs. The project, which is still in the experimental phase, started two years ago. Patient feedback is being used to help improve the quality of the technology. To date, the project has delivered 16 printed prosthetics, according to Pierre Moreau, clinical coordinator for the project. The raw material for a printed prosthesis, a type of thermoplastic polyurethane, costs between $20 and $50. The final costs, including case estimation, assessment of the patient's needs and printing time, is around $250. "The idea is to be able to produce 3D-printed prosthetics in the future in places difficult to access and lacking a sound healthcare system, like in conflict areas," Moreau said. The patients at the hospital mostly come from Gaza, Iraq, Syria and Yemen.

Researchers 3D print ingestible capsule that can be controlled wirelessly

Researchers at MIT, Draper, and Brigham and Women's Hospital created an ingestible capsule, manufacturing using 3D printing technology, that can be controlled using Bluetooth wireless technology. The capsule, which can be customized to deliver drugs, sense environmental conditions, or both, can reside in the stomach for at least a month, transmitting information and responding to instructions from a user's smartphone. The team said the system could provide closed-loop monitoring and treatment, which could be used to deliver drugs for a variety of diseases or be used to sense infections, allergic reactions or other events. These devices could also be used to communicate with other wearable and implantable medical devices, which could pool information to be communicated to the patient's or doctor's smartphone. The capsule builds on one developed by the team in 2016, which was designed as a star-shaped capsule with six arms that fold up before being encased in a smooth capsule. After ingestion, the capsule dissolved and arms expand, allowing the device to lodge in the stomach. The new capital is similarly designed to unfold into a Y shape after being ingested, allowing it to remain in the stomach for about a month before breaking down into smaller pieces and passing through the digestive tract. One of the arms includes four small compartments that can be loaded with a variety of drugs, which the researchers say could be designed to open remotely via Bluetooth. Using the 3D technology, the team said it may be possible to create customized ingestible electronics where the gastric residence period can be tailored based on a specific medical application.

3D-printed glucose biosensors created by WSU

A team of researchers at Washington State University developed a 3D-printed glucose biosensor for use in wearable monitors, which they say could lead to improved glucose monitors for diabetes patients. Led by Arda Gozen and Yuehe Lin, faculty in the School of Mechanical and Materials Engineering, the team used a method called direct-ink-writing (DIW) to create a monitor with much better stability and sensitivity than those manufactured through traditional methods. The method involves printing "inks" out of nozzles to create intricate and precise designs at tiny scales. The researchers printed out a nanoscale material that is electrically conductive to create flexible electrodes. Their method allowed them to precisely apply the material, yielding a uniform surface and fewer defects, which increases the sensor's sensitivity. The team found their 3D printed sensors were better able to pick up glucose signals than traditionally produced electrodes. Since it uses 3D printing, their system is also more customizable for the variety of people's biology. For large-scale use, the printed biosensors will need to be integrated with electronic components on a wearable platform, the team said. They explained, however, that manufacturers could use the same 3D printer nozzles for printing the sensors to print electronics and other components of a wearable medical device, helping to consolidate manufacturing processes and reduce costs even more.

3D-printed organs and body tissues made possible by controlled curing

Engineers at University of Colorado Boulder developed a layer-by-later printing method to create artificial tissue to replace blood vessels and organs. The technique provides very fine programmable control over rigidity, allowing researchers to mimic the complex geometry of blood vessels that are highly structured and yet must remain pliable. The team said their

technique could provide for more personalized treatments by facilitating the creation of microstructures that can be customized for disease models. The technique takes advantage of oxygen's role in setting the final form of a 3D-printed structure. By keeping tight control over oxygen migration and its subsequent light exposure, the researchers have the freedom to control which areas of an object are solidified to be harder or softer—all while keeping the overall geometry the same. The tabletop-sized printer is currently capable of working with biomaterials down to a size of 10 microns, or about one-tenth the width of a human hair. The researchers are optimistic, however, that future studies will help improve the capabilities even further.

UA scientist hopes to heal bone fractures using combination of 3D printing and adult stem cells

John A. Szivek, PhD, a scientist at the University of Arizona College of Medicine—Tucson, is trying to leverage 3D printing and stem cell technology to help bones heal. Supported by a five-year, $2-million grant from the U.S. Department of Defense, Szivek is studying how to heal bone fractures using a combination of 3D printing and adult stem cells in an effort to help military personal deal with bone defects as a result of combat injuries. With the help of clinical partners in the UA Department of Orthopaedic Surgery, he plans to 3D print scaffolds that can replace large, missing or broken bone segments, which will be filled with calcium particles and adult stem cells. Once implanted, the scaffold will serve as a template for the bone to grow on. Piot studies have yielded positive results, achieving complete bone formation and covering large bone defects in about three months. The team will now test whether exercise early in the healing process can help speed up healing and recovery. To do so, the 3D implants will be embedded with tiny sensors that can wirelessly transmit exercise activity. If the study is successful, Szivek anticipates the clinical trials will take place in military personnel. He believes the therapy could also be useful for patients with bone caners that are removed operatively.

NTU Singapore uses 3D-printed anatomical specimens for medical education

Nanyang Technological University, Singapore (NTU Singapore), is using 3D printed anatomical specimens for medical education at the Lee Kong Chian School of Medicine (LKCMedicine), jointly set up by NTU Singapore and Imperial College London. A collaboration between LKCMedicine and NTU's Singapore Centre for 3D Printing, these 3D-printed specimens come in varying materials, colors, hardness and flexibility to mimic the properties of anatomical structures in a real human body. LKCMedicine is also looking into other pedagogical approaches such as a medical tutor powered by artificial intelligence and a mobile app where virtual 3D animated specimens can be accessed. Since its founding in 2010, LKCMedicine has used innovative technologies to provide modern medical education, while transitioning away from traditional lectures by using the flipped classroom pedagogy, where students learn the course content online before class and face time with professors and classmates is devoted to collaborative learning.

Personalised 3D-printed models of patients' hearts can be used to plan surgery

London-based design studio Cellule developed a system for creating personalized digital and 3D-printed models of hearts, which can be used to help doctors plan surgery for transplant patients. Launched in September 2017, the Big Heart Data Project is examining the potential role of 3D printed and parametric modelization in heart surgery. By leveraging innovations in imaging and modelization technologies, researchers can 3D print models of their patients' unique hearts, which can then be used to develop personalised treatments for people with heart failure. The project, a joint effort between Pablo Lamata of the Department of Biomedical Engineering at King's College London and designer Cellule head Salomé Bazin, is using MRI techniques to create 3D printed anatomically correct models of individual patients' hearts. The hearts are printed using a renewable bio-based PLA plastic directly derived from sugarcane. The technology is based on ongoing research by scientists at the Welcome Centre for Biomedical Engineering, who specialise in Cardiac computer modelization. The Big Heart Data project is commissioned by the Science Gallery at King's College London and supported by the Centre for Medical Engineering also at King's College London. The project is speculative, and researchers said it could be ten years before it potentially becomes a seamless technology accessible for all.

Hebrew U team develops shape-shifting 3D printed pills for better targeted drugs

A team of researchers at The Hebrew University of Jerusalem created a new way to develop drug capsules using 3D printers, which they say opens the door for the development of pills that perform better than conventional capsules. The custom-printed pills are made out of a hydrogel in which the medication is inserted. The researchers said the technology allows for the creation of pills with complex designs that can expand, change shape and be activated on a set schedule which isn't currently possible—or very expensive to do—with conventional manufacturing techniques. The 3D pills are just one of the technologies developed by researchers at The Hebrew University. The university has set up a 3D printing center in which researchers, startups, artists and other in the field can use various printers and for their new ideas. The key to moving this field forward is to continue to experiment with various disciplines, said Professor Shlomo Magdassi, head of the Hebrew University's 3D and Functional Printing Center.

Manufacturing & Construction

Report suggests 3D printing could help solve Northern housing issues

A Conference Board of Canada report (reg. req.) suggests 3D printing homes could be a viable option for Canada's North. The board writes that construction in the North needs to work around the short transportation season and noting that in Nunavut, it costs between $400,000 and $550,000 to construct a public housing unit. The report points out if the technology and materials work in Arctic and sub-Arctic settings using 3D printing could cost a third or less of current prices. It writes that the printers likely won't prove a "panacea." The report provides recommendations for policymakers to begin investigating the technology, including changing the policy environment by working toward investigation and investing in innovative construction approaches.

Startup constructs India's first 3D printed structure

Tvasta Manufacturing Solutions, an emerging 3D printing startup founded by Indian Institute of Technology, Madras (IIT-Madras) alumni, developed India's first 3D Printing Construction Technology and built India's first 3D Printed Structure. Tvasta, along with the IIT Madras Civil Engineering Department constructed India's first 3D room module and the prototype will serve as a foundational model for accelerating R&D and testing in the startup's plan of making affordable sanitation and housing a reality in India. The startup and the Civil Engineering Department established the IIT Madras Printability Lab to formulate tech solutions for the construction sector and take its 3D printing construction technology to the mass market. The startup is also working on 3D Bio-Printers to design, print and control living cell structures such as plant cells and hydrogels.

3D printing in construction could save costs, improve architectural expression

Conventional approaches to construction involve casting concrete into a mold (known as formwork). But additive construction combines digital technology and insights from materials technology to allow free-form construction without the use of formwork. Eliminating the cost of formwork is the main economic driver of 3D concrete printing. Built using traditional materials, formwork accounts for about 60% of the total cost of concrete construction. Free-form additive construction could also enhance architectural expression. The cost of producing a structural component wouldn't be tied to the shape, so construction could be freed from current designs. Conventional concrete is not suitable for 3D printing, so alternatives must be developed and special printers are needed. Typically, the size of the printer needs to be larger than the component being printed. However, researchers are exploring printers or robots that can "climb" on parts of the concrete that are already set to print other sections.

Voxeljet sees construction industry as growth area for binder jetting technology

The large format binder jetting process from voxeljet can create complex 3D printed formworks. The advantage is that 3D printing enables the most complex formwork elements to be designed using CAD specifications. After the printing and infiltration process, the 3D printed formwork elements can be used like conventional formwork. Depending on the geometry, the formwork produced with powder binder jetting technology can be used up to 40 times. voxeljet formwork elements withstand concrete casting pressure of up to 100 kN/mÇ and there are no limitations regarding used release agents and concrete. If a three-dimensional shape is repeated—but in a different size, the data can be easily digitally rescaled and used to create another mold. The voxeljet VX4000 printing system can achieve build volumes of up to 8 cubic meters. Since the voxeljet formwork does not release resins (as is often the case with wood formworks) and doesn't change, the quality of the casting result is consistent. The 3D printed formworks are also weather-resistant.

PERI Group acquires stake in 3D Printhuset's COBOD International

Denmark's 3D Printhuset built the Building On Demand (BOD), the first 3D printed building in Europe that met the necessary building codes. The company's BOD2 won the first ever EU tender for 3D construction printers. This led it to create COBOD International, a company just for construction 3D printing which is responsible for the manufacture and sale of 3D Printhuset's BOD2. Germany's PERI Group acquired a significant minority stake in COBOD International. As a result of this investment, COBOD's 3D construction printers will be made available to all of PERI's global customers.

ICON raises $9M to improve affordable 3D printed housing technology

ICON, a Texas-based construction tech company, raised $9 million in funding through a seed round led by Oakhouse Partners to continue its mission of transforming construction using new technologies with the goal of making housing more affordable, durable and sustainable. When ICON teamed up with non-profit New Story to 3D print a home for just $4,000 it made headlines across the world and gained significant attention from the mainstream media. The prototype house was 3D printed in under 24 hours using ICON's mobile construction 3D printer—the Vulcan—and cost less than $4,000 to make. Measuring 600 to 800 square feet, the compact home is built from cutting-edge materials which comply to safety and comfort standards and which are designed to be used in environments where there may be limited water, power or other challenges.

Hamilton Labs launches 3D construction printer designed to tackle India's sanitation issues

Singapore-based construction 3D printing company Hamilton Labs dedicated a portion of its work to the development and production of sanitation systems to improve public health in India. The company's work is being taken to the next level with the launch of an entry level, gantry-based concrete 3D printer. The printer, measuring 2 x 2 x 2 m, comes pre-installed to build the Hamilton Labs' toilet. The construction 3D printer can be upgraded or customized to add further functionalities. For this endeavor, Hamilton Labs partnered with Indian 3D printing and rapid prototyping service Morphedo.

Autodesk brings robots, 3D printing systems together in portable shipping container

Autodesk is showcasing an additive manufacturing "toolbox" for the construction industry, with robots and 3D printing systems coming together in a portable shipping container. The idea is that various robots and printing systems—capable of printing large, usable metal components—can be packaged up in a shipping container and sent to different job sites. This method, the company says, enables buildings to be built quickly, parts to be produced more accurately and helps to fill the construction labor shortage. Autodesk said the shipping container will make its way around Europe this winter.

N3XTCON grant will help COBOD develop next-gen construction 3D printer by 2021

COBOD International, the construction 3D printing branch of Danish company 3D Printhuset, received a grant to help develop the next generation construction 3D printer. The grant is part of the N3XTCON project, which itself has over 2 million euros in support from the Innovation Fund Denmark. The N3XTCON project involves participation from materials suppliers, construction companies, architects, building owners, research institutions and universities. The goal of the project is to 3D print a demonstration building in Denmark designed by architect Bjarke Ingels' BIG Architects firm. The development of the next generation construction 3D printer will advance in close collaboration with research institutions and universities, which will offer their own expertise to create a machine that is more advanced than anything on the market today.

Clothing & Wearables

Canadian start-up creates the first 3D-printed cycle helmet

Kupol partnered with 3D printing specialist Sculpteo to develop and manufacture a ready-to-market cycle helmet promising improved levels of comfort and safety. This 3D printed helmet has a three-layer protection system designed to absorb multidirectional impacts while ensuring optimal comfort and breathability. The helmet's "Kinetic Bumpers" absorb low-speed impacts while the "3D Kore" takes the brunt of larger hits, from all angles. Over 100 sucker-shaped flexible "Oktopus" pods adjust to the wearer's head shape while providing protection against quick rotational movements.

3D printing at the heart of fashion designer's new collection

Ganit Goldstein launched a fashion collection called "Between the Layers," which started as a graduation project. Seven outfits and six pairs of shoes make up the collection, which was made from 3D printed PLA and TPU. She began working with upcycling, shredding second-hand fabrics and industrial textile leftovers and then creating new garments using a Japanese textile technique called IKAT weaving. When she returned home to Israel, Goldstein developed her own weaving process using a Prusa i3 Mk3 3D printer, combining the printing with hand-woven layers. Sustainability is an important value to her, and she appreciates 3D printing for the environmentally friendly opportunities it provides. In addition

to her own 3D printing and weaving techniques, Goldstein also worked with Stratasys to 3D print a pair of shoes, using a Connex3 color 3D printer.

Fashion designers launched 3D printed fashion at NY Fashion Week

Julia Daviy, a Miami-based designer, launched her own line of 3D-printed garments named 'The Liberation Collection' at New York Fashion Week. Daviy's 3D printed wearable tech-infused collection signals a growing focus on the potential of mass manufacturing fashion garments with the help of additive manufacturing. With the help of TPU materials and flexible resins, churned into large-format FDM 3D printers based on SLA technology, Daviy hopes to contribute to a less wasteful and more ethical fashion movement. Daviy is also fascinated by the movement toward intelligent garments and apparel following the advent of smart sensors and wearables technology.

3D printing moves into global eyeglass-frame market

Eyewear makers throw away roughly 75% of every sheet of acetate from which most plastic frames are cut, while 3-D printing leaves almost no waste. Consumers will pay up to 20% extra for customized frames, producers say, and personalization adds no cost with 3-D printing. Current printers are good for small quantities but not mass production. Printed frames generally sell for between $100 and $500—roughly the same as traditional high-end eyewear—but the range of materials and finishes remains limited. The practice is attracting big names to the field, including BASF of Germany, Italy's Safilo Group and Hoya of Japan. In the U.S., startup Skelmet offers custom-made sunglasses using digital facial scans that will be available through 10 opticians on the East Coast. Larger producers are eager for progress in part because their traditional business model involves mass-producing frames that they sell to opticians, often leaving as much as 40% of production unsold.

Food

Israeli startup creates meat alternative with 3D printing

Jet-Eat is using 3D printing to create plant-based food alternatives that have the flavor and texture of meat. The company is now working on a seed round investment, aiming to have a product on the market by 2020. Researchers in Spain are working on similar initiatives, while other organizations have discussed 3D bioprinting as a way to create meat.

Novameat unveils 3D-printed meat-free steak

Spanish startup Novameat' 3D printed meat-free steak is made from vegetable proteins. The ingredients mimic the texture of beef. Scientists combined tissue engineering and bio-printing with modern cooking method to create a product that has the same consistency, appearance and nutritional properties as animal meat products. While other efforts have focused on creating artificial meat from animal cells, that can take a long time, while Novameat can print a 100-gram piece of steak in 30 minutes.

Dutch students use food waste to create 3D-printed snacks

Upprinting Food, launched by two Dutch women, is using 3D printing technology to create food snacks out of food waste. The company is able to use a variety of wasted ingredients, including fruits and vegetables to create printable food waste. The company aims to help restaurants analyze and reuse food waste.

Filaments.ca launches food-safe filament for 3D printing

Filaments.ca, a Canadian AM materials webstore, released a filament that's food-safe. The True Food Safe PLA is made of raw materials and color pigments that follow the pharmaceutical industry's Good Manufacturing Practice. Batches are given tracking serial numbers and spools are individually tested before being vacuum sealed for protection.

Canadian startup Genecis using food waste to create biodegradable 3D printing filament

Genecis developed a way to recycle food waste and turn it into biodegradable plastics. The product can be used to make flexible packaging and containers that are 100% biodegradable and can be mixed with a variety of colors. The company is currently working to commercialize its first PHA bioplastic pellet product line and looking for partners to act as user of its polymers.

Columbia University develops machine that creates and simultaneously cooks 3D printed food

The researchers say the machine was developed to open up new possibilities for 3D printed foods, including creating customized foods for people with dietary needs. The system uses laser cooking methods, which the researchers say is much more precise. PhD researcher Jonathan Blutinger says he expects 3D printed laser-cooked foods to be commercially viable in the next five to 10 years.

Whisky company events feature 3D-printed bar, cocktails

Bulleit Frontier Whiskey developed a series of events where attendees can enjoy a 3D-printed drinking experience. A 3D-printed bar was created in collaboration with architecture firm FAR and fabricated by design studio Machine Histories. 3D-printed cocktails were created through a collaboration between robotics pioneer Benjamin Grimeil and mixologist Elmer Mejicanos. Guests also enjoyed 3D-printed light bites and performances by local artists.

Education

Purdue University develops method to 3D print energetic materials, launches startup

A team of researchers from Purdue University developed a 3D printing method for processing energetic materials. The 3D printer developed by the team uses high-amplitude ultrasonic vibrations to reduce friction on the nozzle walls, enabling the viscous energetic materials to flow through. This allows for more precise flow control, which is advantageous for printing energetic materials. The technique is reportedly faster, safer and more eco-friendly than existing processes. The researchers have also launched a faculty-owned startup for the technology called Next Offset Solutions. It will further their research and scale the production of the 3D printers as well as printable energetic materials. The company will also pursue other R&D, testing and evaluation initiatives for the additive manufacturing of energetic materials.

Virginia Tech developed method for using Kapton in 3D printing

A team of researchers in the Macromolecules Innovation Institute (MII) at Virginia Tech developed direct ink writing (DIW) as a method for processing Kapton in 3D. A research article describing the Kapton DIW 3D printing method was published in *ACS Applied Materials & Interfaces* journal. The project is an expansion on a previous SLA-based Kapton 3D printing project conducted by the Department of Mechanical Engineering's Design, Research, and Education for Additive Manufacturing Systems (DREAMS) Laboratory last year. The task of the DREAMS Lab, and its interdisciplinary collaborators at MII, is to unlock potential applications of Kapton which commonly only exists in 2D sheets. The latest MII technique for processing Kapton in 3D is a UV-assisted DIW method. UC-curable inks used in this process are derived from the Kapton/photopolymer solutions developed in the DREAMS Lab's previous Kapton SLA research. The next steps for the group are to further investigate the material composition of these 3D printed parts, then trial the method with some more complex structures.

3D printing shown to improve design thinking, creativity in primary schools

The Makerspaces in Primary School Settings study conducted by researchers at Macquarie University in Sydney, Australia found 100% of 3D printing and modeling lessons had high levels of student engagement. In addition, creativity (recorded with a 71% frequency in responses) and design thinking (recorded at 64.5% frequency) were the top two skills demonstrated by students throughout the study. An unanticipated, outcome was an increase in collaboration between teachers and technology, including a willingness by some to introduce similar pedagogies across other lessons.

Engineering students learn 3D design and printing

In a paper entitled Application of Additive Manufacturing in Design & Manufacturing Engineering Education, researchers from University College Dublin detail how they implemented a program on digital manufacturing and materials processing using 3D printing in an undergraduate engineering course to fabricate a turbocharger turbine part. The students were not given any prescribed methodologies or solutions on turbine design. The project was designed to be carried out for low cost; two 3D printers were used, one of them a Zmorph. The material used was PLA. A student survey was carried out to evaluate the students' prior knowledge in 3D printing as well as the level of interest and value in the course. All of the student's prior knowledge of 3D design, but limited experience. Overall, the course was successful, with the students reporting positive and enthusiastic feedback.

Environmental Efforts

Australian entrepreneur aims to convert plastic bottles into 3D printing filament

In search of a PET recycling plant anywhere in Australia, Perth native Darren Lomman found only one, and it only recycled a portion of the state's plastics. The rest were sold to the international waste market. Now, Lomman is converting plastic waste into 3D printer filament. When his idea of creating a desktop machine that would shred and melt plastic bottles to create filament proved too expensive, he launched social enterprise GreenBatch, which is working to build a system that will reprocess plastic bottles into filament. Lomman and GreenBatch are also building an industrial-scale recycling plant, and a network of secondary schools in Western Australia will collect plastic and send it to the facility. Once the plastic waste has been turned into filament, it will be returned to the same schools for use in educational 3D printing projects.

Arts & Entertainment

Ottawa Symphony Orchestra project creates, performs with 3D-printed instruments

The Ottawa Symphony Orchestra played a show—dubbed the "3D StringTheory Project"—with a full ensemble of instruments, including eight violin-type instruments created by a 3D printer. The OSO first came up with the plan to play with 3D instruments in 2016 after receiving a grant from the Canada Council for the Arts. Mary-Elizabeth Brown was the lead musician on the project and helped test the prototypes over the eight-month design period. Brown said the dimensions and feel of the 3D-printed violins are pretty much the same as a real violin. But, each of the instruments are white due to the material used to print them. The sound produced is slightly different from traditional instruments, she said. OSO's original plan was to create a 3D-printed instrument from every family of the orchestra. But it was too costly in terms of time and research and development to create so many unique instruments, Brown said.

MIT's RePaint recreates paintings with the help of 3D printing

Researchers at MIT's CSAIL developed RePaint, a system that recreates artwork using an AI-guided 3D printer. The technology promises color-accurate reproductions even in less-than-flattering conditions.

RePaint works by stacking ten different transparent inks in thin layers, with the AI predicting the ideal stack needed to generate the intended colors. The team also fed the AI paintings to help it determine which colors were needed in particular areas of a painting, adjusting for changes in lighting conditions to guarantee consistency. The technology also relies on halftoning to more closely match colors. The technology can't recreate surface texture and reflection and the output is the size of a postcard. If it scales, RePaint could produce a more authentic-looking Monet or Van Gogh replica for people's homes, while museums could protect originals by showing reproductions when possible.

Weta Workshop to take big *3D printing* to the big screen

Weta Workshop, a special effects design studio, acquired a Massivit 1800 3D printer at its facility in Wellington, New Zealand. The creative design studio, known for its intricate and realistic creature costumes, animatronics and props, will utilize the large format 3D printer to produce components for the entertainment industry. The studio already utilizes CNC routers, industrial robots and desktop-sized 3D printers—though none of these have been particularly well suited to producing large-scale parts. One of the first jobs for the Massivit 1800 at Weta Workshop will be to 3D print geometrically complex, large-scale molds. The studio expects it will save thousands of dollars by using the large format printer instead of CNC routers or desktop-sized printers.