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3D Printing for Different Casting Patterns

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Abstract —*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. FDM is one of the technique in additive manufacturing. By using 3D printer T type box shaped split patterns, unsymmetrical objects, sharp corned patterns can be made. These patterns can be made in less time and most rigidly. By this project the cost of patterns in casting process can be reduced by 3D Technology. The close tolerances of finished product with fiber made patterns can be achieved. Lead time taken for a wooden pattern is high when compared 3D printing .3D printing technology is useful to reduce the lack of agility in preparing the non symmetrical shapes or irregular shapes.*

By FDM technique an object is created by laying down successive layers of material until the object is created. These layers can be seen as a thinly sliced horizontal cross section of the eventual object. Any type of patterns can be made through 3D printing. The printed object does not vary from the original pattern. Generally the pattern is done for printing a pattern in 3D we have to design the pattern in software named CATIA. By using this software the pattern is prepared and is converted into format named STL. This format is made to save in the chip which is attached to 3d printer machine. STL file format is saved in a code form. Then the printing is done.

Keywords-*3D printing machine; poly lactic acid; gold pattern; mould powder.*

I. INTRODUCTION

3D printing is a quickly expanding field and its use increases daily. It is the wide range of technologies in 3D printers .3D printing is also known as additive manufacturing.3D printing is one of the latest technology and quickly expanding by the users. The term 3D printing is a host of processes and technologies that offer a full spectrum of capabilities for production of parts and products in different materials. Essentially all processes and technologies have a common thing is which production is carried out by a layer by layer in an additive process by involving subtractive methods or molding or casting processes. 3D printing is a process for making a physical object from a three dimensional digital model typically by laying down many successive thin layers of a material. It brings a digital object into its physical form by adding layer by layer of materials. There are several different techniques to 3D print an object. FDM is one of the technique. Fused deposition modeling is an additive manufacturing technology. It is used for modeling, prototyping and production. It works on additive principle by laying down material layer by layer.

In a machine the material is taken and from the extrusion of nozzle the material is formed layer by layer. By layers the material is formed and filament goes on heating until it is finished the printing the given one. The below picture shows the filament coming from the nozzle and forming layer by layer.

Fused deposition modeling (FDM) was first developed and commercialized by Stratasys, in U.S.A. A continuous filament of a thermoplastic material (polymer or wax) through a resistively heated nozzle is deposited to fill the contours of the desired slice. A sketch of FDM process is

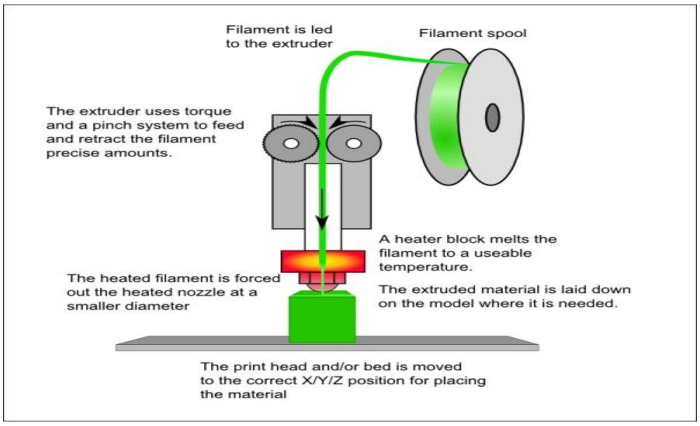

Fig1: sketch of fused deposition modeling process.

The raw material is in the form of a filament wire of about 3mm diameter. Using a pinch wheel drive (spool) it is fed into an extrusion chamber nozzle which is kept at a temperature slightly above its flow point. The thermoplastic wire itself acts as the piston initially in the extrusion chamber which subsequently gets melted and pushed out through the nozzle. The extruder head velocity is about 50mm/second. The filament coming out of the nozzle solidifies relatively quickly after it exists nozzle. The diameter or width of the filament deposited need not be same as that of the nozzle since it depends on the ratio of the wire speed into the extrusion chamber and the transversal speed of the nozzle. When the first layer is completed, table is lowered so that further layers can be superimposed.

The extruder head has a diameter of about 1mm. minimum thickness of layer obtained is about 0.25mm – 0.50mm. This indicates the tolerance obtainable in z direction in x and y direction the dimensional accuracy can be obtained up to 0.025mm.

Short overhanging features can be formed without the need for any support in this process. However supports are needed for longer overhanging features. These support structures are initially drawn out as thin wall sections that can easily be removed upon completion. In some machines there is a separate extrusion head for depositing support material.

II. EXPERMENTAL SETUP

Hardware:
Print Technology: Fused Deposition Modeling.
Build volume : 210×250×260mm^3.
Layer Resolution
: 317- 217 microns.
Dimensional accuracy: XY: 50 – 100 microns.
Z: 20 – 50 microns.
Filament diameter: 1.75 mm.
Nozzle diameter : 0.3 – 0.8 mm. (replaceable).
Filament compatibility: ABS,PLA, Nylon, PHA, Wood fill, carbon fiber, Ninja Flex, XT- copolymer.

Software:
Software bundle: Fracktory
File types : .stl.obj.
Support: windows (XP32 bit/7+)

Fused Deposition Modeling (FDM) machine is one of the Technology in 3D printing machine. Fracktal works is the name of the machine working system is the thermoplastic filament goes to the nozzle and gets heated then passes through out the extruder. For the controlling of the filament the extruder wheels are present inside. The heated filament deposits layer by layer.

III. PROCEDURE

The pattern is taken and is designed in software named CATIA. The pattern consists of two pieces. It is a gold pattern. The gold pattern is taken and is designed in CATIA software. The first and second parts are from the Fig3 and Fig 4.

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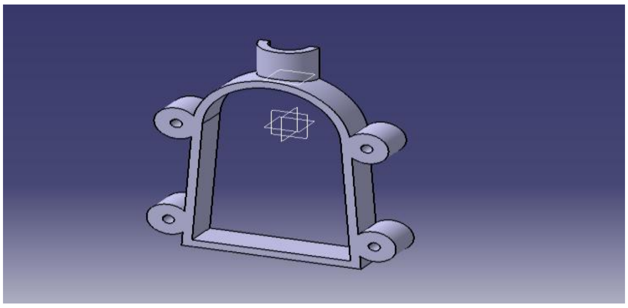


Fig 3: First part

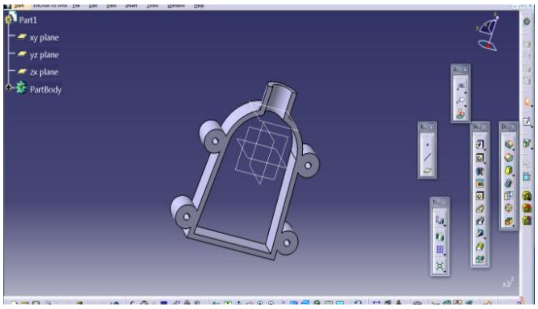


Fig 4: Second part

Then the two parts are converted into STL format. Then the STL format is dragged into the workbench into fracktory software. The workbench is shown in the Fig 5.

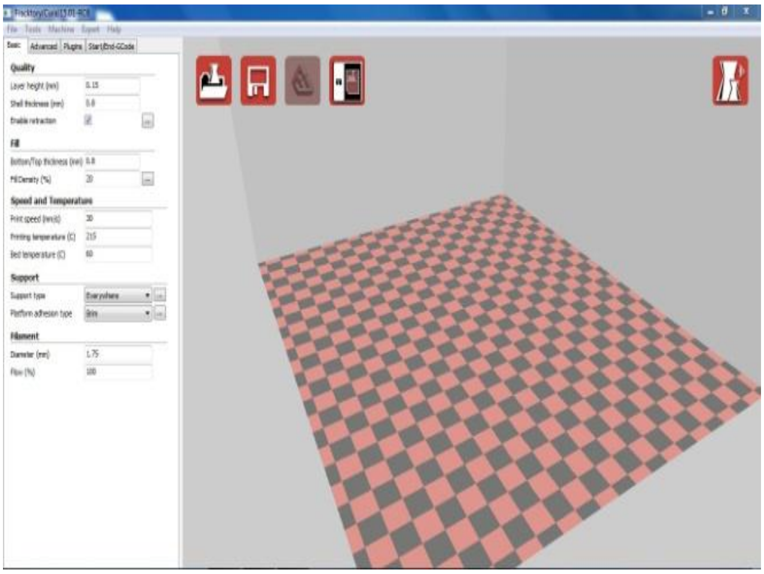


Fig 5: Workbench of fracktory software.

When the pattern is placed on the workbench and the time taken for printing and the filament needed for printing

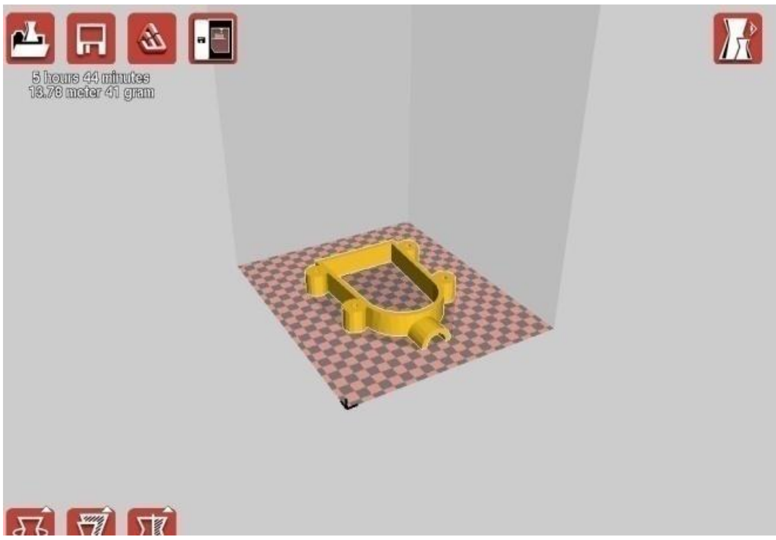
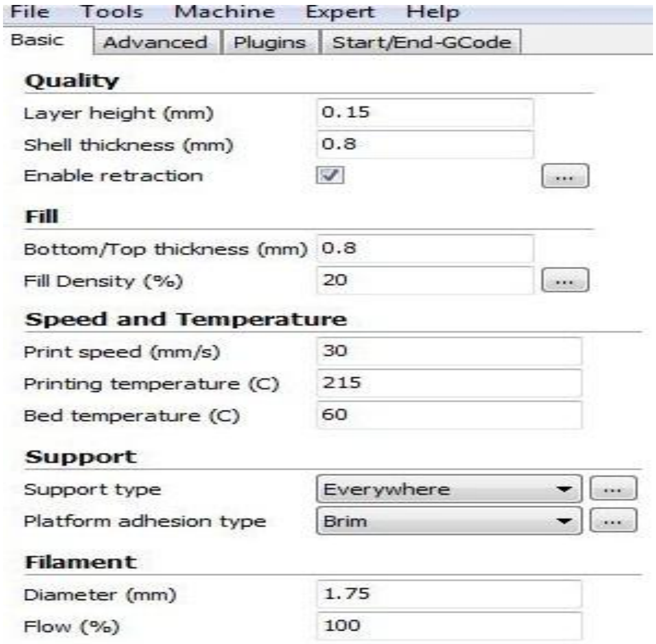


Fig 6: The part placed on the workbench.

Then the settings are done for the gold pattern. The layer height is about 0.15 mm and shell thickness is 0.8 mm. shell thickness is the combination of the nozzle size to define the number of perimeter lines and thickness of those perimeter lines. Bottom or top thickness is 0.8. The thickness controls the bottom and top layers. The amount of solid layers is calculated by layer thickness and its value. A multiple layer thickness has sense and its value is near to the wall thickness to get a stronger part. Fill density is about 50%. It controls the densely filled inside of your print. For a solid print 100% and empty print 0%. Generally 20% is enough. Printing speed depends on many factors. Printing temperature is 210°C and bed temperature is 60°C. Filament diameter is 1.75mm. it is accurate. It needs to calibrate for the measurement. Higher number resembles the less extrusion. Flow is 100%. It is the amount of material extruded and is multiplied by its value.



The pattern is checked in the layer forming and the number of layers form.

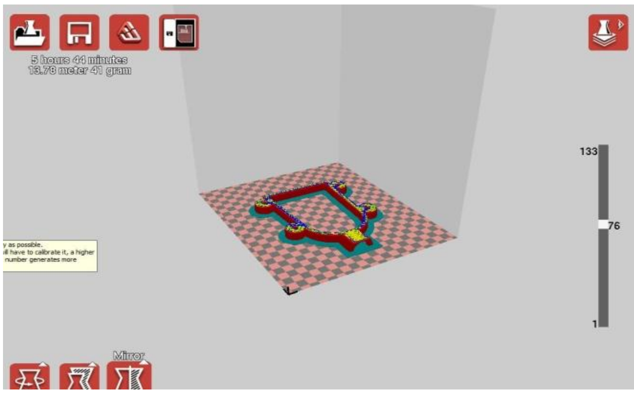


Fig 8: The part is checked in layer position

Then the pattern is send to the casting. The patterns two are placed on it and the sand is poured and the molten metal is poured into the cavity and the casting is completed. The patterns are kept in boxes called core, drag and cheek shown in the Fig 9. The sand is poured into the boxes. The pattern is kept on the sand. The image is formed by removing the pattern. The heat is given to the images shown in Fig 10. The molten metal is poured into the cavity of the pattern from Fig 11. The solidified pattern from Fig 12. The final products of patterns are shown in Fig 13.

Fig 9: The patterns in box.

Fig 10: Heating image of pattern

Fig 11:Molten metal pouring

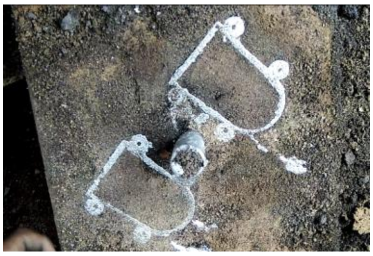


Fig 12:After pouring metal.

Fig 13: Final product

Create la mould powder is taken and is mixed with water the mix is poured into the dish the 3D printed pattern is placed on it. After solidification of the mix the Plaster Of Paris is poured in the gap. The molding powder is mixed with a ratio 1:2. For one cup of moulding powder is taken to the two cups of cold water. Then it takes two minutes for solidification. The Plaster Of Paris is taken and mixed with water from Fig 14.

Fig 14: Plaster Of Paris is with water

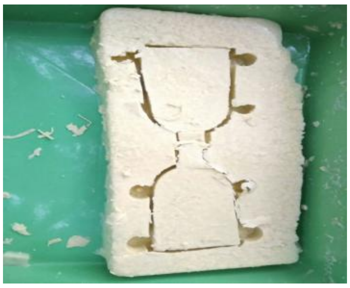


Fig 15: Image of pattern

Fig 16: The Plaster Of Paris is poured into the pattern.

Teeth set:

- Teeth jaw is made by using FDM technique in the machine JULIA.
- JULIA is the name of the 3D printer which has been used for printing.
- By this technique any jaw can be prepared.
- An experiment had made..
- The teeth jaw is prepared by using PLA filament.
- It is prepared by using FDM technique and PLA filament.
- Generally the teeth jaw is prepared by using SLS technique.
- As the machine is having FDM technique the jaw is done by this.
- SLS means selective laser sintering.
- This is the technique which to used for dental industry.


Fig 17: 3D printed teeth set of lower jaw

RESULTS AND DISCUSSION

The production lead time decrease with 3D printing and the dependency of third party is reduced. The lack of agility and the cost of pattern is reduced. Unsymmetrical and complex shapes of gold pattern can be produced by 3D printing. For a wooden pattern making time takes about one day that is 24 hours whereas for a 3D printing pattern it takes about 3 hours. Lot of time decreases and helps in printing more number of products.

CONCLUSION

Sharp edged and cornered patterns can be done easily. Small scale production like foundry increases in making the patterns. Mismatching of the patterns cannot be happened. Any type of the pattern of any size or material can be done by designing the pattern and printing. Launching of new products into market becomes easy as the time decreases. Innovation increases. With the decrease of time more number of patterns is made. Travelling near to the foundries and finding the labour for working decreases.

Whenever a small change happens in existing design then the product like gold ornaments making 3D printed pattern is quiet easy.

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