Science VIEW

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3D PRINTING

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science VIEW

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From the Editor's desk

We are happy to launch the fourth issue of GSFC University's e-Magazine – Science View. I feel fortunate to be a part of this issue of the magazine which is known to be a magazine for the student, by the student.

The term "3D printing" can refer to a variety of processes in which material is deposited, joined or solidified under computer control to create a three-dimensional object, with material being added together typically layer by layer. In other words we can say that, 3D scanning is a process of collecting digital data on the shape and appearance of a real object, creating a digital model based on it.

3D printing covers a host of processes and technologies that offer a full spectrum of capabilities for the production of parts and products in different materials. Essentially, what all of the processes and technologies have in common is the manner in which production is carried out layer by layer in an additive process which is in contrast to traditional methods of production involving subtractive methods or molding/casting processes.

3D printing encompasses many forms of technologies and materials as 3D printing is being used in almost all industries you could think of. It's important to see it as a cluster of diverse industries with a myriad of different applications. Few of them all are consumer products (eyewear, footwear, design, furniture, apparel), Construction industry, industrial products (manufacturing tools, prototypes, functional end-use parts), dental products, prosthetics, architectural scale models & Marquette, reconstructing fossils, replicating ancient artifacts, reconstructing evidence in forensic pathology, movie props

I would like to thank all my team members for helping me making this issue successful. I also wish extend my gratitude to all faculties and students participated dynamically in materializing this magazine. I am also heartily thankful to university management for providing me such an opportunity, furnishing their support and encouragement.

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3D-Printing in SPACE

To lighten the load and reduce cost, NASA is using the ISS as a testbed to demonstrate a way of manufacturing the necessary parts in space through 3D printing. NASA's additive manufacturing efforts for the International Space Station have focused mostly on the 3D printing of polymers or plastic materials.

Refabricator is a hybrid 3D printer that can recycle hard, polymer plastic material of various sizes and shapes into 3-D print items. The whole process happens in a single automated machine about the size of a mini-refrigerator.

Fig, 1 The original Made In Space Additive Manufacturing Facility (AMF) now aboard the ISS. Photo via Made In Space

Except for other reasons, one fundamental reason for no space travel right after the Apollo mission is – Cost of Space Travel. Everything we ever put in space is manmade and came from the surface. But what if required things will directly be made in space. The moment when things got started manufactured in space, then we have completely change the game. And here how breakthrough idea come, To print spare parts & tools in outer space like- at International Space Station

In 2014, NASA made important progress toward the in-space manufacturing necessary for deep space exploration by "printing" tools in space using a 3-D printer on the International Space Station with the help of the startup "Made In Space" firm who give this idea of printing things in space.

While 3D printing is a technology with that many people are now familiar, there is one 3D Printer 250 miles above us on the International Space Station (ISS) which is far different than our earth 3D Printer. It is known as "Refabricator", a hybrid 3D printer that can recycle hard, polymer plastic numerous times to make new items. About the size of a dorm room refrigerator, the device is controlled by operators on Earth who oversee its manufacturing via video cameras.

In 2018, the nation's space agency will take the next step toward a sustainable in-space manufacturing capability when it launches a machine that can not only print plastic parts but can also recycle them back into reusable raw materials to make more and/or different parts.

During one interview Niki Werkheiser (NASA's In-Space Manufacturing Manager at Marshall Space Flight Center, in Huntsville, Alabama) said that "Recyclers on Earth grind plastic pellets to create their products. But that grinding creates material sheer which prevents it from reusing. By this process, the material is no longer strong enough for further use. Tethers Unlimited Inc. developed a novel recycling process that doesn't require grinding – and that allows us to recycle the plastic multiple times."

Niki Werkheiser also added that "When we are talking about deep space travel, the crew have to carry stockpile printing material roll which occupies a particular space in Shuttle. That's why Refabricator can recycle plastic items not normally associated with Earthbound 3D printers. For instance, almost all of the materials that are delivered to the station are packed using foam or plastic bags. Both can be loaded into the Refabricator to deliver items such as a plastic syringe, an eating utensil, or a custom made wrench. They can replace a lot of things that they need during orbiting above Earth. This ability limits the number of backup materials that need to take with the crew on a long range expedition. After all, in space, space is at a premium."

Refabricator's technology demonstration will be composed of two phases. During each phase, the Refabricator will perform seven cycles of recycling and printing parts while onboard the ISS. All of the items printed by the Refabricator will eventually be sent back to Earth for testing and analyses to determine the effects of repeated recycling on the material properties of the plastic.

The Refabricator will be key in demonstrating a sustainable logistics model to fabricate, recycle, and reuse parts and waste materials

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(Figure 1)

https://www.nasa.gov/sites/default/files/thumbnails/image/refabricator_etu_open_pao-update.jpg

(Figure 2)

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3D-Printing - Way to the Stars

Solving the Challenges of Long Duration Space journy with 3D Printing

When planning a mission to the International Space Station, NASA's traditional approach has been similar to how one might prepare for a long camping trip: bring everything, 'cause we're not going home.

The International Space Station has continuously been home to astronauts for more than nineteen years. Astronauts conduct scientific research using dozens of special facilities aboard the space station, which also provides them with a place to eat, sleep, relax, and exercise.

To support spaceflight missions NASA sends up about 7,000 pounds of spare parts to the ISS every year. Another 29,000 pounds of spaceflight hardware spares are stored aboard the station and another 39,000 on the ground, ready to fly if needed.

When you're 200 miles from Earth, after all, you want to make sure that you have all of your necessary supplies, from bolts to cable mounts. NASA's "better to be safe than sorry" approach, however, means that a vast majority of parts stored on ISS(International Space Station) are never used. However. Astronauts on these long voyages need to be able to make their spare parts, tools, and materials essentially on-demand – both for routine needs and to adapt quickly to unforeseen ones. In-space manufacturing (ISM) using 3D printing technology could be an answer.

NASA Astronaut Barry (Butch) Wilmore holds a ratchet wrench created in 2014 with the 3D printer aboard the International Space Station using a design file transmitted from the ground._Credits: NASA

The 3D Printing in Zero G Technology Demonstration Mission

The project sent the first 3D printer to the space station in 2014. Developed by Made in Space, this printer used a fused filament fabrication (FFF) process, feeding a continuous thread of plastic/polymer through a heated extruder and onto a tray layer by layer to create a three-dimensional object. The 3D Printing in Zero-G investigation produced dozens of parts, which researchers analyzed and compared with those made on the ground. The analysis revealed that microgravity had no engineering-significant effects on the process, demonstrating that a 3D printer works normally in space and paving the way to new logistics systems for long-duration missions.

The ReFabricator unit, from the Seattle, WA-based aerospace company Tethers Unlimited, was flown to ISS in 2019. ReFabricator is designed to print parts with ULTEM 9085, which can then be recycled back into feedstock for further printing -an important feature when considering efficiency and cost savings.

NASA on Metal 3D Printing

A printed product floats in front of the AMF on the ISS. (Image Credit: NASA)

Many of the parts needed on space missions are aluminum, titanium, and steel. On Earth, the preferred metal 3D printing method for aerospace is selective laser melting (SLM). In this process, metal powder is fed from a hopper onto a build plate. Each deposited layer is about the thickness of a human hair. A laser then selectively melts the powder and fuses it. These systems, however, are very large and have high power requirements. Additionally, the powders are combustible, a respiration hazard, and would be difficult to manage/control in a microgravity environment.

Such constraints have driven NASA to consider other processes beyond SLM for adaptation to space: ultrasonic techniques that use force and vibrations to join adjacent layers of metal foil, wire+arc technologies that employ a welding process to deposit and fuse subsequent layers of metal wire, and bound metal deposition-type methods that use filament or pastes of metal particles packed in a polymer binder.

A larger project called the Multimaterial Fabrication Laboratory ("FabLab" for short) from Techshot will include a metal additive manufacturing process, a furnace and endmill for post-processing of the printed part, and an in-process inspection capability which monitors the part as it is being built. The FabLab is designed to occupy a full EXPRESS rack on ISS.

NASA on Electronics Printing

Many of the components which malfunction or need to be replaced on ISS are electronic. Currently, NASA's printed electronic team is fabricating sensors for various applications, such as CO2, humidity sensing, and crew health monitoring, which will be 3D-printed on the ground at first and then tested on ISS, perhaps in the next couple of years

NASA is not alone in using 3D printing for space travel. Elon Musk's SpaceX used Powder Bed Fusion to 3D print its SuperDraco thruster, which powers its Dragon spacecraft. According to Musk, "through 3D printing, robust and high-performing engine parts can be created at a fraction of the cost and time of traditional manufacturing methods. SpaceX is pushing the boundaries of what additive manufacturing can do in the 21st century."

Advances in 3D printing for space exploration are coming from around the world. In 2015, England's University of Birmingham 3D printed a complex, high-performance ceramic rocket engine thruster, at a fraction of the cost of making such a part with traditional methods. New Zealand's Rocket Lab 3D printed its Rutherford rocket engine, named after native son Ernest Rutherford, a Nobel Prize-winning physicist. Using Powder Bed Fusion, Rocket Lab printed the engine's thrust chamber, injector, turbopumps, and main propellant valves, using titanium alloys. Some of these parts could not be made by traditional methods and were 3D printed in days rather than months. The European Space Agency 3D printed a platinum rocket engine combustion chamber and spacecraft thruster nozzle. The parts performed at least as well as their traditionally made counterparts, at a greatly reduced cost.

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Knowledge Of 3D-Printing

3D printing refers to processes in which material is joined or solidified under computer control to create a three-dimensional object, with the material being added together.3D printing is used in both rapid prototyping and additive manufacturing. Objects can be of almost any shape or geometry and typically are produced using digital model data from a 3Dmodel or another electronic data source such as an additive manufacturing file.

Chuck Hull of 3D Systems Corporation In 1984, Chuck Hull of 3D Systems Corporation filed his patent for a stereolithography fabrication system, in which layers are added by curing photopolymers with ultraviolet light lasers.

The basic workflow of 3D printing is the following:

- We design it in CAD software and output 3D printing format.
- Slice software will translate to 3D printing language according to our Configuration.

Update date to 3D printing and then run it

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Role of 3D-Printing in Medical Field

Every year, 3D printing offers more and more applications in the healthcare field helping to save and improve lives in ways never imagined up to now. 3D printing has been used in a wide range of healthcare settings including, but not limited to cardiothoracic surgery, cardiology, gastroenterology, neurosurgery, oral and maxillofacial surgery, ophthalmology, otolaryngology, orthopedic surgery, plastic surgery, podiatry, pulmonology, radiation oncology, transplant surgery, urology, and vascular surgery.

Thanks to the different benefits that this technology could induce in the field, the main direct applications of 3D printing in the medical and clinical field are as follows :(i)Used for personalized presurgical/treatment and for preoperative planning. This will lead to a multistep procedure that, integrating clinical and imaging information, will determine the best therapeutic option. Several studies have demonstrated that patient-specific presurgical planning may potentially reduce time spent in the operating room (OR) and result in fewer complications. Moreover, this may lead to reduced postoperative stays, decreased reintervention rates, and lower healthcare costs. The 3D-printing technology allows providing to the surgeon a physical 3D model of the desired patient anatomy that could be used to accurately plan the surgical approach along with cross-sectional imaging or modeling custom prosthetics (or surgical tool) based on patient-specific anatomy. In this way, a better understanding of complex anatomy unique to each case is allowed. Furthermore, 3D printing gives the possibility to choose before the implantation the size of the prostheses components with very high accuracy. (ii)Customize surgical tools and prostheses: 3D printing can be used to manufacture custom implants or surgical guides and instruments. Therefore, the customization of surgical tools and prostheses means a reduction of cost given by the additive manufacturing technique. (iii)Study of osteoporotic conditions: following a pharmacological treatment, 3D printing is useful for invalidating the results achieved by the patient. This enables a more accurate estimation of a patient s bone condition and a better decision on surgical treatment. (iv)Testing different device in specific pathways: a clear example is the reproduction of different vascular patterns to test the effectiveness of a cardiovascular system used to treat peripheral and coronary artery disease. In this way, 3D printing enables us to quickly produce prototypes of new design concepts or improvements to existing devices. (v)Improving medical education: 3D-printed patient-specific models have demonstrated that they can increase performance and foster rapid learning, while significantly ameliorating the knowledge, management, and confidence of the trainees regardless of the area of expertise [8]. The benefits of 3D printing in education are the reproducibility and safety of the 3D-printed model concerning the cadaver dissection, the possibility to model different physiologic and pathologic anatomy from a huge dataset of images, and the possibility to share 3D models among different institutions, especially with ones that have fewer resources. 3D printers that have the capability to print with different densities and colors can be used to accentuate the anatomical details. (vi)Patient education: patient-centered care makes patient education one of the top priorities for most healthcare providers. However, communicating imaging reports verbally or by showing patients their CT or MRI scans may not be effective; the patients may not fully understand 2D images representation of a 3D anatomy. On the contrary, 3D printing may improve doctor-patient communication by showing the anatomic model directly. (vii)Storage of rare cases for educational purposes: this role is closely linked to the previous one. This allows the generation of a large dataset composed of datasets of patients affected by rare pathologies, allowing the training of surgeons in specific applications. (viii)Improve the forensic practice: in the courtroom, a 3D model could be used to easily demonstrate various anatomic abnormalities that may be difficult for jury members to understand using cross-sectional imaging. (ix)Bioprinting: 3D printing allows also the modeling of implantable tissue. Some examples are the 3D printing of synthetic skin for transplanting to patients, who suffered burn injuries. It may also be used for testing cosmetic, chemical, and pharmaceutical products. Another example is the replicating of heart valves using a combination of cells and biomaterials to control the valve's stiffness or the replicating of human ears using molds filled with a gel containing bovine cartilage cells suspended in collagen. (x)Personalized drug 3D printing: the 3D printing of drugs consists of printing out the powdered drug layer to make it dissolve faster than average pills. It allows also personalization of the patient's needed quantity. (xi)Customizing synthetic organs: 3D printing may represent an opportunity to save life reducing the waiting list of patients that need transplantation. Bioprinted organs may also be used in the future by pharmaceutical industries to replace animal models for analyzing the toxicity of new drugs.

Therefore, these examples demonstrated that 3D printing is one of the most disruptive technologies that have the potential to change significantly the clinical field, improving medicine and healthcare, making care affordable, accessible, and personalized. As printers evolve, printing biomaterials get safety regulated and the general public acquires a common sense about how 3D printing works.

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3D Bio-printing: Future of Biotechnology

Introduction

3-D Bioprinting is one of the emerging technologies, which is exceptionally used in tissue engineering and regenerative medicine to develop complex tissue structures to mimic original organs and tissues. 3-D Bioprinting is a form of additive manufacturing that uses cells and other bio-compatible materials as "inks", also known as bioinks, to print living structures layer-by-layer which mimic the behavior of natural living systems.

3D-bioprinting allows to set up tri-dimensional cell cultures, cultivate different cell types in the same structure, simulate cell to cell and cell to environment interactions in vivo, build human tissues for regenerative medicine applications, restore damaged organs, wound healing or correct maxillo-facial defects, and much more.

It starts with a model of a structure, which is recreated layer-by-layer out of a bioink either mixed with living cells or seeded with cells after the print is complete. These starting models can come from anywhere – a CT or MRI scan, a computer-generated design (CAD) program, or a file downloaded from the internet.

That 3D model file is then fed into a slicer– a specialized kind of computer program which analyzes the geometry of the model and generates a series of thin layers, or slices, which form the shape of the original model when stacked vertically. Cura and slic3r are examples of slicers commonly used in 3D printing.

Once a model is sliced, the slices are transformed into path data, stored as a g-codefile, which can be sent to a 3D bioprinter for printing. The bioprinter follows instructions in the g-code file in order, including instructions to control for the temperature of the extruders, extrusion pressure, bed plate temperature, cross-linking intensity and frequency, and, of course, the 3D movement path generated by the slicer. Once all of the g-code commands are completed, the print is done and can be cultured or seeded with cells as part of a bio-study.

4-D printing is governed using 3 different approaches: Biomimicry, Autonomous self-assembly, and mini-tissue building blocks. We will discuss all three approaches in brief.

Biomimicry: Its application to 3D bioprinting involves the manufacture of identical reproductions of the cellular and extracellular components of a tissue or organ[2]. This can be achieved by reproducing specific cellular functional components of tissues, for example, mimicking the branching patterns of the vascular tree or manufacturing physiologically accurate bio material types and gradients. For this approach to succeed, the replication of biological tissues on the microscale is necessary. Thus, an understanding of the micro-environment, including the specific arrangement of functional and supporting cell types, gradients of soluble or insoluble factors, the composition of the ECM as well as the nature of the biological forces in the micro-environment is needed. In the figure attached below, a complete overview of bio-printing has been given.

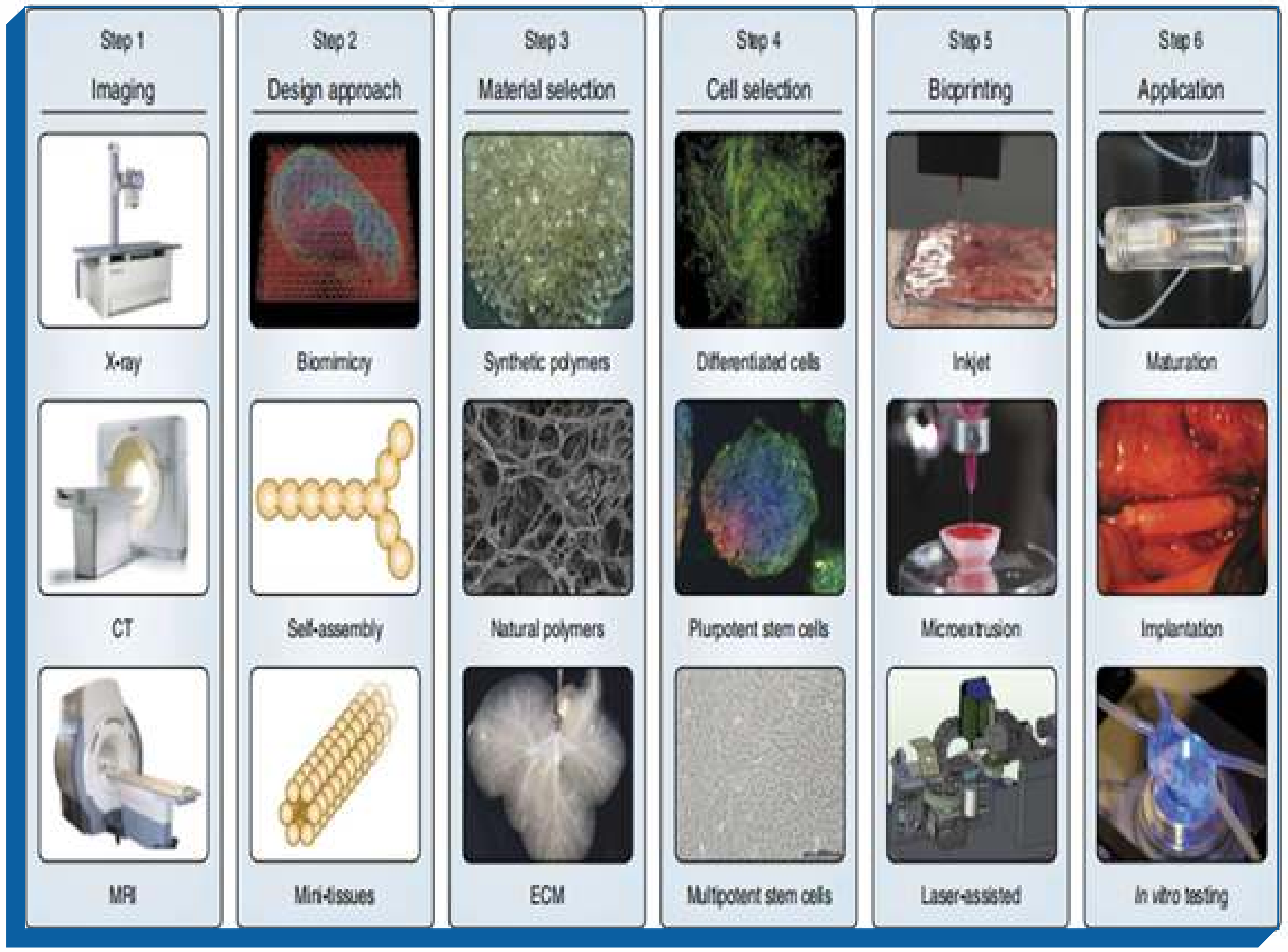

Figure 1: A typical process for bioprinting 3D tissues. Imaging of the damaged tissue and its environment can be used to guide the design of bio printed tissues.

Source: 3D bioprinting of tissues and organs", Nat Biotech, 32, 773–785, 2014.

Autonomous self-assembly. Another approach to replicating biological tissues is to use embryonic organ development as a guide. The early cellular components of a developing tissue produce their own ECM components, appropriate cell signaling and autonomous organization and patterning to yield the desired biological micro-architecture and function [3, 4]. A 'scaffold-free' version of this approach uses self-assembling cellular spheroids that undergo fusion and cellular organization to mimic developing tissues. Autonomous self-assembly relies on the cell as the primary driver of histogenesis, directing the composition, localization, functional and structural properties of the tissue [5, 6]. It requires an intimate knowledge of the developmental mechanisms of embryonic tissue genesis and organogenesis as well as the ability to manipulate the environment to drive embryonic mechanisms in bio printed tissues.

Mini-tissues. The concept of mini-tissues is relevant to both of the above strategies for 3D bioprinting. Organs and tissues comprise smaller, functional building blocks or mini-tissues. These can be defined as the smallest structural and functional component of a tissue, such as a kidney nephron. Mini-tissues can be fabricated and assembled into the larger construct by rational design, self-assembly or a combination of both. There are two major strategies: first, self-assembling cell spheres (similar to mini-tissues) are assembled into a macro-tissue using biologically inspired design and organization [7, 8]; second, accurate, high-resolution reproductions of a tissue unit are designed and then allowed to self-assemble into a functional macro-tissue. Examples of these approaches include the self-assembly of vascular building blocks to form branched vascular networks [9,10] and the use of 3D bio printing to accurately reproduce functional tissue units to create 'organs-on-a-chip', which are maintained and connected by a microfluidic network for use in the screening of drugs and vaccines or as in in vitro models of disease [11].

The principal technologies utilized for deposition and patterning of biological materials are **inkjet printing, micro extrusion printing and laser assisted printing.**

1. Inkjet printers: They are the type of printer most commonly used for both non-biological and biological applications. Now, inkjet-based bioprinters are custom-designed to handle and print biological materials (bio-ink) at increasing resolution, precision and speed on a solid biocompatible surface (bio-paper). Inkjet printers make use of thermal or acoustic forces to eject drops of liquid onto a substrate, which can support, or form part of, the final construct. Advantages of acoustic inkjet printers include the capability to generate and control uniform droplet size and ejection directionality, as well as to avoid exposure of cells to heat and pressure stressors [12]. Different cell lineages can be printed at the same time using different nozzles and cartridges, and the acoustic waves allow the deposition of drops as large as a cell, giving a high resolution potential. Because of the availability of standard 2D inkjet printers, researchers can readily access and modify them. Moreover, commercially available inkjet 3D bioprinters are also relatively cost-effective owing to their simple components and readily available design and control software. The wide application of this technology by many groups has accelerated advances in inkjet bioprinting technology [12].

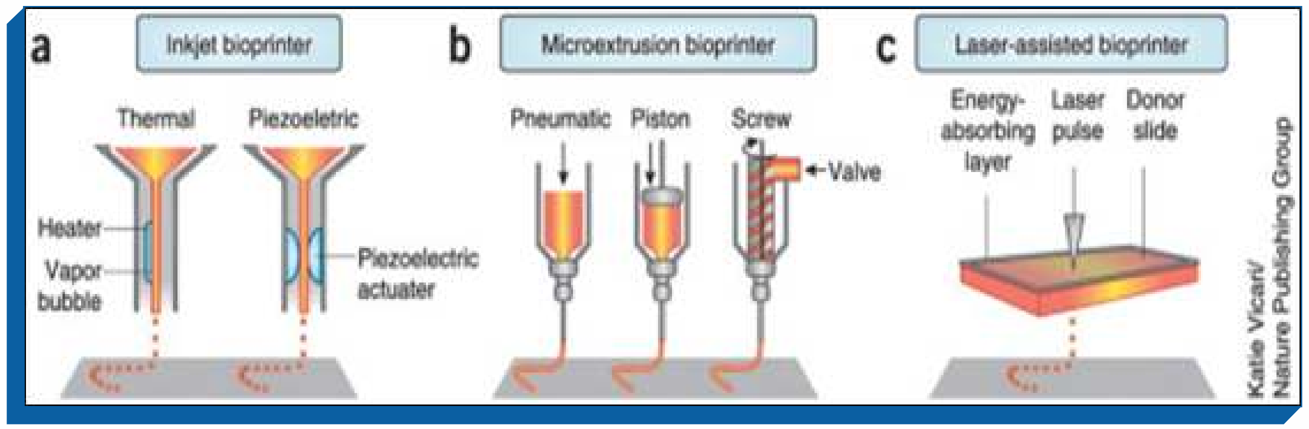

Figure 2: The three main bioprinting techniques: (a) Inkjet bioprinting; (b) Micro-extrusion bioprinting; (c) Laser-assisted bioprinting (LAB).

Source: "3D bioprinting of tissues and organs", Nat Biotech, 32, 773–785, 2014.

2. Microextrusion bioprinters are usually based on a temperature-controlled, material-handling and dispensing system that extrudes tubes or spheroids of materials, which are superimposed on one another and then cured through the addition of radiation or chemical reactions, or by time [12]. Nearly 30,000 microextrusion-based 3D-printers are sold worldwide every year, and academic institutions are increasingly purchasing and applying microextrusion technology in tissue and organ engineering research. Microextrusion-based printers are considerably more expensive but have better resolution, speed, spatial controllability and more flexibility in the material they can print, such as hydrogels, biocompatible copolymers and cell spheroids. A few systems use multiple print heads to facilitate the serial dispensing of several materials. The main advantage of the microextrusion bioprinting technology is the ability to deposit very high cell densities, covering one of the major goals for the bioprinting field: to achieve physiological cell densities in tissue-engineered organs. To create 3D tissue constructs with microextrusion printing, some groups used solutions comprised of cells only. Multicellular cell spheroids are deposited and allowed to self-assemble into the desired 3D structure. Tissue spheroids are thought to possess material properties that can replicate the mechanical and functional properties of the tissue ECM. Cell viability after microextrusion bioprinting is lower than that with inkjet-based bioprinting, due to the shear stresses inflicted on cells in viscous fluids. Although cell viability can be maintained using low pressures and large nozzle sizes, the drawback may be a major loss of resolution and print speed [12].

3. Laser-assisted bioprinting (LAB), albeit less common than other methods, is being increasingly used for tissue- and organ-engineering applications. LAB is based on a pulsed laser beam that acts on a laser energy-absorbing layer (gold or titanium) and a layer of biological material (cells and/or hydrogel) prepared in a liquid solution. LAB is compatible with a range of viscosities and can print cells with negligible effect on cell viability and function. LAB can deposit cells at a high density with microscale resolution of a single cell per drop. The application of LAB to fabricate a cellular zed skin construct demonstrated the potential to print clinically relevant cell densities in a layered tissue construct, but it is unclear whether this system can be scaled up for larger tissue sizes [12].

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3D-Printing Technology

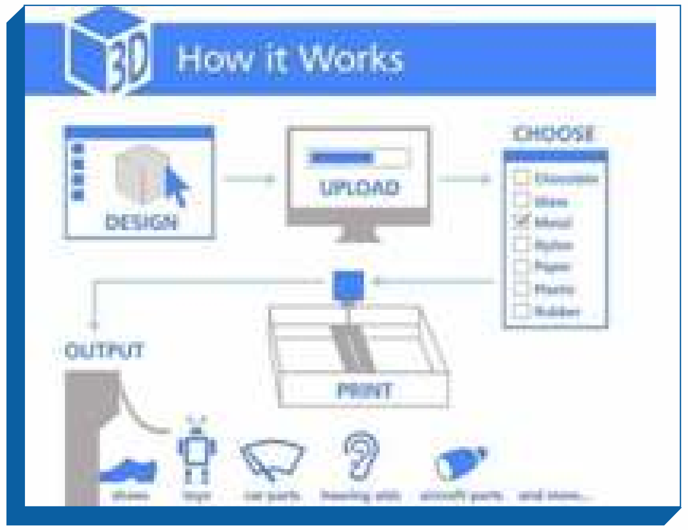
3D printing, or additive manufacturing, is the construction of a 3-dimensional object from a CAD model or a digital 3D model. The term"3D Printing" can refer to a variety of processes in which material is deposited, joined or solidification under computer control to create a three-dimensional object, with material being added together, typically layer by layer.

3D Printing Of Current Status

3D printing or additive manufacturing is a process of making three dimensional solid objects from a digital file. The creation of a 3D printed object is achieved using additive processes. In an additive process, an object is created by laying down a successive layer of material until the entire object is created. Each of these layers can be seen as a thinly sliced horizontal cross-section of the eventual object.

How 3D Printing works ?

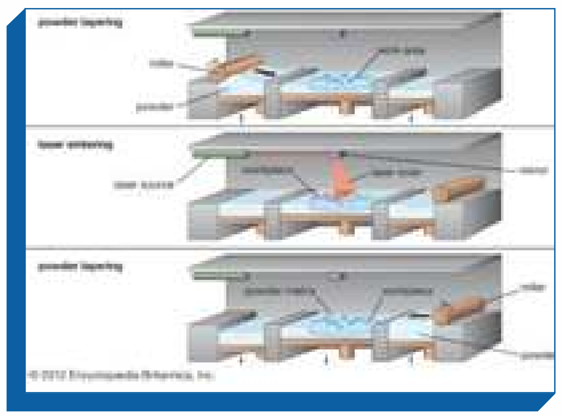
It all starts with making a virtual design of the object one wants to create. This virtual design is made in a CAD (Computer-Aided Design) file using a 3D modeling program (for the creation of a new object) or with the use of a 3D scanner. The scanner makes a 3D digital copy of an object and puts it into a 3D modeling program. To prepare the digital file created in a 3D modeling program for printing, the software slices the final model into hundreds or thousands of horizontal layers. When this prepared file is uploaded to the 3D printer, the printer creates the object layer by layer. The 3D printer reads every slice (or 2D Image) and proceeds to create the object blending each layer with no sign of the layering visible resulting in one three-dimensional object.



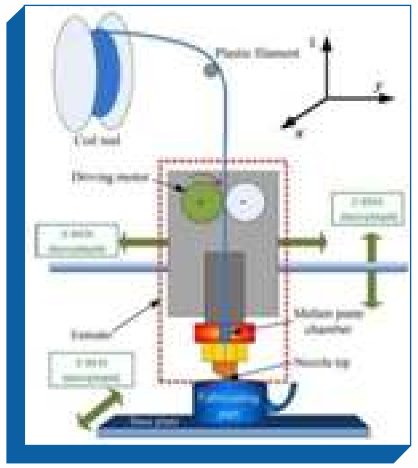
Method and Technologies

Selective laser sintering (SLS)

This technology uses a high power laser to fuse small particles of plastic, metal, ceramic, or glass powders into a mass that has the desired three-dimensional shape. The laser selectively fuses the powdered material by scanning the cross-section (or layers) generated by the 3D modeling program on the surface of a powder bed. After each cross-section is scanned, the powder bed is lowered by one layer thickness. Then a new layer of material is applied on top and the process is repeated until the object is completed.

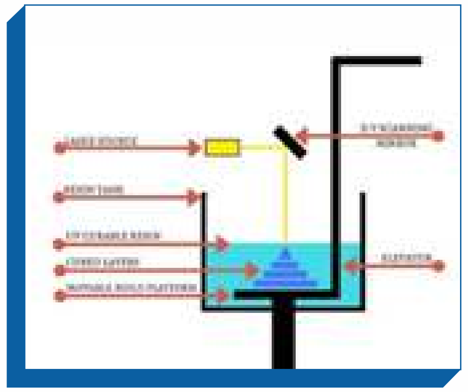


Fused deposition modelling (FDM)



The FDM technology work using a plastic filament or metal wire which is unwound from a coil and supplies material to an extrusion nozzle which can turn the flow on and off. The nozzle is heated to melt the material and can be moved in both horizontal and vertical directions by a numerically controlled mechanism. The object is produced by extruding melted material to form layers as the material hardens immediately after extrusion from the nozzle.

Stereo lithography (SLA)



This main technology in which photopolymerization is used to produce a solid part from a liquid is SLA. This technology employs a vat of liquid ultraviolet curable photopolymer resin and an ultraviolet laser to build the object's layers one at a time. For each layer, the laser beam

traces a cross-section of the part pattern on the surface of liquid resin. Exposure to the ultraviolet laser light cures and solidifies the pattern traced on the resin and joins it to the layer below. After the pattern has been traced, the SLA's elevator platform descends by a distance equal to the thickness of a single layer, typically 0.05mm to 0.15mm. On this new liquid surface, the subsequent layer pattern is traced, joining the previous layer. The complete three-dimensional object is formed by this project

Applications

Applications include design visualization, prototyping/CAD, metal casting, architecture, education, geospatial, healthcare, and entertainment/retail. Product formation is currently the main use of 3D printing technology. These machines allow designers and engineers to test out ideas for dimensional products cheaply before committing to expensive tooling and manufacturing processes. In Medical Field, Surgeons are using 3d printing machines to print body parts for reference before complex surgeries. Other machines are used to construct bone grafts for patients who have suffered traumatic injuries. Looking further in the future, research is underway as scientists are working on creating replacement organs. Architects need to create mockups of their designs. 3D printing allows them to come up with these mockups in a short period and with a higher degree of accuracy. 3D printing allows artists to create objects that would be incredibly difficult, costly. Or time intensive using traditional processes. Creating complete models in a single process using 3D printing has great benefits. This innovative technology has been proven to save companies time, manpower, and money. Companies providing 3D printing solutions have brought to life an efficient and competent technological product.

After the COVID-19 virus invades a human cell, it begins to replicate or copy itself. To achieve this, the virus uses its enzyme called "copy machine". With the enzyme, the virus creates its copies after copies. The researchers

Scientists from China and United States have developed a 3-D printing method to produce highly uniform 'blocks' of embryonic stem cells. The method was developed by the recently have invented the 3D structure of the copy machine enzyme. This invention has made it possible…

Scientists develop 3D-Printed soft silicone heart.

Scientists from ETH Zurich in Switzerland have developed a 3D printed soft silicone heart that closely resembles and functions like the human organ. It is not exact biological replica of the actual, but can help to save lives of people who suffer from cardiac failure. It can be also used as an artificial heart in cases…

Key Facts:-

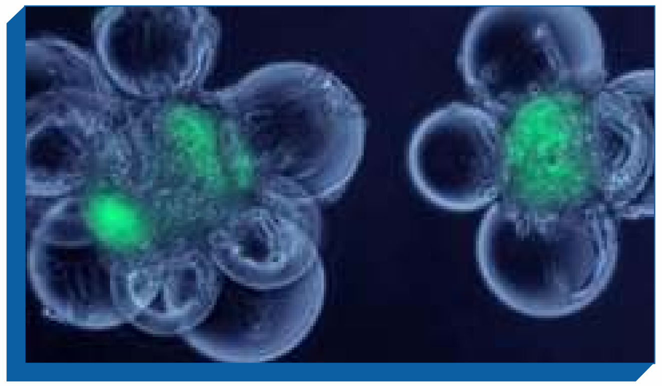
The 3D-printed soft artificial heart is a silicone monoblock with complex inner structure. It weighs 390 grams and has a volume of 679 cubic centimeters. It is made of silicone using a 3D printed mold. It represents one of the most advanced replicas yet created of one of human's most important organs.

The artificial heart has a right and a left ventricle which are not separated by a septum but by an additional chamber. This chamber is inflated and deflated by pressurised air required to pump fluid from the blood chambers.

This current model is not yet stable enough to be used in an actual patient. At present, it can only work for several thousand beats, lasting around 30 to 45 minutes. Researchers are planning to develop an advanced model which could conceivably work over a period of years.

Scientists Develop 3D printing method to make embryonic stem cells

Scientists from China and United States have developed a 3-D printing method to produce highly uniform 'blocks' of embryonic stem cells. The method was developed by the researchers from Beijing based Tsinghua University (China) and Philadelphia based Drexel University (US).



Key facts:-

The new method used extrusion-deposition based 3-D printing technology to produce a grid-like 3-D (three dimensional) cell structure to grow embryoid body.

This 3D printed embryoid body demonstrated cell viability and rapid self-renewal for 7 days by maintaining high pluripotentcy. The grown embryoid body in such a controlled manner is uniform and homogenous and serves as a basic starting point for further tissue growth.

Potential Applications:- These cells are capable of generating all cell types in the body which could be used as the 'Lego bricks' to build larger structures of tissues , tissue constructs and even micro-organs.

NASA for first time emails hardware digital file for 3D printing on ISS

For the first time in history, NASA has emailed hardware digital file for 3D printing to International Space Station (ISS). Using this digital file, a ratcheting socket wrench (hardware) was manufactured using ISS's onboard 3D printer. This 3D printer was installed in ISS in September 2014 by collaboration between NASA and company Made In Space. In November 2014, the 3D printer had started manufacturing the first 3-D printed object in space as a replacement part for itself. Previously, if astronauts in space needed an item or any technical part they would have to wait until it is flown up on supply flights. But now, the 3D printing is providing astronauts on-demand printing and manufacturing of a custom-designed tool whenever they needed.

ACKNOWLEDGMENT

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Dimensional Art of Printing

The Art Is Not What You See But

What You Make Others See

As we are leading towards a new generation there are many new changes which couldn't be ever imagined by humans. “Change” brings variations in thoughts, ideas, imagination, culture, and vivid aspects to look upon. A similar change is brought up presently in the field of printing. Dimensional Printing is the magical conjunction of space/no space; movement in stillness. A balanced experience of absorption and self-awareness. It is both a tangible surface and a perceptual space. The task of doing that well is mammoth.

Creativity Is Nothing But The Way To Solve New Problems

Modernization in the field of printing brings about a new way or rather a new vision to look at a painting in a different manner and with various meanings. 3Dimensional printing is one of those types of paintings which gives us detailed, specific, realistic, and sophisticated information about the particular description. The general concept of and procedure to be used in 3D-printing was first described by Raymond F. Jones in his story, "Tools of the Trade," published in the November 1950 issue of Astounding Science Fiction magazine. He referred to it as a "molecular spray" in that. 3D printing or additive manufacturing is a process of making three dimensional solid objects from a digital file. 3D printing techniques were considered suitable only for the production of functional or aesthetic prototypes, and a more appropriate term for it at the time was rapid prototyping One of the key advantages of 3D printing is the ability to produce very complex shapes or geometries that would be otherwise impossible to construct by hand, including hollow parts or parts with internal truss structures to reduce weight. 3D printable models may be created with Computer-Aided Design (CAD) package, via a 3D scanner, or by a plain digital camera and photogrammetry software. 3D printed models created with CAD result in relatively fewer errors than other methods. Errors in 3D printable models can be identified and corrected before printing.

As we know every coin has two sides this rule is applicable here also A study has found the particles emitted from consumer-grade 3 D printer could negatively impact indoor air quality, with the potential to harm respiratory health, this printing equipment and materials cost make the technology expensive, used in enclosed places such as homes can generate potentially toxic emissions, with 3D printers, it is easy to create 3D knives, guns, explosives, and any other dangerous items. In a lot of industries, 3D printing provides countless benefits. However, it is not going to replace traditional manufacturing. It is still an emerging technology with some disadvantages that need to be considered when selecting a product development method.

Taking everything into the consideration we should keep the value and importance of art because the “The Aim Of Art Is Not To Represent The Outward Appearance Of The Things But Their Inward Significance”

Prathamesh B Kapshikar
1st Year, Chemical Engineering,
School of Technology

3D-Printing – A New Dimension

3D Printing is an additive manufacturing process that uses a digital design to create a physical product. The major 3D Printing technologies, and materials available, are based on the principle of creating a solid three-dimensional physical object by adding layers of material, one layer at a time.

How does 3D Printing work?

As with any form of artistic creation, we begin with a blueprint that guides us in creating the desired end product. Similarly, any 3D Print begins as a digital design, divided into countless horizontal layers before being sent to the 3D Printer, which begins to carefully print our product – layer by layer!

Based on the technology available, the printing process uses a variety of materials, ranging from plastics to rubber, sandstone, metals and alloys – with more and more options appearing on the market every year!

The Pros and Cons of 3D Printing

The rapidly evolving technology of 3D Printing comes with a vast collection of benefits, but also presents its own unique set of challenges in manufacturing.

Pros of 3D Printing

Ability to create complex designs

Customisation of each and every detail

Lower Fixed Costs, with no need for tools & hardware

Rapid Response in Prototyping Less Wastage from Production

Cons of 3D Printing

Higher costs for large production facilities

Less choice in Materials, Colours, Finish etc.

Limited Endurance & Strength

Less Precision & Control during process

The Potential Usage of 3D Printing?

The benefits of 3D Printing extend past the boundaries of industry or profession, providing value to each and every one of us, in some way or another. Here are a few of its potential uses –

Medical Manufacturing

Prosthetic Manufacturers

Doctors

Dentists

Construction

Improved Infrastructure in Developing Areas

Automobile Manufacturing

Motor Vehicle Manufacturers

Aerospace Manufacturers

Art & Design

Engineers

Architects

Product Designers

Interior Decorators

Consumer Goods

Clothing Manufacturers

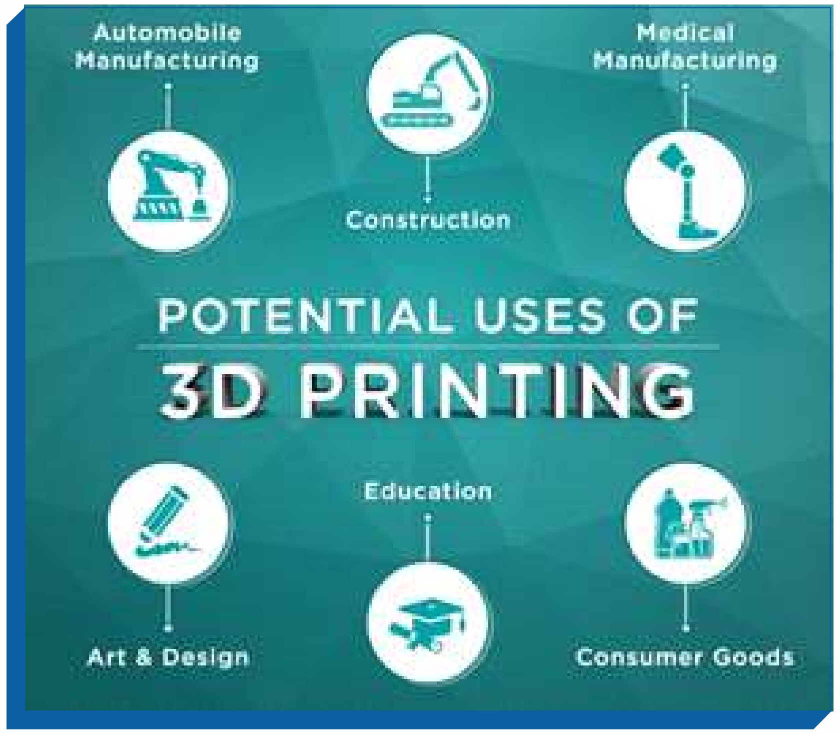
Home Utensil Manufacturers

Comfort & Leisure Goods

Education

Learning Tool for Infants,

Students, Professionals



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School of Technology

Poem on 3D-Printing

3-D printing is no rocket science,
It is as simple as counting from 1 to 9,
A machine the size of car battery printing
wonders in seconds,
Making us believe in the world of fiction,
fantasizing our own imaginations,
Sitting in front of your gadget, stare your
imagination grow upright,
Create something unique, create
Something unseen,
Because shortly you are going to flaunt it on
every site,
People are going to appreciate you, questioning
how your gadget works so well,
Lets be creative, lets be imaginative,
lets be initiative,
Because 3-D printing is no rocket science.

Khyati Shah
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3D-Printing Technology

In the not too distant future, common household mishaps like a broken mug or the last screw won't require a trip to the hardware store. Instead, you will just click the correct template on your home 3D printer and manufacture a replacement yourself. The technology behind 3D printing is moving fast, and it may be among the next disruptive forces in the field from medicine to defense to manufacturing to home renovation.

The aviation industry is already using 3D printing to manufacture thousands of replacement parts. Major companies such as General Electric have invested heavily in the technology and are looking for ways to incorporate it in their production processes. On the consumer level, machines that print common household items or custom decorative fixtures could become the next widely used appliance. Big box and home improvement stores have started selling home 3D printers at prices that make them accessible to many consumers.

As technology advances, it could create ease and precision of design and may revolutionize manufacturing could reduce reliance on human labor, and may even reorganize global manufacturing markets.

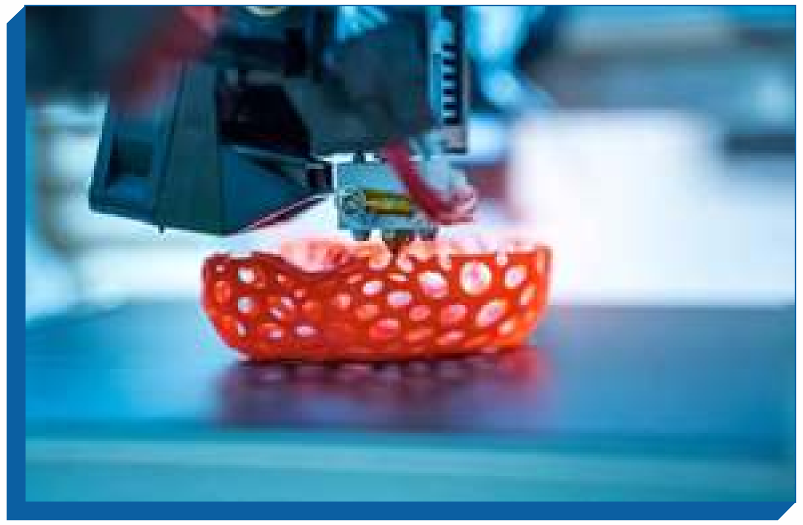
This technology could also open a whole new world for counterfeiters-not to mention the disturbing idea of printing homemade plastic guns that could evade metal detectors. Could it also spell the end of craftsmanship? Perhaps, it is just craftsmanship of a new sort.

3D printers can be used to custom-fit hearing aids, casts, and other medical devices. Doctors already use 3D processes in reconstructive surgery, and the creation of skin grafts and personalized organs for transplant could be a reality in near future. In 2014, scientists at the Massachusetts Institute of Technology printed miniature livers about a thousandth the size of the average human liver. While technology has a way to go, researchers hope eventually to use printed organs for transplants and to screen the safety and effectiveness of drugs before they are tested in humans.

Ujas Lakod
1st Year, B.Sc. - Chemistry
School of Science

Blessings of 3D-Printing

As a new era of the life the technologies become the life partner of the person. In the person life there are many technologies out of them one is 3D printing. You will think what is 3D PRINTING? How it is invented? How it make person life Easier?



There are many uses of 3D printing. But for the mankind one of the best use is in medical Departments .in today's life it is also useful in surgery. By the 3D printing one invention also done or say it's an inheritance of it

BIOPRINTING. In Bio printing we used a special kind of ink which is used for making HUMAN CELLS and TISSUES. By using this technology a doctor can also make an ORGAN of human body. So from all this thing you can think how much this technology is essential in our life. It can also give the life to some people. Due to this the life span. It's a Blessings of 3D-Printing for the mankind.

YADAV ABHISHEK
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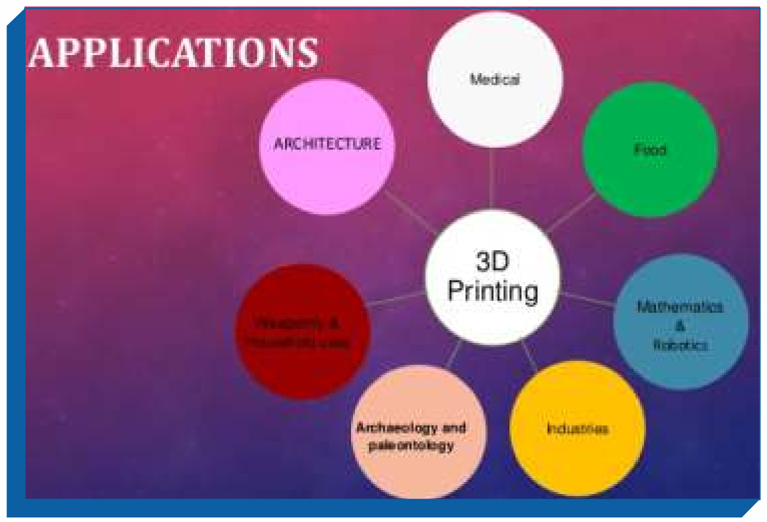
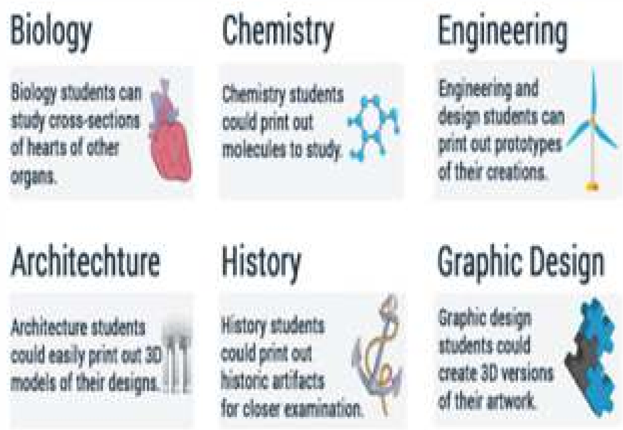
Application of 3D-Printing

Three-dimensional printing is a process of building 3D objects from a digital file. In this process, a digital 3D object is designed using computer-aided design (CAD) software. Solid Works, AutoCAD, and ZBrush are some examples of popular CAD software used commercially in industries. Blender, FreeCAD, Meshmixer, and SketchUp are some examples of the freeware commonly used to make 3D models. These 3D objects are saved in a 3D printer-readable file format. The most common universal file formats used for 3D printing are STL (stereolithography) and VRML (virtual reality modeling language). Additive manufacturing file format (AMF) and GCode are some of the other 3D printer readable file formats [1]. Since its conception during the 80s, 3D-printing, also known as additive manufacturing, has been receiving unprecedented levels of attention and interest from industry and research laboratories. This is in addition to end-users, who have benefited from the popularity of desktop-size and relatively cheap printing machines available. 3D-printing enables almost infinite possibilities for rapid prototyping. Therefore, it has been considered for applications in numerous research fields, ranging from mechanical engineering, medicine, and materials science to chemistry. Almost all the subjects can be dealt with with the help of 3D printers. For subjects such as Science, Technology, Engineering, Mathematics, Physics, Design, Art, Law, Ethics, Psychology, and Anthropology as well as several other fields that require physical models for illustrating situations 3D printers can be used. Wide accessibility and a broad range of applications have made 3D-printers a commonplace tool in the science community. From tier-one research institutions to community public libraries and high schools, 3D-printers are being used to enrich STEM education through a variety of learning techniques and experiences. Reports of 3D-printed models for improved visualization of chemical phenomena, as well as the educational use of 3D-printed laboratory devices, are rapidly increasing.





3D printing is becoming increasingly widespread in modern chemistry laboratories. This technology provides chemists with the ability to design, prototype, and print functional devices that integrate catalytic and/or analytical functionalities and even to print common laboratory hardware and teaching aids. Electrochemistry is another branch of science that can certainly benefit from 3D-printing technologies, paving the way for the design and fabrication of cheaper, higher performing, and ubiquitously available electrochemical devices. review of recent electrochemistry related studies adopting 3D-printing as a possible rapid prototyping fabrication tool. With 3D printers, it is possible to create 3D mini models with just the click of a button. This will bring into the classroom a highly interactive culture that makes the class interesting. 3D printing for education will undoubtedly add value in teaching a wide range of skills. The amalgamation of 3D printing and education is unique because it brings in the mindset of experimentation and the student becomes very comfortable with this idea in the learning process. It gives students the ability and freedom to design, engineer, and test their projects and also contribute to the digital manufacturing sector.

Sector	Applications
Industry	Jigs, fixtures, and end-use parts for aeronautical industry Prototypes and spare parts for automotive industry
Medical	Surgical models for perioperative surgical preparations Dental fixtures, bridges, and crowns Customized patient specific implants and prostheses Living tissue scaffolds for tissue engineering and regenerative medicine
Pharmaceutical	Customized implants for drug delivery Tablets, capsules, and other patient specific dosages
Food	Designing and 3D printing complex shaped cakes, cookies, candies, pizzas, and other desserts
Fashion	Jewelry, clothes, shoes, and other accessories
Household	Plates, cups, spoons, holders, and other common household objects
Miscellaneous	Space: building prototypes and parts in space Chemical industry: fabricating complex molecules and compounds Construction: scale models with intricate architectures

With the advancement in 3D modeling software and mechanics of the printing machine, the dimensional precision, speed, and tunability of a 3D printer have been vastly improved. Using finite element analysis, the change in the mechanical properties of the finished product concerning printing parameters can be simulated, and the best suiting parameters can be obtained beforehand. Even with all these advancements, medical 3D printing is still budding and has the incredible potential [1].

Reference:

1. Karthik Tappa and Udayabhanu Jammalamadaka, "Novel Biomaterials Used in Medical 3D Printing Techniques" Journal of Functional Biomaterials 2018, 9, 17.

Dr. Parin Kanaiya
Assistant Professor, Chemistry
School of Science

Creo Parametric

What is 3D Printing?

3D printing is a process of making three dimensional solid objects from a digital file.

The creation of a 3D printed object is achieved using additive processes. In an additive process, an object is created by laying down successive layers of material until the object is created. Each of these layers can be seen as a thinly sliced cross-section of the object.

3D printing is the opposite of subtractive manufacturing which is cutting out / hollowing out a piece of metal or plastic with for instance a milling machine.

3D printing enables you to produce complex shapes using less material than traditional manufacturing methods.

Examples of 3D Printing

3D printing encompasses many forms of technologies and materials as 3D printing is being used in almost all industries.

A few examples:

- consumer products (eyewear, footwear, design, furniture)
- industrial products (manufacturing tools, prototypes, functional end-use parts)
- dental products
- prosthetics
- architectural scale models & maquettes
- reconstructing fossils
- replicating ancient artefacts
- reconstructing evidence in forensic pathology
- movie props

3D SOFTWARE

There are many different software tools available. Among them one of the important software is Creo Parametric.

Creo Parametric:

Creo is a family or suite of Computer-aided design (CAD) apps supporting product design for discrete manufacturers and is developed by PTC. The suite consists of apps, each delivering a distinct set of capabilities for a user role within product development.

Creo runs on Microsoft Windows and provides apps for 3D CAD parametric feature solid modeling, 3D direct modeling, 2D orthographic views, Finite Element Analysis and simulation, schematic design, technical illustrations, and viewing and visualization.

Creo Elements and Creo Parametric compete directly with CATIA, Siemens NX/Solidedge, and SolidWorks. The Creo suite of apps replace and supersede PTC's products formerly known as Pro/ENGINEER, CoCreate, and ProductView. Creo has many different software package solutions and features.

PTC began developing Creo in 2009, and announced it using the code name Project Lightning at Planet PTC Live, in Las Vegas, in June 2010. In October 2010, PTC unveiled the product name for Project Lightning to be Creo. PTC released Creo 1.0 in June 2011.

Creo apps are available in English, German, Russian, French, Italian, Spanish, Japanese, Korean, Chinese Simplified, and Chinese Traditional. The extent of localization varies from full translation of the product (including Help) to user interface only.

Creo is part of a broader product development system developed by PTC. It connects to PTC's other solutions that aid product development, including Windchill for Product Lifecycle Management (PLM), Mathcad for engineering calculations and Arbortext for enterprise publishing software.

Release history

Version	Release date
Creo 1.	06 January 2011
Creo 2.0	27 March 2012
Creo 3.0	17 March 2014
Creo 4.0	15 December 2016
Creo 5.0	19 March 2018
Creo 6.0	19 March 2019
Creo 7.0	14 April 2020

Creo is a software used for various purpose like...

1. 3d modeling
2. drafting
3. analysis
4. simulation
5. mechanism
6. animation
7. optimization
8. solver and more...

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Teaching assistant - Mathematics
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Yashika Adhvait Dixit – Student (Class 6)
Navrachana School, Sama - Vadodara

3D-Printing: The Beginning Of A New Era In The Ethos Of The Bits-bytes World…

The invention of computers opened a whole new dimension for mankind to explore and to travel through its deep and mysterious valleys. It baffled the whole world as it was the first time someone was witnessing something like that! At that time, it was established that these machines would only be used for the so-termed "Sci-fi" methodologies and would be difficult for a common man to afford them both monetarily and physically. But we know how the scenario is of today!

ENIAC- First computer(1946)

Worlds' smallest computer next to a grain of rice.

The above two pictures speak for themselves. From gigantic machinery to the PCs we use today and to the micro-computers. These machines have shaped the world we know of today. People of the era were so amazed by what they were seeing on the computer screen until one fine day, in the year 1968, the tech-savvies of Epson thought, "Hey, what if what we could print what we see on the screen, it would be revolutionary!" And so, it was. They designed the first-ever computer printer named EP-101 (Printers used to exist as far back as the 15th century, but they were mechanical printers used to print stuff like newspapers, magazines which required human effort. They were sort of type-writers).

The first computer printer EP-101.

Then began the era of 2-D printing. Everything ranging from Government paperwork to our grocery details got started to print on paper. What you could see on the screen was now available in your hands. But it didn't stop there. One fine day in the 1980s, Chuck Hull got struck with an idea, "Hey, what if we could print the objects we see on our computer screen in 3-D!". And that's where a new aspect of printing took shape. Imagine 3D printing of the Iron man toy you see on the internet! That could be the moment for every Marvel fan! That was where we opened doors to the next level in printing technology.

3-D Printing: Ins and Outs…

One might wonder how the technology works! What's the rocket science behind it? And it is very fascinating to know the mechanism by which this works.

The creation of a 3D printed object is achieved using additive processes. In an additive process, an object is created by laying down successive layers of material until the object is created. 3D printing enables you to produce complex shapes using less material than traditional manufacturing methods. It all starts with a 3-D model of the object. The credentials of the object viz its height, width color, etc. are collected by the scanning device present in the printer system, and with the information gained, the data is transferred to the processing unit. Plastic threads are used to construct the object using the data obtained. This might seem to be a very simple process but is complicated. Having overcome the complications and creating a printing revolution is itself a successful step in its way.

The process of 3D printing begins by making a graphic model of the object to be printed. These are usually designed using Computer-Aided Design (CAD) software packages, and this can be the most labor-intensive part of the process. Programs used for this include TinkerCAD, Fusion360, and Sketchup.

One of the main benefits of 3D-printing is that it allows the rapid prototyping of pretty much anything. The only real limitation is your imagination.

Some objects are simply too complex to be created in more traditional manufacturing or prototyping processes like CNC milling or molding. It is also a lot cheaper than many other traditional manufacturing methods.

After the design, the next phase is digitally slicing the model to get it for printing. This is a vital step as a 3D printer cannot conceptualize a 3D model in the same way as we do. The slicing process breaks down the model into many layers. The design for each layer is then sent to the printer head to print, or lay down, in order. The slicing process is usually completed using a special slicer program like CraftWare or Astroprint. This slicer software will also handle the "fill" of the model by creating a lattice structure inside a solid model for extra stability if required.

This also happens to be an area where 3D printers excel. They can print very strong materials with very low densities through the strategic addition of pockets of air inside the final product.

The slicer software will also add in support columns, where needed. These are required because plastic cannot be laid down in thin air, and the columns help the printer to bridge the gaps. These columns are then later removed if needed.

Once the slicer program has worked its magic, the data is then sent to the printer for the final stage.

From here, the 3D printer itself takes over. It will begin to print out the model according to the specific instructions of the slicer program using different methods, depending on the type of printer used. For example, direct 3D printing uses technology similar to inkjet technology, in which nozzles move back and forth, and up and down, dispensing thick waxes or plastic polymers, which solidify to form each new cross-section of the 3D object. Multi-jet modeling uses dozens of jets working simultaneously, for more rapid modeling.

In binder 3D printing, the inkjet nozzles apply a fine dry powder and liquid glue, or binder, that come together to form each printed layer. Binder printers make two passes to form each layer. The first pass deposits a thin coating of the powder, and the second pass uses the nozzles to apply the binder.

In photopolymerization, drops of a liquid plastic are exposed to a laser beam of ultraviolet light, which converts the liquid into a solid.

Sintering is another 3D printing technology that involves melting and fusing particles to print each successive layer. The related selective laser sintering relies on a laser to melt a flame-retardant plastic powder, which then solidifies to form the printed layer. Sintering can also be used to build metal objects.

The process of 3D can take hours or even days, depending on the size and complexity of the project. No matter which type of 3D printer is used, the overall printing process is usually the same.

Some interesting examples of 3D-printed objects include, but are not limited to:

- Prosthetic limbs and other body parts
- Homes and other buildings
- Food
- Medicine
- Firearms
- Liquid structures
- Glass products
- Acrylic objects
- Movie props
- Musical instruments
- Clothing
- Medical models and devices

3D printing clearly has applications in many industries. Some of the many advantages of 3-D printing are…

- Faster production
- Easily accessible
- Better quality goods
- Cost effective (at industrial scale, still a little expensive at domestic scale).
- Huge possibilities of innovations.

The future is of 3-D printing. We, as of now are swimming in a little pond, still there is a vast ocean of possibilities and innovations, waiting for us to swim through and explore the unexplored!

Kalyani Joshi
Teaching assistant - Mathematics
School of Science

Discover A Great 3D-Printing Business Ideas

The Kupol project:

Gabriel Boutin, a 3D Designer, Created the Kupol Project using additive manufacturing technology. It is a bike helmet, 3D Printed with the HP Multi Jet Fusion technology, using Sculpteo's online 3D Printing Service. This 3D technology helped this innovative designer to develop a relevant and resistant project. 3D Printing can help you with rapid prototyping. Indeed, it is a simple and economical way to produce prototypes. With this technique, you only have to create your 3D design using 3D modeling software, and modify it as much as you want and need. This way, you only have to change the 3D model and print your 3D file to get your different iterations. This process could help you to save money to develop your project and speed up the production process. Indeed, interacting with your project using additive manufacturing is cheaper than with a traditional prototyping technique.

Netlook:

"We are at the moment in the eyewear industry when we have to do something unexpected. We are at a Crossroads of technology and craftsmanship", explains Pierre Andrieu, founder of Netlooks, a custom-made eyewear company and one of our clients. The goal of Netlooks is to provide their clients with the intimate made to measure experience. To achieve that, they Complement craftsmanship we the latest technologies. Netlook uses scanning to get the perfect fit for the client's head, and Additive Manufacturing provided them with time and cost-efficient prototypes before the final product is hand made.

This 3D technology became an essential part of the production process. Manufacturing the prototypes with Additive Manufacturing allowed the company to work faster, speed up the product development time, and to reduce costs. On top of that, thanks to Additive Manufacturing, Netlioks can achieve the ultimate customization and comfort.

Endeer:

We just saw that 3D printing allows mass-customization. But it could also be the perfect manufacturing technique to turn your product into a service. How? It can lead to amazing 3D printing business ideas.

Claire Chabaud, One of my former colleagues from Sculpteo decided to start her own business, Endeer from this idea. By combining 3D scanning and3D printing, they can create custom-made armatures for women's bras, and then insert them in their great underwear collection. The armatures are 3D Printed in Nylon PA12 through our 3D Printing service. The result is simple: a custom made, perfectly shaped to the women, at a reasonable cost.

Volkswagen Autoeuropa:

3D Printing can be an asset on different levels, and not only for your products. We saw on Our recent blog post that a 3D Printing tool could considerably reduce your tooling investment. For example, do you know that Volkswagen Autoeuropa, the car manufacturer, is using 3D Printing for the manufacturing some of its tools? The company estimates that thanks to 3D Printing they saved 250,000 in 2017.No matter what your sector is, reducing your tooling costs could be a huge asset for your company.

Using additive manufacturing to get custom made tools is reducing costs but is also a convenient method that could help you to create a successful business. This way, these tools are adapted to their activity, and they are less expensive than produced with another traditional manufacturing technique.

P&N:

To stay on top of their game, companies like P&G have to chase the latest technology. Where can 3D Printing be an asset for Procter &Gamble? In the supply chain innovation sector additive Manufacturing brings new solutions to existing problems and improves business strategies.

Peter Hewett, Global Product Supply Platform Leader, explains:" It only took a short investment of time, understanding the technology and services offered by companies like Sculpteo, to realize how we might be able to solve current business manufacturing challenges differently and more smartly. We're already bringing the experts together seeking breakthrough solutions which wouldn't be possible with traditions which wouldn't be possible with traditional technologies".

Adidas:

We already saw on our blog that additive manufacturing is an amazing manufacturing method to create custom made shoes. Adidas created different 3D printing Projects and has been working on sneakers made with plastic found in the ocean. It is showing how plastic can be recycled and used by 3D printing businesses. Recycling plastic parts could be more and more important in the 3D printing industry in the upcoming years.

Feetz:

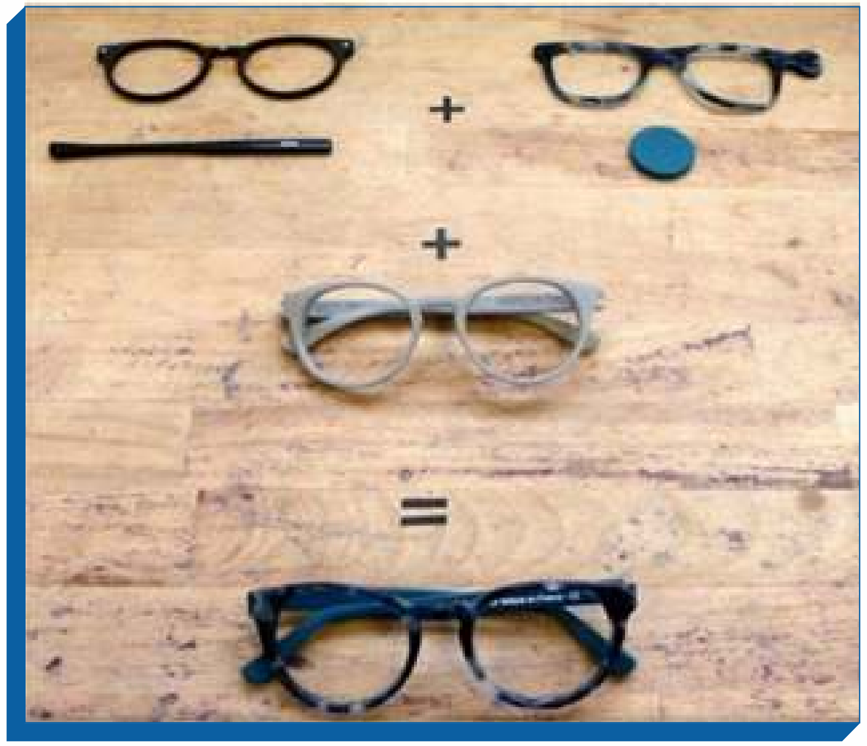
Feetz is an American startup run by Lucy Beard, specialized in custom-made shoes, comfortable to wear and with a beautiful style. They can be adapted to any feet! Feetz is using 3D printing technology to protect the environment. Indeed, 3D printing also means no material waste. When using this technology to manufacture your products, you only use the amount of material that you need to print your objects, and these 3D printed shoes prove that.

•The Different 3D printing Business Opportunities In India:-

•The burgeoning 3D printing industry of India offers multiple business opportunities. Because of the tremendous growth, India's young entrepreneurs are being attracted towards setting up a 3D printing business in the country. It is also mainly because of these reasons that the Indian 3D printing industry is largely dominated by startups. However, to establish a profitable 3D printing business, it is first important to know the different business opportunities that this industry offers.

Let us look at some of the 3D printing business opportunities in India.

- 3D Printing Service Provider:
- 3D Printer Manufacturer:
- 3D Printing Filament/Resin manufacturer:
- 3D Printer & Filament Reseller Distributor:
- 3D Printing Accessories & Supplies:
- 3D Printing Courses:
- Niche Product Manufacturing(Dentistry, Jewellery, Architecture, Healthcare, Gifting, Engineering, etc.) :
- 3D Printer Add-Ons:
- 3D Modelling & Designing Services



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