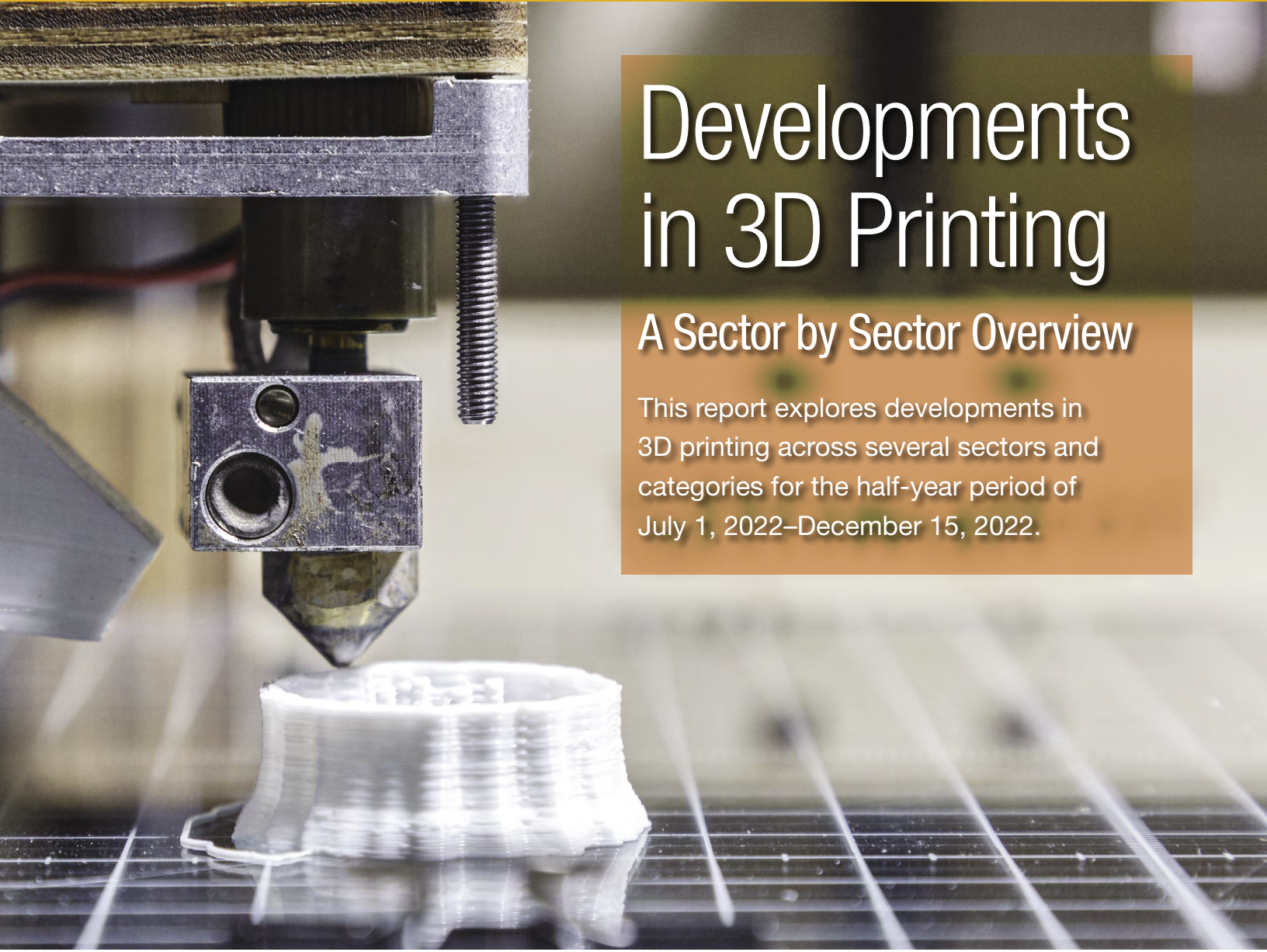


3D PRINTING - A FAST-MOVING MARKET



Developments in 3D Printing

A Sector by Sector Overview

This report explores developments in 3D printing across several sectors and categories for the half-year period of July 1, 2022–December 15, 2022.

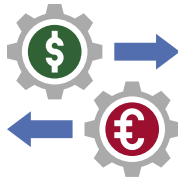


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Transactions

Stratasys Makes Investment Into Axial3D to Target 3D Printing Solutions for Medical Industry (November 2022)

Stratasys closed a \$15 million investment in Axial3D. The two companies plan to launch a joint offering that will provide patient-specific 3D printing solutions to hospitals and medical device manufacturers. Axial3D's AI-powered algorithms allow healthcare providers to segment CT and MRI scans without significant investments in time, or large upfront costs. Stratasys's J850 Digital Anatomy 3D printer enables medical customers to create models that accurately represent the appearance of human tissue that are also biomechanically realistic while suturing, cutting, or inserting and deploying medical devices.

Makerbot and Ultimaker Merge (September 2022)

MakerBot and Ultimaker completed a merger and will now be known as UltiMaker. Both companies count over a decade of experience behind them in developing desktop 3D printers, but decided to join forces to continue creating 3D printing hardware, software, and materials. The product lines of both organizations will be consolidated. There is also going to be a new focus to "amplify R&D efforts" and develop new products for education and professional customers.

Stratasys and 3D Systems Announce New Acquisitions (August 2022)

Stratasys signed an agreement to acquire the additive manufacturing materials business of Covestro, a supplier of premium polymers. Stratasys will acquire R&D facilities and activities, global development and sales teams across Europe, the U.S. and China, a portfolio of about 60 AM materials and an extensive IP portfolio with hundreds and of patents and patents pending. Stratasys hopes that the system can be leveraged with its own polymers materials portfolio and Oqton's software technology to bring high-speed mass production AM to several critical industries. Meanwhile, 3D Systems acquired dp polar GmbH, and its unique system that allows for continuous printing thanks to a segmented rotating print platform and a patented polar coordinate control which keeps a print head stationary above a rotating platform. With the acquisition, 3D Systems aims to accelerate high-volume additive manufacturing.

Carbon Acquires 3D Printing Software ParaMatters (August 2022)

Carbon acquired ParaMatters, a software as a services (SaaS) company providing solutions for the 3D printing sector. Carbon makes a full range of products—including software—for its line of Digital Light Synthesis (DLS) polymer printers. ParaMatters is known for creating CogniCAD, one of the first widely available generative design and topology optimization programs for AM.

Munich-Based AM Ventures Closes \$100 Million Fund (July 2022)

AM Ventures fund focuses specifically on the early growth stages of industrial and commercial 3D printing applications. Investing internationally, the firm went from a de facto family office to a multi-LP VC firm. The firm's portfolio to date spans 18 companies across three continents. It lists Headmade Materials, LightForce Orthodontics and Conflux Technology among some of its marquee investments.



Academic

[Using Artificial Intelligence to Control Digital Manufacturing](#) (August 2022)

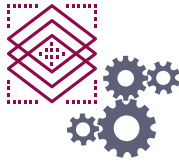
MIT researchers have used artificial intelligence to streamline the procedure of how to print with new materials. They developed a machine-learning system that uses computer vision to watch the manufacturing process and then correct errors in how it handles the material in real-time. They used simulations to teach a neural network how to adjust printing parameters to minimize error, and then applied that controller to a real 3D printer. Their system printed objects more accurately than all the other 3D printing controllers they compared it to. The work avoids the prohibitively expensive process of printing thousands or millions of real objects to train the neural network. And it could enable engineers to incorporate novel materials more easily into their prints, which could help them develop objects with special electrical or chemical properties. It could also help technicians adjust the printing process on-the-fly if material or environmental conditions change unexpectedly.

[MSU Researchers Unveil 3D Printing Technology That Could Advance Biofilm Science](#) (July 2022)

MSU's Center for Biofilm Engineering is developing a tool for replicating microbial mosaics so that treatments can be studied. For the past two years, MSU researchers have designed and tested a 3D printing device that can precisely lay out a grid of individual bacteria in hydrogel. Tapping into advances in 3D printing, the researchers can map out the microbes within drops of liquid hydrogel resin and then use laser light to solidify the material, constructing a rudimentary biofilm.

[Researchers Create 3D Printed Surgical Table](#) (July 2022)

North American University researchers created a 3D-Printed surgical table. The project, a collaboration between the University of Western Ontario and Michigan Technological University, was conducted using open-source hardware and resulted in the production of a fully functional medical application that cost only a fraction of its regular cost. The surgical table market in North America alone exceeded \$456 million in 2021 and a single surgical table can cost up to \$250,000. The entire printing process was finished in a little more than a week, and the end product, a fully functioning surgical fracture table, only costs around \$4,000.



Material and Manufacturing

New Nanoscale 3D Printing Material Designed by Stanford Engineers Could Offer Better Structural Protection for Satellites, Drones, and Microelectronics

(November 2022)

Researchers at Stanford have developed a new material for printing at the nanoscale and used it to print minuscule lattices that are both strong and light. In a paper [published in *Science*](#), the researchers demonstrated that the new material can absorb twice as much energy than other 3D-printed materials of a comparable density. To design a better material for 3D printing, the researchers incorporated metal nanoclusters—tiny clumps of atoms—into their printing medium. The researchers are printing with a method known as two-photon lithography, where the printing material is hardened through a chemical reaction initiated by laser light. In the future, their invention could be used to create better lightweight protection for fragile pieces of satellites, drones, and microelectronics.

Manufacturing may be Possible on Mars Thanks to 3D Printing (September 2022)

Researchers at Washington State University succeeded in making a solid, high-performance material that could be used to 3D print tools or rocket parts on Mars. To do this, tests were conducted with Martian regolith, a black powdery substance used to mimic the rocky material found on the surface of the planet. The material was mixed with titanium alloy. Notably, the researchers printed several parts, each with a different percentage of Martian regolith. According to WSU professor Amit Bandyopadhyay, the parts 3D printed with 5% of the black powder are stronger than those made with titanium alone. The objects made of 100% regolith, however, turned out to crack more easily and lack strength. Nevertheless, the material is still useful for the manufacturing of coatings to protect equipment from rust or radiation damage.

3D Printing Drones Work Like Bees to Build and Repair Structures While Flying

(September 2022)

Through a collaboration with researchers at the University of Pennsylvania and the Imperial College London, Empa researchers have created a swarm of bee-inspired drones that can collectively 3D print material while in flight, allowing limitless manufacturing for building and repairing structures. This novel approach to 3D printing addresses the challenges of the deployment of construction 3D printers by using drones. The drones are fully autonomous while flying but are monitored by a human controller who checks progress and intervenes, if necessary, based on the information provided by the drone.

3D-Printed Wood Could Start Flat then Twist into Furniture as it Dries (August 2022)

Wood shavings have been turned into 3D printer ink to make objects that start off as damp, flat sheets and then twist and warp into shape as they dry. This method of 3D printing could make wood sturdy enough to be used for furniture or parts of buildings in the future. Wood naturally changes shape as it dries because of the structure and orientation of its cells. The researchers took advantage of this by 3D printing with an ink made primarily of “wood flour” or ground-up leftover wood from other construction. They printed objects from this ink by making layers or adjacent rows of wet strips that warped as they dried.

Method Turns Plastic into Resin for 3D Printing (August 2022)

Researchers developed a simple and efficient way to convert polylactic acid (PLA), a bio-based plastic used in products such as filament, plastic silverware, and food packaging, to a high-quality resin. About 300,000 tons of PLA are produced annually, and its use is increasing dramatically. Although it's bio-based, PLA, which is categorized as a number seven plastic, doesn't break down easily. It can float in fresh or salt water for a year without degrading. It is also rarely recycled because like many plastics, when it's melted down and re-formed, it doesn't perform as well as the original version and becomes less valuable.

**Construction****World's Tallest On-Site 3D Printed Building Completed in Saudi Arabia**

(November 2022)

At 9.9 meters in total height, the Dar Al Arkan villa in Saudi Arabia is the tallest on-site 3D printed building in the world. Dar Al Arkan, a real estate development company located in Riyadh, revealed their first project: a 3-story 3D printed villa made with a 3D construction printer from COBOD International. The project was executed using local materials and the D.fab solution developed by Cemex and COBOD. This solution allows COBOD customers to source 99% of the concrete materials locally, while only relying on 1% sourced from a central location.

First 100% Bio-Based 3D-Printed Home Unveiled at the University of Maine

(November 2022)

The University of Maine Advanced Structures and Composites Center (ASCC) unveiled BioHome3D, the first 3D-printed house made entirely with bio-based materials. BioHome3D was developed with funding from the U.S. Department of Energy's Hub and Spoke program between the UMaine and Oak Ridge National Laboratory. Partners included MaineHousing and the Maine Technology Institute. The 600-square-foot prototype features 3D-printed floors, walls and roof of wood fibers and bio-resins. The house is fully recyclable and highly insulated with 100% wood insulation and customizable R-values. Construction waste was nearly eliminated due to the precision of the printing process.

CyBe to Build First-Ever 4-Story 3D Printed Building in Eindhoven (October 2022)

CyBe, a 3D concrete printing company, is collaborating with Lab040 in Eindhoven to create the first-ever, 3D printed, four-story apartment. It will be assembled by Prefabricated Prefinished Volumetric Construction (PPVC), which is a way of constructing completed and finished units off-site for on-site installation. Using this modular construction technology, 3D units are produced in controlled factory settings with optimized construction methods and building materials. The modules can be delivered to the construction site in a variety of states—from basic structural blocks to fully finished apartments complete with amenities. The assembly process is quick and maintains the concrete's inherent benefits such as providing fire resistance, sound absorption, and thermal mass.

Building for Humanity to Construct UK's First 3D Printed Homes in Accrington

(October 2022)

Non-profit housing restoration and construction firm Building for Humanity announced plans to build the UK's first 3D printed homes. As part of the £6 million Charter Street regeneration project in Accrington, the company plans to COBOD 3D print 46 new energy-efficient homes. Once built, the housing is expected to be marketed as more accessible lodgings for veterans and low-income families in the town, who can't currently afford to rent or buy there.

Europe's First 3D Printed Office Extension Completed in Austria (September 2022)

Europe's first 3D printed office extension opened in Hausleiten, Austria. The project, first announced in October last year, is a result of a collaboration between the construction technology group STRABAG and the scaffolding and formwork manufacturer and 3D concrete printing pioneer, PERI. The building, printed with a BOD2, COBOD's best-selling 3D construction printer, is a 125m² office extension to an existing building in Hausleiten. The maximum printing speed of the BOD2, at one meter per second, is the fastest in the world. As a result of this speed, the shell construction in Hausleiten was completed in approximately 45 hours of continuous printing time.

Montana has Given Regulatory Approval for Homes with 3D Printed Walls, the First State to Do So (August 2022)

Building code regulators from the Montana Department of Labor & Industry recently confirmed that they have given broad regulatory approval for the use of 3D printing in construction, making it the first state to recognize 3D printed walls as an equal replacement to walls made with concrete masonry units. The original request was made by Tim Stark, a contractor based in Billings, Montana, who intends to use 3D printing construction technologies developed by Florida-based company Apis Cor.

Chinese Propose to Build a Dam with a Distributed 3D Printer (August 2022)

A study [published](#) by a team of researchers at Beijing's Tsinghua University has revealed plans to construct a 594-foot-tall dam using robots, 3D printing, and artificial intelligence. The researchers claim that no human labor needs to be directly employed in building this massive structure—if the plan moves forward, the dam will produce 5 billion kWh of electricity annually. This much energy will be enough to meet the power demands of 50 million homes in China. If everything goes as planned, the Yangqua dam will become the biggest ever AI-made 3D-printed structure on the planet.



Food

Plantish Offers Plant-Based Fish Thanks to 3D Printing (October 2022)

Plantish, an Israeli startup, has tackled the salmon market and offers vegetable fillets, designed via a patented 3D printing technology. It has already raised \$12.5 million and is expected to offer its fish through a network of restaurateurs.

Revo Foods, Mycorena Using 3D Printing to Create Fungi-Based Seafood Alternatives (October 2022)

Vienna, Austria-based Revo Foods announced a research collaboration with Gothenburg, Sweden-based biotechnology company Mycorena to explore 3D printing of seafood alternatives. Mycorena has developed a fungi-based mycoprotein, and the collaborative research will be conducted to explore if it is viable to use it in combination with 3D food printing to create seafood analogs. The soft fibrous texture and light-colored appearance of the “promyc” material shows potential for both meat and seafood analogs, Mycorena R&D Manager Kristina Karlsson said.

Global Food 3D Printing Market to Reach \$15.1 Billion by 2031: Allied Market Research (October 2022)

According to the report published by Allied Market Research, the global food 3D printing market generated \$226.2 million in 2021, and is projected to reach \$15.1 billion by 2031, growing at a CAGR of 52.8% from 2022 to 2031. The report offers a detailed analysis of the top winning strategies, evolving market trends, market size and estimations, value chain, key investment pockets, drivers & opportunities, competitive landscape, and regional landscape.

3D-Printing Insects Mixed with Vegetables Could Help Prevent Food Crisis (August 2022)

A team of researchers at Singapore University of Technology & Design (SUTD) combined crickets and larvae with more commonly eaten vegetables like carrots to change the flavor. The process mainly proceeds by the trial-and-error method. For this reason, SUTD worked with scientists from Khoo Teck Puat Hospital (KTPH) and the University of Electronic Science and Technology of China (UESTC) to make the process go more smoothly.



Health

[3D Printing is Being Used to Make a Safer Mosquito Repellent](#) (October 2022)

A team of researchers at Martin Luther University Halle- Wittenberg (Germany) have developed a 3D printed wearable containing a skin-friendly chemical mosquito repellent. The evaporation rate of the insect repellent depends on factors such as temperature, concentration and structure of the polymer used. As a solution to the problem of this toxic and temporary material they have developed a sustainable, effective, and safe repellent. And in contrast to natural solutions that tend to wear off quickly and require continuous application, this 3D printed repellent is comfortable to wear as it can be in the form of a ring, bracelet, or any design you want, without the need to apply any product on your skin.

[3D Printing is Helping Doctors to Treat Lupus](#) (September 2022)

Engineers and doctors at the University of Minnesota Twin Cities are using 3D printing to develop a unique light-sensing medical device which can be used in the treatment of Lupus. By placing it directly on the skin, the device will enable real-time feedback to correlate light exposure with disease flare-ups. It is expected to help doctors to provide more personalized treatments and information. The researchers used 3D printing to create customized devices which in turn can be used for personalized treatments for patients with Lupus.

[Bio-Inspired Inks for 3D Printing of Next-Gen Wearable Tech](#) (September 2022)

A new bio-ink mimics conductive human tissue for the development of wearable technology that is more compatible with the human body, paving the way for novel “integrated” electronics applications, researchers said. A team from the Department of Biomedical Engineering at Texas A&M University, developed the bio-ink, which is suitable for 3D printing and leverages a new class of 2D nanomaterials known as molybdenum disulfide, or MoS₂.

[Engineers Saved a Baby's Life by Printing the Missing Part of Her Skull](#)

(August 2022)

In Rzeszow, Poland, surgeons used a skull produced from a 3D printer for a newborn baby who was born with a fifth of her skull. A Warsaw technology company specializing in 3D printing called Sygnis has helped and saved the life of a newborn baby with a critically underdeveloped cranium by printing the exact model of the baby's skull in one day. If the surgery were not planned within four days, the baby would be open to all kinds of infections.

[Triastek Forms Pact with Eli Lilly to 3D Print Tablets for Oral Drug Delivery](#)

(July 2022)

Triastek has developed proprietary 3D printing technology that provides solutions for drug development. According to an agreement, Triastek and Eli Lilly will focus on improving the bioavailability of drugs in the intestine. Triastek will first conduct in-depth studies of the excipient—inert ingredients added to a drug product for specific functional roles—to ensure drug stability is maintained during development and 3D printing. Then, Triastek will identify the optimum 3D structure design for achieving targeted and programmed drug release.



Aerospace, Defense & Military

Nasa Awards 3D Printing Firm Icon \$57.2m for Space Construction Research

(November 2022)

NASA awarded 3D Icon \$57.2 million to continue to research and develop technology that could help create structures on the moon's barren surface. Icon received the funding under Phase III of NASA's Small Business Innovation Research program, which funds startups and companies working to meet federal research and development needs. The new NASA SBIR Phase III award will support the development of Icon's Olympus construction system, which is designed to use local resources on the moon and Mars as building materials. Icon plans to use the money to continue its research into the uses of locally available materials on the moon to build landing pads, blast shields and roads. The continued funding comes as both public and private entities work towards NASA's goals for lunar exploration.

Redwire to Launch Improved 3D Bioprinter to the ISS on Mission to Aid US Military Veterans

(November 2022)

Redwire unveiled plans to launch a new version of its 3D bioprinter to the NASA International Space Station (ISS). Specifically, working with the Uniformed Services University of the Health Sciences Center for Biotechnology (4DBio3), Redwire aims to send up an upgraded edition of its BioFabrication Facility (BFF). Once there, the system's human cell deposition capabilities will be utilized to investigate the potential of 3D bioprinting in helping treat the meniscal injuries often suffered by US military service personnel.

US, UK Explore Interoperable, Battlefield-Ready 3D Printing Capabilities

(October 2022)

At Project Convergence 22, a U.S.-hosted all-service and multinational experiment designed to improve future force interoperability and readiness, British Army officer Maj. Alex Shand and his colleagues were able to successfully print—for the first time ever—U.S. Army materiel replacement parts using a British Army 3D printer. This functionality is important because it shows how a multinational partner could potentially assist the U.S. military in making rapid equipment repairs on the battlefield, Shand explained. The increased flexibility could prove beneficial if a nearby unit lacked a 3D printer, for example, or if supply chain disruptions were preventing the timely delivery of missing parts.

U.S. Military Turns to 3D Printing for Mission-Critical Supplies

(September 2022)

A survey conducted by McKinsey found that, in response to the pandemic, 93% of senior supply-chain executives planned to make their supply chains more flexible, agile, and resilient. In the early months of the Covid-19 pandemic, 3D printing addressed several medical supply chain challenges. Now, amid ongoing disruptions, the U.S. military is ramping up its usage of 3D printing to acquire mission-critical parts. In February of this year, the Department of Defense (DoD) released an assessment of defense-critical supply chains. The report recommended increased use of 3D printing to drive mission success.

The Royal Dutch Navy Uses Nanoe’s 3D Printing Solutions (September 2022)

The Royal Dutch Navy concluded a partnership with additive manufacturing company Nanoe. Together, they want to focus on producing parts for LPD ships—or “Landing Platform Dock” which are generally used in wartime and integrate a landing station. The parts are planned to be manufactured using Nanoe’s Zetamix filaments. Nanoe has focused on, among other things, the production of materials in the ceramic sector since its founding in 2008. Just 10 years later, in 2018, it introduced its Zetamix solution, which consists of ceramic and metal filaments for additive manufacturing. It is also being marketed as the first ceramic and metal filament accessible in the industry.

Aerospace 3D Printing Materials Market to Reach \$8.39 Billion, Globally, by 2027

(September 2022)

The global aerospace 3D printing materials market size is projected to grow from \$2.75 billion in 2022 to \$8.39 billion by 2027, at a CAGR of 25%. Increased demand for lightweight and durable aerospace components and simplification of complex designs will drive the growth of the aerospace 3D printing materials market.

Boeing, Northrop Grumman Join Group Pushing 3D Printing to Small Suppliers

(August 2022)

Boeing and Northrop Grumman joined a White House-backed consortium that is pushing smaller aerospace and defense suppliers to manufacture more 3D-printed parts. The companies join Lockheed Martin, Raytheon Technologies, GE, Siemens, and Honeywell as members of the AM Forward group that the Biden administration announced in May 2022.

VA Cleared to Use 3D Printing Tech to Assist Veterans’ Surgeries (August 2022)

The Department of Veterans Affairs has gotten its first 3D printing medical device cleared to assist in veterans’ surgeries. The product, a combination of “software and physical goods,” will be used to help doctors preparing for reconstructive surgeries of the jaw and face. Known as the OroMaxilloFacial Advanced Surgical Planning System, the device, which was officially cleared for use by the Food and Drug Administration, will assist surgeons with pre-surgical planning by using virtual and 3D-printed physical models to guide procedure and treatment options for patients.

First 3D Printer Installed on U.S. Navy Ship for Evaluation Underway (July 2022)

The U.S. Navy recently installed its first 3D printer aboard one of its vessels in a program designed to test the capabilities of the technology and its potential contribution to enhancing maintenance aboard active duty vessels. The Navy joins with the commercial shipping industry which has also been looking at the capabilities of 3D printing and tested the first parts for ships made with the technology. The 3D printing system was recently placed aboard the USS Essex, a Wasp-class Landing Helicopter Dock currently based at Pearl Harbor, Hawaii.



Energy

Shell and GE Additive 3D Print Oxygen Hydrogen Micromixer with Green Energy Generating Potential (November 2022)

GE Additive partnered with oil and gas multinational Shell to develop a unique oxygen hydrogen micromixer demonstrator. Also known as hydrogen-oxygen burners, such parts are often used in furnaces designed to efficiently melt metal scrap, or within industrial, refinery or energy-generating turbines. Produced from nickel alloy 718 using a Concept Laser M Line 3D printer, the model was only initially developed as a prototype, but with GE working on many turbine R&D projects, something similar could one day find end-usage.

Shell Comes Aboard Subsea 3D Printing Joint Industry Project (November 2022)

Shell joins project partners Kongsberg Ferrotech, Equinor, Gassco and SINTEF who have been working on this industrial project, named SAMLE, since 2021. Project partners believe that new methods represent a game-changing way of conducting subsea repairs, as additive manufacturing for lifetime extension of subsea assets is expected to have great financial and environmental benefits for installed and future assets and 3D printing meets the main criteria for sustainability.

New 3D Printing Process Offers Novel Energy Storage Design Options

(September 2022)

UNSW engineers have developed a process to print solid-state polymer electrolytes into any shape desired for use in energy storage. The research team from the School of Chemical Engineering say the 3D printing process of such material could be particularly useful in future medical devices where small, intricately designed energy storage offers several benefits.