International Journal of Engineering Research and Development
e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 11, Issue 09 (September 2015), PP.37-40

Study on the Fused Deposition Modelling In Additive Manufacturing

Tharun George Thomas
Vidya Jyothi Institute of Technology, Hyderabad

Abstract:- Additive manufacturing process, also popularly known as 3-D printing, is a process where a product is created in a succession of layers. It is based on a novel materials incremental manufacturing philosophy. Unlike conventional manufacturing processes where material is removed from a given work price to derive the final shape of a product, 3-D printing develops the product from scratch thus obviating the necessity to cut away materials. This prevents wastage of raw materials. Commonly used raw materials for the process are ABS plastic, PLA and nylon. Recently the use of gold, bronze and wood has also been implemented. The complexity factor of this process is 0% as in any object of any shape and size can be manufactured.

Keywords:- Additive manufacturing process, 3-D printing, Fused Deposition Modelling, CAD, ABS plastic.

I. INTRODUCTION

To understand the importance of this revolutionary manufacturing process, we need to scrutinize existing methods. The turn of the 19th century saw transition to new manufacturing processes, from handcrafted materials to machine made. These methods included the conventional processes like turning, drilling, grinding, shaping etc. Parts produced by casting required die casts. The parts formed often required further machining processes to meet required standards. The term machining is used to describe processes which involve removal of material from work piece. Machining is implemented to perfect geometrical profiles with good surface finish and dimensional accuracy. [1] There has been rapid growth in the development of harder and difficult to machine metals and alloys over the past few decades. These manufacturing processes require a careful and detailed analysis of the part geometry to determine what tools and processes must be used and what additional parts may be required to complete the part.[2] Another limitation is that none of the above processes facilitated the development of readymade working prototypes. It required further supplements like gears, bolts and assembling to prepare a working model.

Additive manufacturing is a process which can achieve work pieces of any shapes and sizes. It significantly simplifies the process of manufacturing complex 3D objects by fabricating it from CAD model. Products can be fabricated directly without the need for process planning. But its greatest advantage is its ability to manufacture working prototypes. The product is printed in its end form. Since It is the process of manufacturing parts directly from a computer design, it obviates the use of a die cast. [3] It has the capability to replace even advanced mechanisms like Computerized Numeric Control (CNC).

II. HARDWARE OF 3-D PRINTER

The capabilities of a three dimensional printer is determined by its specifications. The specifications to be considered are:

1. Build volume – l x b x h
2. 3D movement – Nozzle movement (or) Build plate movement
3. Nozzle diameter
4. Diameter of filament used

Hardware Specifications of a 3-D printer:

Build volume	:	24.6 x 15.2 x15.5 cm
Power requirements	:	100-240 V, ~4 amps
Operating temperature	:	15-32°C
3D movement	:	nozzle movement
Nozzle diameter	:	0.4 mm

Other equipments:

Filament	:	ABS plastic
Filament diameter	:	1.75 mm

III. FUSED DEPOSITION METHOD

Fused Deposition Model uses a layer based approach. The thinner each layer is, the closer the final part will be to the original. The accuracy of the final part is based on factors like the material used, how the layers are created and how they are bonded to each other.

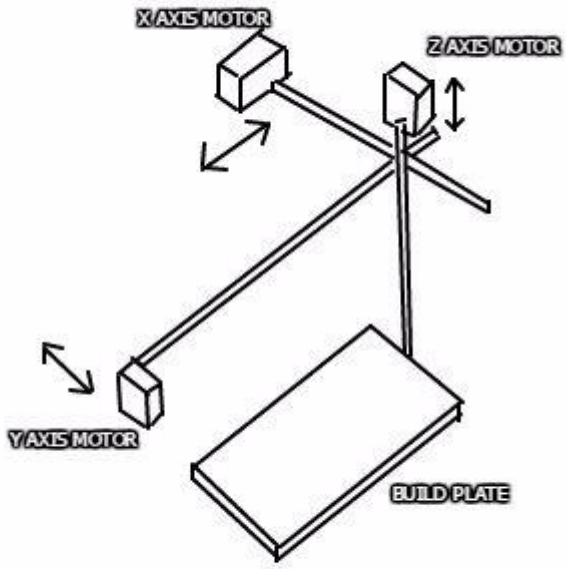


Fig. 1: Basic Layout of a Three Dimensional Printer

Steps involved in Fused Deposition Modelling printing:
1. Design of the product in a CAD software
2. Conversion to.stl file (stereo lithography file format)
3. Printing the product

(i). Design of the product:
The product to be printed is initially designed in a CAD software like CATIA, PRO-E. The parts of the product are designed in the part design workbench using sketch based tools and drafting tools. The parts so designed are saved with the file extension ".CATPart". Once the parts are designed in Part Design, they are assembled in the Assembly workbench. The tools used include Manipulation tools and Constraint tools. The individual parts are to be constrained in order to avoid undesired translation or rotation of individual parts. Once the assembly is finished, the file gets saved with the file format ".CATProduct".

(ii). Conversion to .stl format:
The ".CATProduct" files are not recognised by the 3-D printer. As such, these files are to be converted to ".stl" file extensions. This is achieved by a pre processing program. It slices the design into many layers and creates a systematic path as per which the product will be printed. In case of rounded corners and complex contours, supports are introduced by the program to act as a pillar to support it. It is possible to use one material to manufacture the model and another soluble material to build the support.

(iii). Printing the product:
The ".stl" extension file is now transmitted to the printer via a connecting cable. Thin strings (also commonly known as filaments) of ABS plastic or PLA , as required, is loaded onto the handlers. The filament is initially preheated past their glass transition temperature and loaded on the extrusion head. For an ABS plastic, it is to be preheated to 230°C for a period of 15 minutes. Once the filament is sufficiently heated, printing is initiated on to a build plate. The material is extruded in molten state to form layers.

Fig. 2: Filament

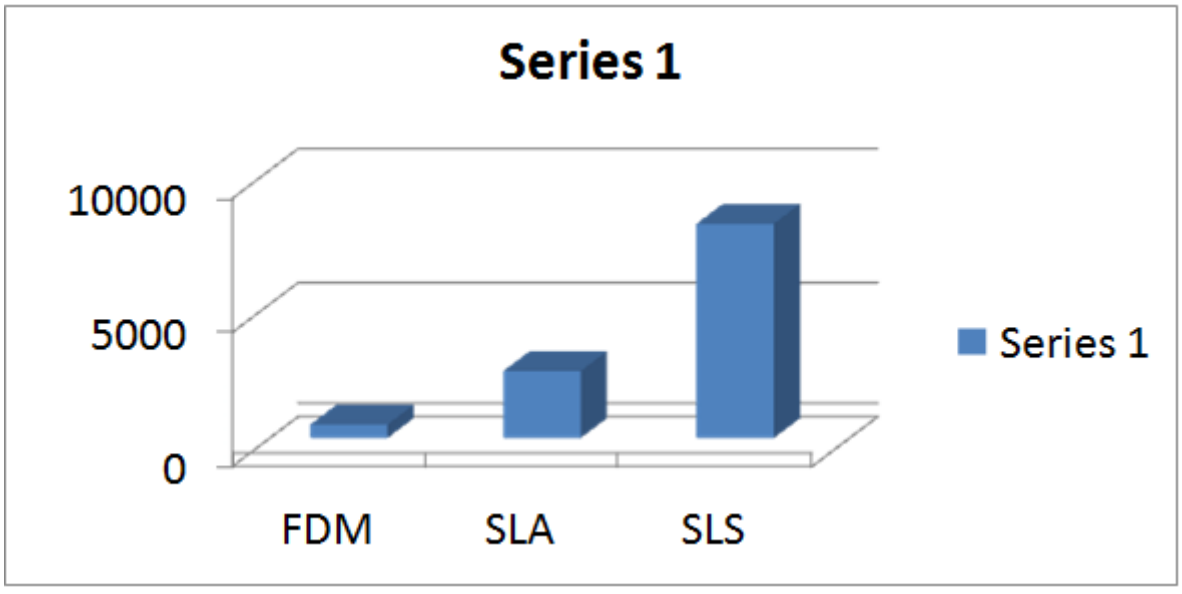
The movement of the extrusion head is achieved by use of a servo motor. The nozzle can move in horizontal and vertical directions. The extrusion nozzle drives as per the path determined in the previous step. The product is printed layer by layer. The new layers bind with previous ones as they are extruded. The feed of the material can also be programmed depending on the time required for the material to fuse together. The supports can be removed manually once the product has cooled down.

IV. COMPARISON WITH OTHER ADDITIVE MANUFACTURING METHODS

Other Methods of 3-D printing deployed are:
1. Stereolithography (SLA)
2. Selective Layer Sintering (SLS)

Sl No.	Method of printing	Type of input material	Method of treatment
1.	Fused Deposition Modeling	Solid	Heat treatment
2.	Stereolithography	Liquid	Ultraviolet light
3.	Selective Layer Sintering	Powder	Laser

The following is a graph showing the market cost of having a product manufactured by a third party dealer for different methods of Additive Manufacturing. The cost per kilogram of the product is considered.



V. CONCLUSIONS

In short, we can summarize that Fused Deposition Method of Additive Manufacturing is widely used currently. The operational skills required are rudimentary in the sense anyone with a basic knowledge of a designing software and material handling is capable of handling it with virtuoso. Variants of this type of printer are commercially available at affordable prices making it available for household uses and enabling widespread further research. Currently limited to handling one or two materials at the most simultaneously remains a drawback. But recent studies in the field are promising and soon it will be able overcome even this and be able to mix and congeal different materials at once.

REFERENCES

[1]. Pakirappa, Metal cutting and machine tool engineering, 1st ed, 2012

[2]. Dr. Ian Gibson, Dr. David W. Rosen, Dr. Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 2010: Springer

[3]. Emanuel Sachs, "Three dimensional printing: The physics and implications of Additive manufacturing", CIRP Annals- Manufacturing Engineering, Vol 42, Issue 1, 1993