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Modelling and Fabrication of Basic 3D Models Using 3D printing machine Technology

NARESH KUMAR B[1], BHARATI[2], SOWMYASHREE P[3]

[1] Senior Lecturer, Department of Mechanical engineering, GPT Raichur-DTE, Bangalore, India

[2] Senior Lecturer, Department of E&C engineering, GPT Bidar-DTE, Bangalore, India

[1] Lecturer, Department of Mechanical engineering, GPT Lingasur-DTE, Bangalore, India

Abstract

Design and fabrication using Digital Technology, also referred to as 3D printing or additive manufacturing, creates physical objects from a geometrical representation by successive addition of materials. A 3D printing technology increasingly used for the mass customization, production of any types of open source designs in the field of agriculture, in healthcare, automotive industry, locomotive industry and aviation industries. 3D printing technology can print an object layer by layer deposition of material directly from a computer aided design (CAD) model. 3D printing technology is a fast-emerging technology 3D printing, unlike other manufacturing processes, being an additive process has emerged as a viable technology for the production of engineering components. The aspects associated with 3D printing such as less material wastage, ease of manufacturing, less human involvement, very less post processing and energy efficiency makes the process sustainable for industrial use. In this paper we seek to explore how it design and fabrication of basic models.

Introduction

3D Systems and released the first 3D printer, the SLA-1, in 1987 3D printing origins: The first 3D printing technology, Stereo lithography (SLA), was invented by Chuck Hull in 3D printing applications: 3D printing has been used for various applications, such as prototyping, bio printing, prosthetics, jewellery, art, and architecture. 3D printing has also enabled the creation of complex and customized shapes that are difficult or impossible to make with traditional methods. 3D printing democratization: The expiration of some key patents in the 2000s and 2010s led to the emergence of low-cost and open-source 3D printers, such as RepRap and Makerbot. These printers made 3D printing more accessible and affordable for hobbyists, educators, and small businesses. Later years a rapid growth in 3d technology emerged. In Traditional machining techniques rely on the removal of material by methods such as cutting or drilling whereas 3D printing layers are added successively. Thus it uses a layering technique where an object is constructed layer by layer until the complete object is manufactured. In this way 3D printing moves us away from the mass production line to a one-off customizable production You can literally make any object from a house to a bar of chocolate, so to say. The initial 3D printers were used in the 1980s where a pattern submerged in a liquid polymer would be traced by a computer. The traced pattern hardened into a layer, thanks to the laser, and that was how you built an object out of plastic. Since then tremendous progress has been made in additive manufacturing. 3D printing technology has the potential to revolutionize industries and change the production line. The adoption of 3D printing technology will increase the production speed while reducing costs. At the same time, the demand of the consumer will have more influence over production. Consumers have greater input in the final product and can request to have it produced to fit their specifications. At the meantime, the facilities of 3D printing technology will be located closer to the consumer, allowing for a more flexible and responsive manufacturing process, as well as greater quality control. Furthermore, when using 3D printing technology, the need for global transportation is significantly decreased. This is because, when manufacturing sites located nearer to the end destination, all distribution could be done with fleet tracking technology that saves energy and time. Lastly, the adoption of 3D printing technology can change the logistics of the company. The logistics of the companies can manage the entire process, offer more comprehensive and start-to-finish services. Nowadays, 3D printing is widely used in the world. 3D printing technology increasingly used for the mass and customised fabrication.

Keywords: 3D printing, Fabrication, Design, additive manufacturing, printing layers, Technology, Basic models, cost effective

Types of 3D Printing:

1.Binder jetting

Binder jetting is a rapid prototyping and 3D printing process in which a liquid binding agent is selectively deposited to join powder particles. The binder jetting technology uses jet chemical binder onto the spread powder to form the layer. The application of the binder jetting is would be producing the casting patterns.

2. Directed energy deposition

Directed energy deposition is a more complex printing process commonly used to repair or add additional material to existing components The process of directed energy deposition is similar in principle to material extrusion, but the nozzle not fixed to a specific axis and can move in multiple directions. Furthermore, the process can be used with ceramics, polymers but is typically used with metals and metal-based hybrids, in the form of either wire or powder.

3. Materials extrusion

Material extrusion-based 3D printing technology can be used to print multi-materials and multi-colour printing of plastics, food or living cells. This process has been widely used and the costs are very low. Moreover, this process can build fully functional parts of product [8]. Fused deposition modelling (FDM) is the first example of a material extrusion system. FDM was developed in early 1990 and this method uses polymer as the main material

4. Materials jetting

material jetting is a 3D printing process in which drop by drop of build material are selectively deposited. In material jetting, a print head dispenses droplets of a photosensitive material that solidifies, building a part layer-by-layer under ultraviolet (UV) light. At the same time, material jetting creates parts with a very smooth surface finish and high dimensional accuracy

5. Powder bed fusion

The powder bed fusion process includes the electron beam melting (EBM), selective laser sintering (SLS) and selective heat sintering (SHS) printing technique. This method uses either an electron beam or laser to melt or fuse the material powder together. The example of the materials used in this process are metals, ceramics, polymers, composite and hybrid

6. Sheet lamination

sheet lamination is the 3D printing process in which sheet of materials are bond together to produce a part of object. The example of 3D printing technology that uses this process are laminated object manufacturing (LOM) and ultrasound additive manufacturing (UAM)

7. Vat Photo polymerization

Vat Photo Polymerization The main 3D printing technique that frequently used is photo polymerization, which in general refers to the curing of photo-reactive polymers by using a laser, light or ultraviolet (UV). The example of 3D printing technologies by using photo polymerization is stereo lithography (SLA) and digital light processing (DLP). In the SLA, it was influenced by the photo initiator and the irradiate exposure particular conditions as well as any dyes, pigments, or other added UV absorbers. Light source is the major difference. Digital Light Process uses a more conventional light source, such as an arc lamp with a liquid crystal display panel. It can apply to the whole surface of the vat of photopolymer resin in a single pass, generally making it faster than Stereolithography. The important parameters of Vat Photo polymerization are the time of exposure, wavelength, and the amount of power supply. The materials used initially are liquid and it will harden when the liquid exposed to ultraviolet light. Photo polymerization is suitable for making a premium product with the good details and a high quality of surface.

Materials Used for 3D Printing Technology in Manufacturing Industry

1.Metals

The materials of metal have the excellent physical properties and this material can be used to complex manufacturer from printing human organs to aerospace parts. The examples of this materials are aluminium alloys, cobalt-based alloys, nickel-based alloys, stainless steels, and titanium alloys. Cobalt-based alloy is suitable to use in the 3D printed dental application. This is because, it has high specific stiffness, resilience, high recovery capacity, elongation and heat-treated conditions. low weight and processing flexibility. Mostly, the materials of polymers played important role in biomaterials and medical device products often as inert materials,

2. Polymers

such as polylactic acid (PLA), acrylonitrile butadiene styrene (ABS), polypropylene (PP) or polyethylene (PE). Lately, thermoplastics filaments with higher melting temperatures such as PEEK and PMMA can be used as materials for 3D printing technology.

3. Ceramics
Nowadays, 3D printing technology can produce 3D printed object by using ceramics and concrete without large pores or any cracks through optimization of the parameters and setup the good mechanical properties.

4. Composites
Composite materials with the exceptional versatility, low weight, and tailorable properties have been revolutionizing high-performance industries. The examples of composite materials are carbon fibres reinforced polymer composites and glass fibres reinforced polymer composite. Carbon fibre reinforced polymers composite structures are widely used in aerospace industry because of their high specific stiffness, strength, good corrosion resistance and good fatigue performance. At the same time, glass fibres reinforced polymer composites are widely used for various applications in 3D printing application.

5. Smart materials
Smart materials are defined as this material have the potential to alter the geometry and shape of object, influence by external condition such as heat and water. The example of 3D printed object produces by using smart materials are self-evolving structure and soft robotics system.

The Applications of 3D Printing machine.

1. Aerospace industry
2. Food Industries
3. Healthcare and medical industry
4. Garment and Garment Industries
5. Pharmaceuticals
6.Aeronautics and space application
7. Architecture, building, and construction industry etc.

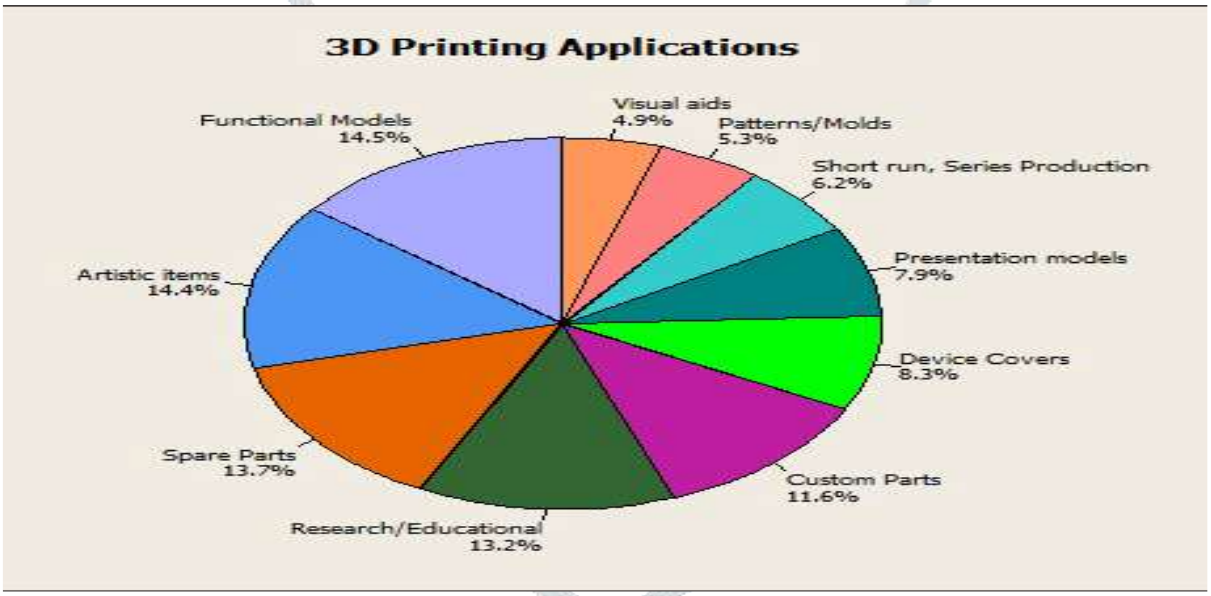

Figure shows the applications of 3D printing machine in various fields.

Modelling and fabrication to generate basic models using 3d printing machine.

Step 1: CAD All AM parts must start from a software model that fully describes the external geometry. This can involve the use of almost any professional CAD solid modelling software, but the output must be a 3D solid or surface representation. Some of the top CAD software products for professional use include:

1. AutoCAD — one of the first CAD suites to be released, all the way back in 1982. AutoCAD is widely used across all industries for 3D design, and known to be extremely versatile in expert hands.

2. Creo — a market leader in product design that includes a wide range of design functionality and the ability to complete dimension calculations during the modelling process.

3. Solid Works — widely used for industrial object design. Solid works includes an extremely wide range of engineering tools and features.

Step 2: Conversion to Standard Tessellation language (STL) Nearly every AM machine accepts the STL file format, which has become a standard, and nearly every CAD system can output such a file format. This file describes the external closed surfaces of the original CAD model and forms the basis for calculation of the slices. It is a triangulated representation in a 3D CAD model.

Step 3: Slicing in software Slicing is the process of transforming an STL file into G-code. G-code contains printer commands, so what slicing does is it takes the STL file's geometry data and creates a list of instructions the printer must follow to print the model.

Slicing gives your printer instructions based on nozzle size, filament and print profile, taking into account temperature range, speed and extrusion type.

Many 3D printer manufacturers have their own slicing software like Formlabs PreForm and Ultimaker Cura. You can also use third-party software like Slic3r.

Step 4: Machine Setup The AM machine must be properly set up prior to the build process. Such settings would relate to the build parameters like the material constraints, energy source, layer thickness, timings, etc.

Step 5: Build Building the part is mainly an automated process and the machines can largely carry on without supervision. Only superficial monitoring of the machine needs to take place at this time to ensure no errors have taken place like running out of material, power or software glitches, etc.

Step 6: Removal Once the AM machine has completed the build, the parts must be removed. This may require interaction with the machine, which may have safety interlocks to ensure for example that the operating temperatures are sufficiently low or that there are no actively moving parts.

Step 7: Post processing Once removed from the machine, parts may require an amount of additional cleaning up before they are ready for use. Parts may be weak at this stage or they may have supporting features that must be removed. This therefore often requires time and careful, experienced manual manipulation. This may involve abrasive finishing, like polishing and sand papering, or application of coatings. This stage in the process is very application specific. Some applications may only require a minimum of post-processing. Other applications may require very careful handling of the parts to maintain good precision and finish. Some post-processing may involve chemical or thermal treatment of the part to achieve final part properties.

Step 8: Application Parts may now be ready to be used. However, they may also require additional treatment before they are acceptable for use. For example, they may require priming and painting to give an acceptable surface texture and finish. Treatments may be laborious and lengthy if the finishing requirements are very demanding. They may also be required to be assembled together with other mechanical or electronic components to form a final model or product.

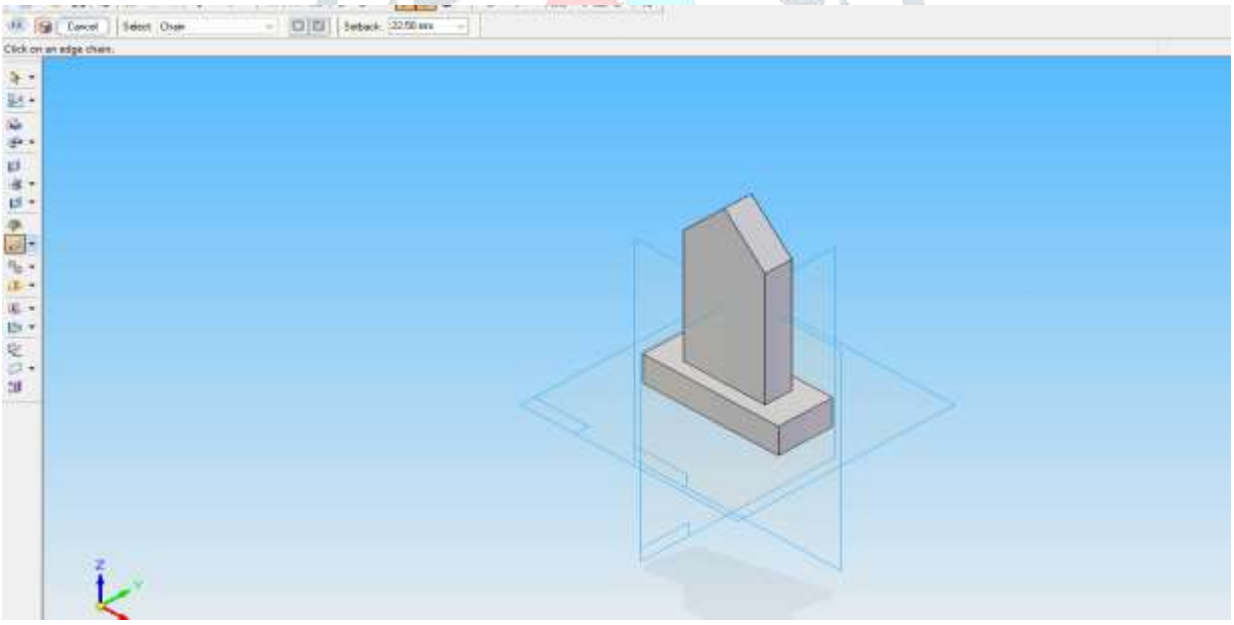

Figure shows the modelling of the model using CAD software

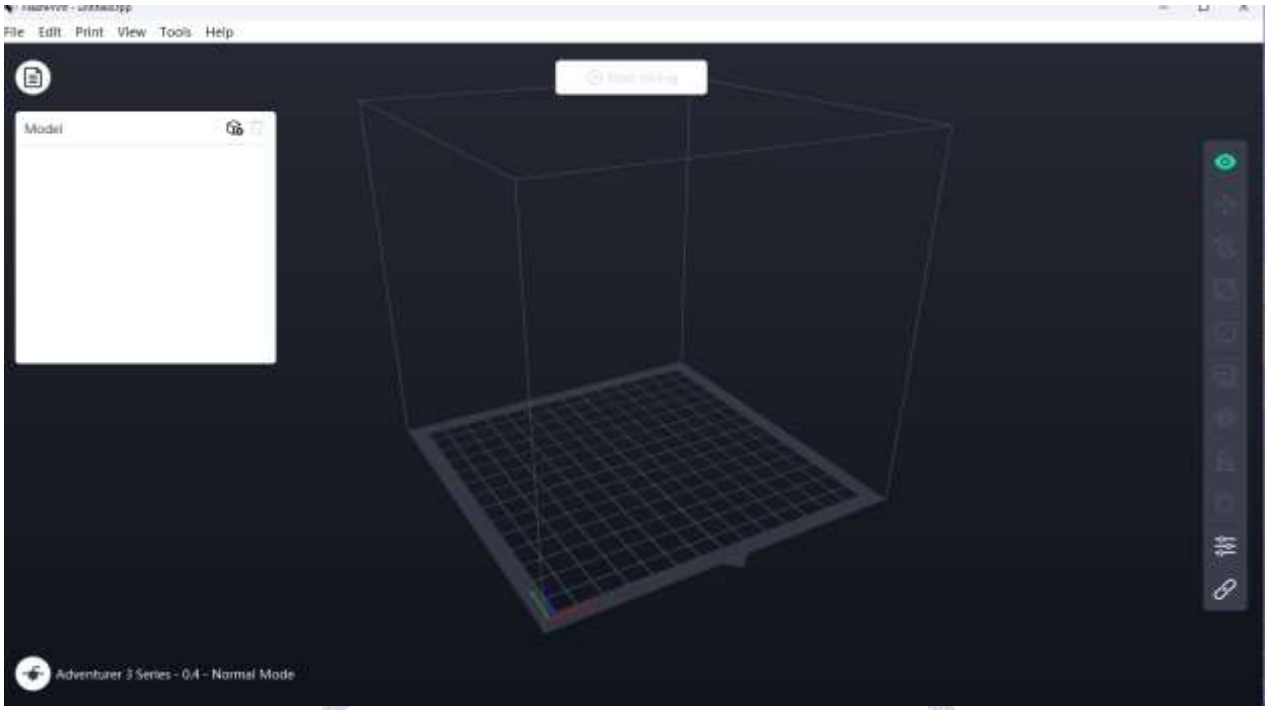

Figure shows the slicing software window

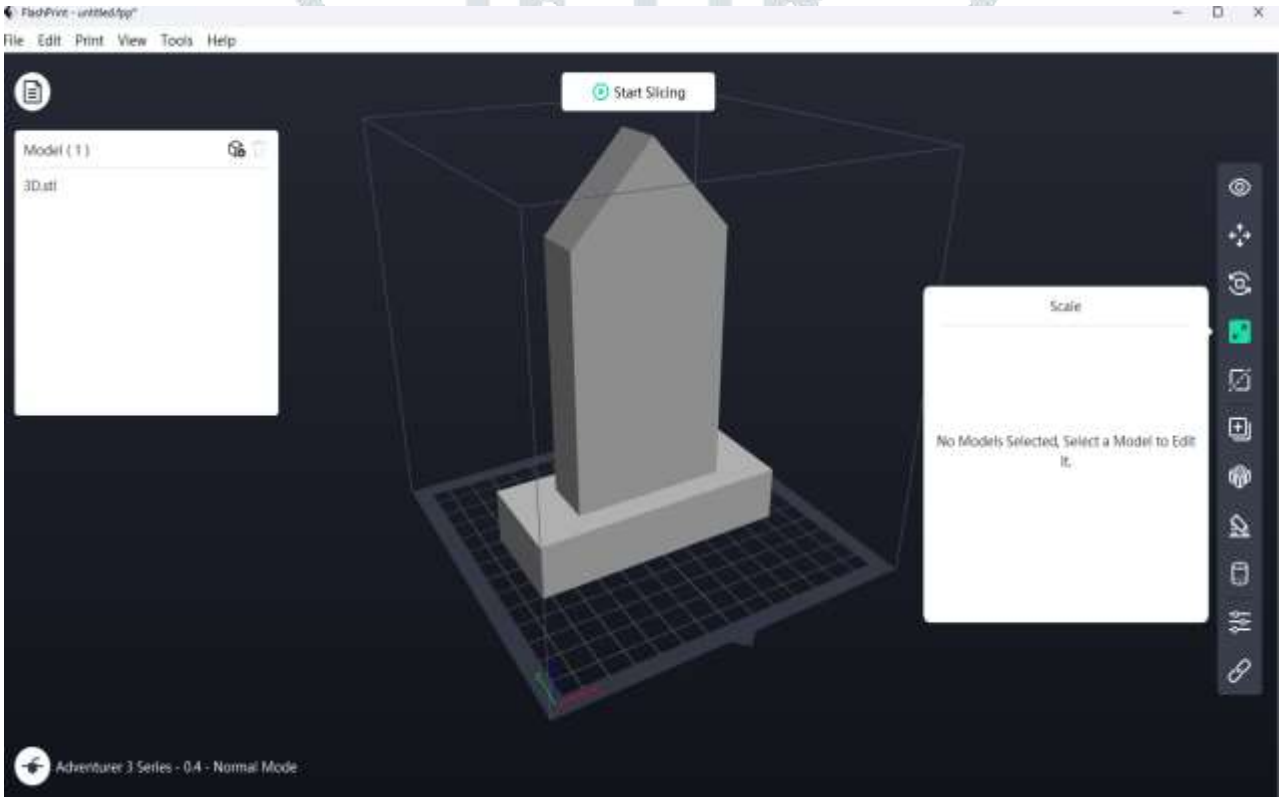

Figure shows model saved in. stl format

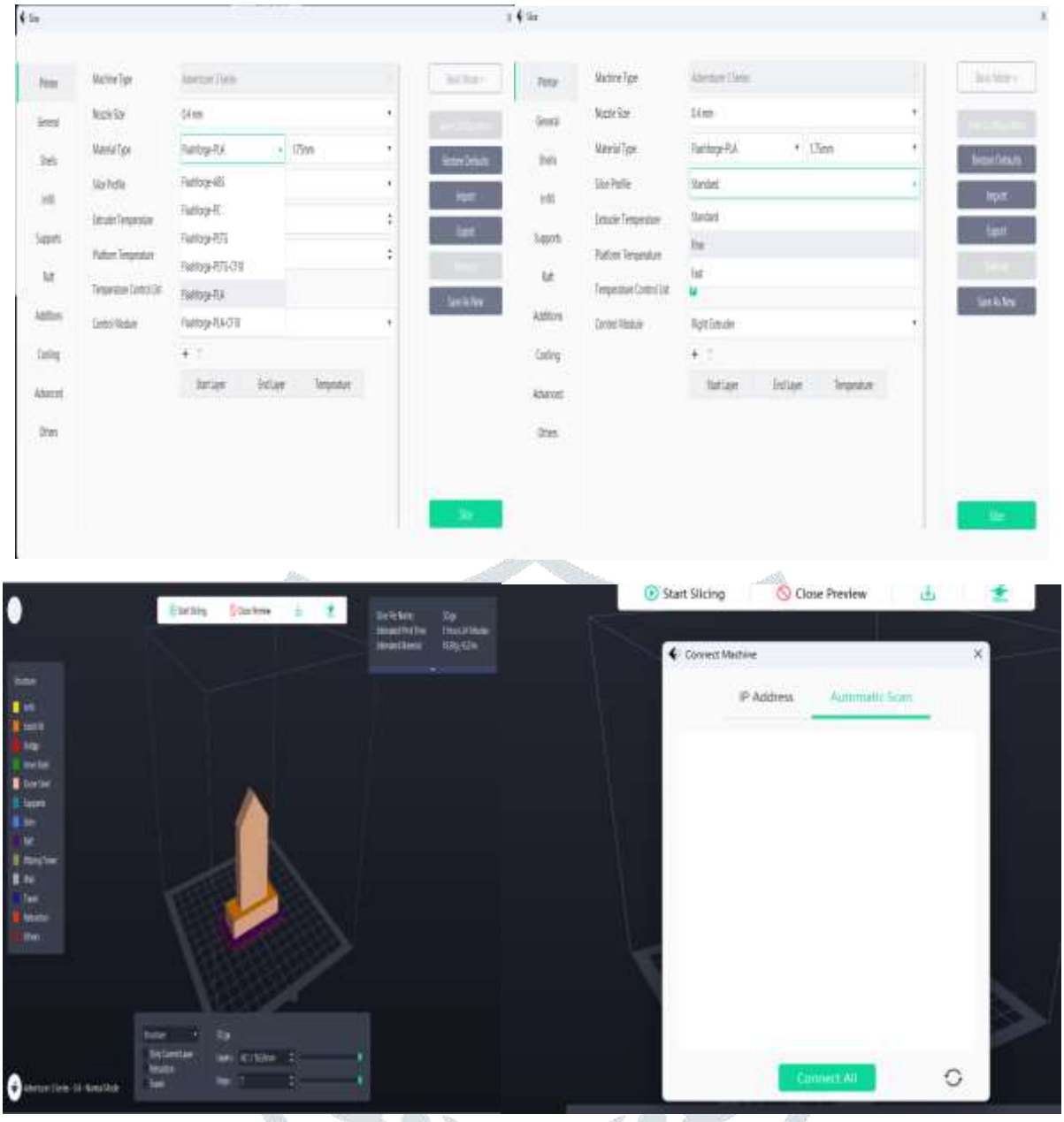

Figure shows the preview of the sliced model and connecting the model to 3d printing machine

The following are the basic models generated by using the 3d printing machine.

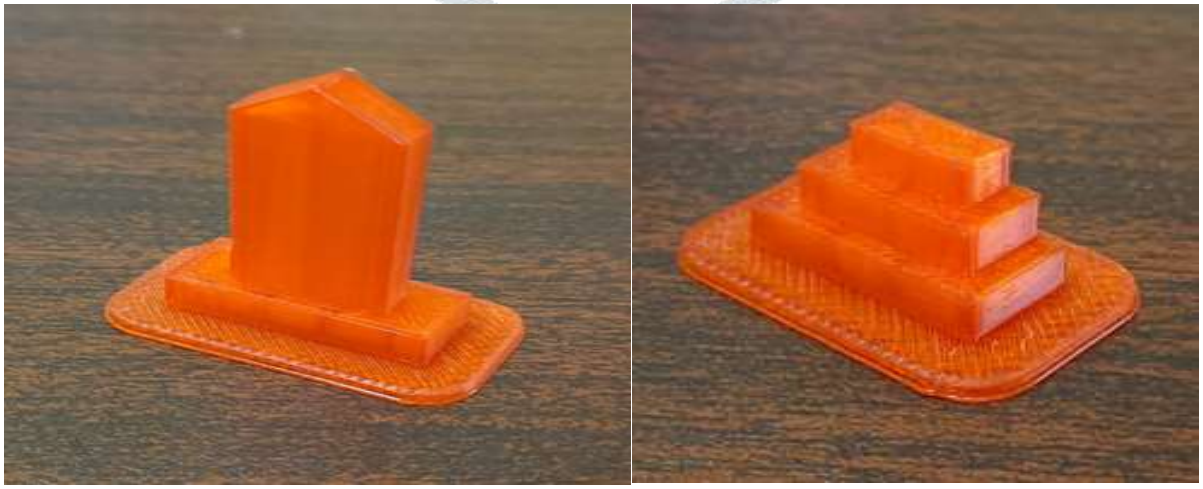

Figure shows the finished products generated by a 3d printing machine

Conclusion

Digital fabrication technology, also referred to as 3D printing or additive manufacturing, creates physical objects from a geometrical representation by successive addition of materials. 3D printing technology is a fast-emerging technology. Most desirable thing for a human being is health and 3D printing plays a fantastic role in this sector. In case of food printing, the diet control and personalized food can be provided using this technology is another health beneficiary part. The best alternates of traditional manufacturing and designing process are being provided by the 3D printing technology for the jewellery making, housing and construction. 3D printing has long passed the point of being viewed only as a prototyping solution. Every day, companies are finding new ways to incorporate the technology into their production, with applications ranging from tooling to spare/replacement parts and some end-use components. From automotive to consumer goods, companies across industries are becoming aware of the advantages 3D printing offers for production. Considering the recent progress of the technology and these expert predictions, 3D printing is clearly headed for a bright future of digital, smart manufacturing.

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