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# LOW COST 3D PRINTER FOR HOME USERS

**Ms.Yugwini V. Deshmukh[1], Dr. P.S. Gajjal[2]**

*Student*, Mechanical design engineering, *All India Shri Shivaji Memorial Society College of Engineering*, pune, India[1]

*Associate professor*, Mechanical design engineering, *All India Shri Shivaji Memorial Society College of Engineering*, pune, India[2]

Yugwini2d@gmail.com[1], psgajjal@aissmscoe.com[2]

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**Abstract: - Print in India' campaign in Indian is a current affair in the maker community. The actual 3D printing starts with an idea and thinking of the user, secondly, he has to think of material for his use of the printed 3D item. There is a limitation and also a vast variety of material available for 3D printing for the selection to match the requirement of user need one has to think and make a decision to select. These need for guidance that might be appropriate at an early stage of the design process, when the design is not yet defined, and creative approaches could be adopted to generate innovative solutions that more cost-effectively exploit AM capabilities This is a paper on study of 3D printing material and review paper on Low cost 3d printer for home use. Rapid prototype, additive manufacturing and other such technology and process all come under the umbrella of 3D printing. The power of 3D printing ideation and design of new product across all industries is really where the revolution is taking place and will continue to thrive. 3D printing creates a physical object based on digital model. Commonly it creates by adding, fusing or melting a raw material successively on layer by layer. Apart from 3D printer itself no specified tool are required to create any shape or form imaginable, fashionable, usable or designable.**

Keywords: - *Layer, Rapid prototyping, SDL, SLS, STL.*

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## I INTRODUCTION

3D printer is an additive manufacturing technique where 3D objects and parts are made by the Addition of multiple layers of material. It can also be called as rapid prototyping as well Desktop fabrication. It is a mechanized method where 3D objects are quickly made as per the required size. Machine connected to a computer containing blueprints of any object. The additive method may differ with subtractive process, where the material is removed from a block by sculpting or drilling. The 3D printing is efficiently utilized various fields Such as aerospace, automobile, medical construction, and in manufacturing of many Household products. It includes many procedures, but FDM is one of the effective and economical processes. Three dimensional 3D printing has the ability to impact the transmission of information in ways Similar to the influence of such earlier technologies as prototyping.

### 1.1 How FDM Works

- Objects created with an FDM printer start out as computer-aided design (CAD) files. Before an object can be printed, its CAD file must be converted to a format that a 3D printer can understand usually .STL format.
- FDM printers use two kinds of materials, a modeling material, which constitutes the finished object, and a support material, which acts as a framework to support the object as its being printed.


Figure 1.1 Principle of 3d printing

- During printing, these materials take the form of plastic threads, or filaments, which are unwound from a coil and fed through an extrusion nozzle. The nozzle melts the filaments and extrudes them onto a base, sometimes called a build platform or table. Both the nozzle and the base are controlled by a computer that translates the dimensions of an object into X, Y and Z coordinates for the nozzle and base to follow during printing.
- In a typical FDM system, the extrusion nozzle moves over the build platform horizontally and vertically, "drawing" a cross section of an object onto the platform. This thin layer of plastic cools and hardens, immediately binding to the

layer beneath it. Once a layer is completed, the base is lowered usually by about one-sixteenth of an inch to make room for the next layer of plastic.

- Printing time depends on the size of the object being manufactured. Small objects just a few cubic inches and tall, thin objects print quickly, while larger, more geometrically complex objects take longer to print.

### 1.2 OBJECTIVES

a. Lowest cost 3D printer.
b. Less maintenance required.
c. Light in weight.
d. Small size 3D printer.
e. High-Precision Printing Quality.
f. Next Generation Technology.
g. Safety Protected Power Supply.
h. Less space required.
i. Useful for domestic purpose.

## II LITERATURE REVIEW

**Thabiso Peter Mpofu, Cephas Mawere et al [1]** Concluded that 3D printing also known as Additive manufacturing technology has been dubbed the next big thing and be as equally wide spread as cellular telephone industry. 3D printers print objects from a digital template to a physical 3-dimensional physical object. The printing is done layer by layer (Additive manufacturing) using plastic, metal, nylon, and over a hundred other materials. 3D printing has been found to be useful in sectors such as manufacturing, industrial design, jewellery, footwear, architecture, engineering and construction, automotive, aerospace, dental and medical industries, education, geographic information systems, civil engineering, and many others. It has been found to be a fast and cost effective solution in whichever field of use. The applications of 3D printing are ever increasing and it's proving to be a very exciting technology to look out for. In this paper we seek to explore how it works and the current and future applications of 3D printing.

**Karel Brans et al [2]** Concluded that it is likely that more articles on 3 D printing have featured in mainstream media over the past two years than during the entire 25 years that the technology has been around. This paper briefly introduces the 3D printing technology and explains the unique benefits compared to traditional manufacturing methods. Some of the most important reasons why the technology is currently attracting so much attention are discussed. Significant improvements in equipment, materials and software have enabled high end applications for 3D Printed end use parts. This is illustrated by examples of some of the most successful applications. Moving towards real manufacturing also brings new challenges in quality assurance. This paper presents a software solution for data management and quality assurance in 3D Printing. At the same time, low endvariants of the technology are becoming more and more affordable for consumers. The question is raised whether people will be printing their own parts at home in the future.

**Hye Won Lim, Tracy Cassidy et al [3]** 3D printing technology, also known as additive manufacturing, is appearing at an amazing rate. It enables the creation of many products in design. This study focused on how 3D printing technology has developed, how it has been adapted from industry, and how it is applied in different areas. In the meantime, it also illustrated how this technology is used in fashion to engage creatively and the exciting potential values inspiring and extending fashion designers' range of work. Nowadays many 3D printing manufacturers are dedicated to developing environmentally friendly products along with more sustainable strategies. It is shown how developers are keen to create with less waste, minimised and ethically manufacturing processes as well as recycling reusable, new eco-friendly materials.

**Izabela Hager, Anna Golonka et al [4]** The paper presents the state of the art concerning the current achievements in the field of 3D printing of buildings and building components. The 3D printing technologies, comparing to traditional techniques of constructing the buildings, could be considered as environmental friendly derivative giving almost unlimited possibilities for geometric complexity realizations. Numerous advantages of this technology, such as reduction of the costs and time, minimizing the pollution of environment and decrease of injuries and fatalities on construction sites could be cited. Despite many advantages and hopes, some concerns are summarized in the conclusions, as the technology still has many limitations. Creating a model that will be appropriate for 3D printers is possible in many different modeling programs. One of the most popular formats for sharing such models is STL format. In the paper sample models crated in Autodesk Inventor are shown, but also other tools suitable for preparing models for 3D printing are briefly discussed.

**Simon Ford, Melanie Despeisse et al [5]** The emergence of advanced manufacturing technologies, coupled with consumer demands for more customized products and services are causing shifts in the scale and distribution of manufacturing. In this paper, consideration is given to the role of one such advanced manufacturing process technology: additive manufacturing. The consequences of adopting this novel production technology on industrial sustainability are not well understood and this exploratory study draws on publically available data to provide insights into the impacts of additive manufacturing on sustainability. Benefits are found to exist cross the product and material life cycles through product and

process redesign, improvements to material input processing, make-to-order component and product manufacturing, and closing the loop. As an immature technology, there are substantial challenges to these benefits being realized at each stage of the life cycle. This paper summarizes these advantages and challenges, and discusses the implications of additive manufacturing on sustainability in terms of the sources of innovation, business models, and the configuration of value chains.

**Vinod G. Gokhare, Dr. D. N. Raut, Dr. D. K. Shinde et al [6]** This is a research paper on 3D printing and the various materials used in 3D printing and their properties which become a notable topic in technological aspects. First, define what is meant by 3D printing and what is significant of 3D printing. We will go into the history of 3D printing and study about the process of 3D printing and what materials used in the manufacture of 3D printed objects and select the best materials among them which are suitable for our 3D printing machine. Also, see the advantages of 3D printing as compared to additive manufacturing. Introduction part is about the brief history of 3D printing, in the next section we have depicted the 3D-printing and the processes used in 3D-printing and the properties of the 3Dprinter materials. In the third section, we have highlighted the main advantages and limitations of the 3D printing technology. One can conclude that the 3-D printing technology's importance and social impact increase gradually day by day and influence the human's life, the economy, and modern society. 3D printing, on the other hand, can enable fast, reliable, and repeatable means of producing tailor-made products which can still be made inexpensively due to automation of processes and distribution of manufacturing needs.

**Ying Zhang and Jyhwen Wang et al [7]** functionally graded porous materials (FGPMs) are porous structures with porosity gradient distributed over volume. They have many potential applications in aerospace, biomedical, and other industries. Despite significant efforts have been made to fabricate FGPMs, the existing manufacturing techniques are either complex, expensive, unable to control exact porosity distribution, or unable to create closed cell structures. This paper presents an additive approach for fabrication of polymer FGPMs with both closed cell and open cell structures using thermal-bonding lamination techniques. Under applied compressive load, controlled heating, and appropriate holding time, it was shown that this thermally induced bonding technique can bond layers of polymer sheets to create porous three-dimensional objects. The effects of various factors on the bonding shear strength were investigated. It was found that the bonding strength can be controlled by properly setting the pressure, temperature, and time in the process

**Ze-Xian Low, Yen Thien Chua et al [8]** Studied that Additive manufacturing, likewise known as 3 dimensional (3D) printing and rapid prototyping, has the ability to create almost any geometrically complex shape or feature in a range of materials across different scales. It has found its applications in various areas, such as medicine, art, manufacturing and engineering. On the other hand, its use in separation membrane engineering is relatively new. The use of additive manufacturing techniques could provide more control towards the design of separation membrane systems and offers novel membrane preparation techniques that are able to produce membranes of different shapes, types and designs which cannot be made using conventional techniques such as phase inversion or sintering. Due to the potential benefits of 3D printing in membrane manufacturing, in particular the unprecedented control over membrane architecture the technique could allow, the use of 3D printing in membrane systems should see significant growth in the near future.

**Mehmet Sakin, Yusuf Caner Kiroglu et al [9]** The paper presents the new technology of 3D printing of buildings for the sustainable houses of the future. 3D printing building technology is a new construction technique started with the invention of 3D printer. Latest technologies were described in this paper with pointing to Contour Crafting as a promising technique that may be able to revolutionize construction industry in near future. It has many advantages of this technology, such as reduction of the costs and time, minimizing the pollution of environment and decrease of injuries and fatalities on construction sites could be listed. Integration of Building Information Modeling with the 3D printing building technique is mentioned in comparison with the traditional construction techniques. Moreover, integration of BIM method with 3D printing modeling will be effective for energy efficiency, better design, cost reduction and isolation of structure.

**Nadim S. Hmeidat, James W. Kemp, Brett G. Compton et al [10]** Studied that Clay-based Nano scale filler materials are commonly used to impart unique and desirable properties to polymer resins. Small volume fractions of Nano clay have disproportionately large effects on stiffness, toughness, strength, and gas barrier properties of polymer matrices due to their high surface-to- volume ratio and platelet morphology. Recent work has suggested that highly loaded epoxy/clay/fiber mixtures possess desirable rheological properties for use as feedstock materials for direct-write 3D printing, but little is known about the effects of the deposition process on the resulting properties of the printed composites. Although the observed anisotropic strength values indicate that the deposition process does impart orientation to the Nano clay, the strength in each direction is significantly greater than values reported for 3D printed thermoplastic composites, suggesting that the epoxy/clay system has high potential for further development as a 3D printing feedstock material.

## III CONSTRUCTION

i. *Controller Board*: The controller board also referred to as the motherboard or main board is the brain of the 3D printer. It's the one responsible for the core operation, directing the motion components based on commands sent from a computer and interpreting input from the sensors. The controller board's quality has a major effect on the overall performance of the 3D printer. A machine made of high-end parts from top to bottom won't be able to print as well as it should if the controller board is crap.

ii. *Filament:* The filament is the material used to print objects on a 3D printer. It's the equivalent of the ink used on a regular office 2D printer. It comes in a spool, which is loaded into the spool holder of the 3D printer, with the end of the filament inserted into the extruder. There are different kinds of filaments, each with their own properties and pros and cons. When it comes it filament compatibility, not all 3D printers are on the same level. Some are versatile enough to print with all sorts of materials, including exotic ones, while others can only print with PLA, the most basic filament. There are also 3D printers designed to only accept proprietary filaments. The majority of 3D printers on the market use filaments with a diameter of 1.75 millimetres.

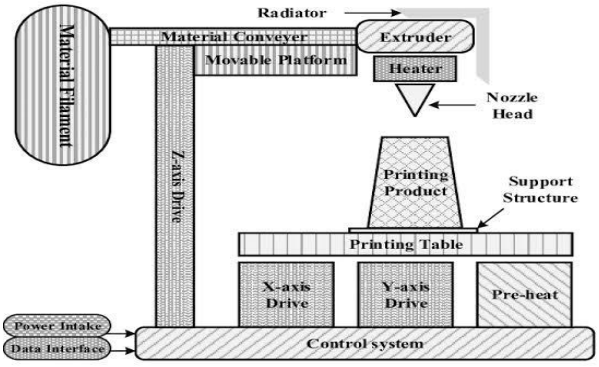


Figure 3.1 Block diagram of 3D printer

iii. *Frame:* The frame is the chassis of the 3D printer. It holds the other components together and is directly responsible for the stability and durability of the machine. These days, 3D printer frames are made of either acrylic or metal, but in the early days of consumer-level 3D printers, wood is often the go-to frame material.3D printers with a metal frame are the most recommended simply because they are more stable and more durable. Going for a metal-framed 3D printer doesn't necessarily mean you have to cough up a lot of money, though. As evidenced by the Mono price Select Mini v2, there are budget 3D printers under 300$ that come with an aluminium frame. Some 3D printers also have an enclosed frame, which protects it from dust and other particles as well as curious fingers that have no business being near the heated components. An enclosure allows for a more stable temperature in the print area, which is beneficial to certain advanced materials. There are semi-enclosed 3D printers, too, which usually come with covered sides but have an open front and/or top. The Ultimaker 3 is a good example of a semi-enclosed 3D printer. Cartesian 3D printers have a different mechanical arrangement on the frame than delta 3D printers. Cartesians have a simple XYZ arrangement while deltas have three arms that move all over the place. Delta 3D printers are actually a lot cooler to watch while they print.

iv. *Motion Components:* The motion components are the parts responsible for the movement of the 3D printer in the three axes. They are the ones that move the print bed and the print head. Basically, the controller board directs how the 3D printer should move while the motion components are the ones that do the actual moving.

v. *Stepper Motors:* The stepper motors, which are run by stepper drivers, are the keys to the mechanical movement of a 3D printer. Stepper motors are connected to all three axes and drive the print bed, the print head, and the threaded rods or lead screws. They make a full rotation in increments or steps, hence the name, making them more suited for 3D printers than a normal DC motor. The print head also comes with a stepper motor that drives the extruder feeding movement.

vi. *Belts:* In a Cartesian 3D printer, the belts, which are connected to motors, move the X-axis and the Y-axis from side to side and are integral to the overall print speed and precision. In a delta 3D printer, belts are often used to drive the movement on the Z-axis. A loose belt can ruin an entire print. That's why many 3D printers come with tensioners. Belt tensioning devices keep the belts in optimum tightness and provide an easy way to adjust the belt tightness.

vii. *Threaded Joints:* In the Z-axis, the movement relies on threaded rods, which are also connected to stepper motors. As the threaded rod rotates, the print head moves up or down. In the case of the Ultimaker 3 and other similar 3D printers, the print bed is the one that moves. Some people confuse a threaded rod with a lead screw. While both have the same function and are similar in appearance, they have different characteristics. A lead screw offers a smoother movement but has a higher price on average. Threaded rods or lead screws can also be used to the drive the movement along the X and Y. But most 3D printers use belts because they are cheaper, lighter, and faster. On the other hand, threaded rods or lead

screws offer more precision but are heavier and more expensive. If you're building a 3D printer from scratch and want an extremely durable machine with an all-metal profile you might want to consider threaded rods or lead screws on all axes.

viii. *End Stops:* Simply put, end stops are like markers that allow the 3D printer to identify its location along the three axes, preventing it from moving past its range, which can result in hardware damages. While many 3D printers use mechanical end stops, there are also those who use optical end stops.

ix. *Power Supply Unit (PSU):* The power supply unit supplies power to the entire 3D printer. No need for an elaborate explanation for this component. The PSU is either mounted on the frame or housed in a separate controller box together with the user interface. It's a lot better if the PSU is mounted on the frame as it translates to a smaller overall machine footprint. If you want to print with more advanced materials on a regular basis, make sure you have the right PSU for the job, as some are not built for high-temperature prints. Cheap 3D printers like the Anet A8 often come with an underpowered PSU good enough for PLA but not for ABS and other materials that need a sustained heating for an extended period. Also, make sure the PSU is compatible with the voltage used in the country you live in. A lot of users have made the mistake of not paying attention to the voltage setting before plugging their machines into a power socket.

x. *Print Bed:* The print bed is where the extruder deposits the filament to form a solid object. Calling back to the 2D printer analogy earlier, the print bed is the equivalent of a piece of paper. A non-heated print bed is good enough for PLA, but for high-temperature materials, a heated print bed is a must in order to cut down on warping issues, improving the overall print quality. Most 3D printers come with an aluminium print bed, but there are also models that have a glass print bed out of the box. Both types of print beds come with pros and cons. An aluminium print bed heats up faster while a glass print bed is flatter and easier to maintain. When choosing between the two, it's often a matter of personal preference. A 3D printer with a manual bed levelling system has a set of thumbwheels under the print bed. These small mechanisms are used to adjust the alignment of the print bed. Some 3D printers are easy to level while others can be a pain, sometimes due to the poor design of the thumbwheels. Cartesian 3D printers have a square or rectangular print bed. Delta 3D printers, meanwhile, have a circular one, which puts a limit on the kinds of objects you can print. A delta print bed is also completely static, unlike a Cartesian print bed, which usually moves along the Y-axis. Once a delta print bed is calibrated, you'll never have to touch it again for a very long time.

xi. *Printing Bed Surface:* As the name suggests, the print bed surface or build surface is what goes on top of the print bed. It helps the object being printed stick to the platform and allows for easier removal of completed objects. There are different types of print surfaces, with Build take and PEI being the most common. All types of print surfaces have pros and cons, so your choice depends on personal preference and also the type of material you want to print with. When the print surface is not sticky enough or has too much adhesion, users often resort to other materials for additional effectiveness, the most popular of which are hairspray and glue.

xii. *Feeder System:* Cartesian and delta 3D printers use either a Bowden feeder system or a direct feeder system. In a Bowden setup, the cold end and the end are separate from each other, and by which we mean the cold end is placed in a different location on the frame. A Bowden setup uses a filament tube to direct the filament into the hot end. Due to the lighter load, the print head moves faster, which means you get faster prints. In a direct setup, the cold end and the hot end are connected. Although a Bowden setup is also capable of producing great results when printing with a flexible material, many people often turn to a direct setup when dealing with that type of material.

### 3.1 Concept design

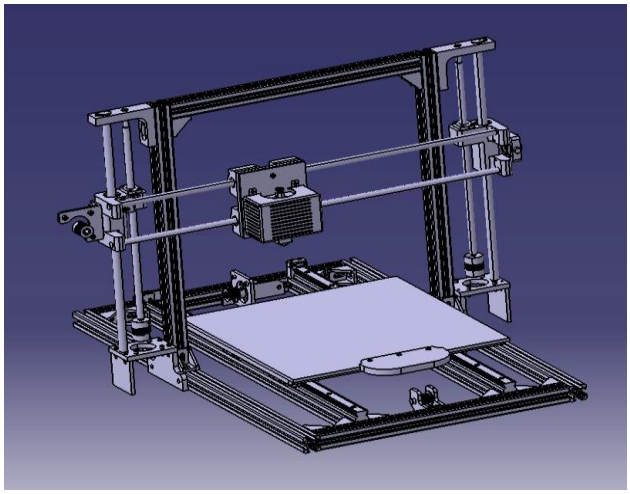

Figure 3.2 Conceptual assembly of Low cost 3d printing system

## IV METHODOLOGY

Step 1: I started the work of this project with literature survey. I gathered many research papers which are relevant to this topic.

After going through these papers, I learnt about Low cost 3D printer for home user.

Step 2: After that the components which are required for project are decided such controller board, motors, extruders, heating bed, etc.

Step 3: select material for 3D printer structural assembly.

Step 4: I will do structural analysis of components on ANSYS.

Step 5: final stage will be checking the performance of all 3 axes(X, Y, Z) along with 3 motors, which are going to use in 3D printer.

Step 6: After completing all these, I will select some sensors such as position sensor, for my project.

### 4.1 Final parameters of Low cost 3d printing system

| **Modeling Technology** | **FDM(Fused Deposition Modeling)** |
|---|---|
| Printing Size | 220*220*250mm |
| Machine Size | 440*410*465mm |
| Package weight | 8kg |
| Max Traveling Speed | 180mm/s |
| Fliament | 1.75mm PLA, TPU, ABS |
| Input | AC 100-265V 50-60Hz |
| Output | DC 24V 15A 360W |
| Layer Thickness | 0.1-0.4mm |
| Nozzle diameter | 0.4mm eom |
| Precision | ±0.1mm |
| File Format | STL, OBJ, G-Code |
| Working Mode | Online or SD ofline |
| Max Nozzle Temperature | 255℃ |
| Max Hot bed Temperature | 110℃ |

## V CONCLUSIONS

Choosing the right polymer for raw material such as PLA, ABS, PETG for printing and frame material for overall structure is critical to get the right properties for a 3D printed part, especially if the part has a functional use. This study will help users to find the right material depending on the properties they need. However, in case of filament material suppliers also often provide blends or add additives to modify the properties of the pure polymer (e.g. adding carbon fibre to make the material stiffer) in the same way by use of different sections of aluminium extrusion profile structural strength can be improved.

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**BIOGRAPHIES**

**Ms.Yugwini V. Deshmukh** completed her BE in Mechanical engineering & currently pursuing her ME in Mechanical design engineering from All India Shri Shivaji Memorial society's college of engineering, pune.

**Dr. P.S. Gajjal** completed her B.E. (Mechanical engineering) & M.E. (Design engg.).She completed his PhD in mechanical engineering and currently working as Assistant professor at Dept. of Mechanical Engineering, in All India Shri Shivaji Memorial society's college of engineering, pune with more than 16 year experience in the field of teaching and research, Which includes the topics as Design Engineering, Tribology.

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