3D PRINTING ADDITIVE MANUFACTURING

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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. In an additive process an object is created by laying down successive layers 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.To prepare a digital file for printing, the 3D modeling software "slices" the final model into hundreds or thousands of horizontal layers. When the sliced file is uploaded in a 3D printer, the object can be created layer by layer. The 3D printer reads every slice (or 2D image) and creates the object, blending each layer with hardly any visible sign of the layers, with as a result the three dimensional object.

Recently, study of 3D freeform fabrication method was working in the various applications. SFF (solid freeform fabrication) technologies are being developed for diverse processes. 3DP (three-dimensional printing), one of these SFF technologies, confers the advantage of high-speed processing at low cost, since it makes use of multi-nozzle inkjet printing. In this paper, we introduce a method of 3D freeform fabrication using a curing of photo-polymer resin and construct a system has multi printing head. A photo-polymer curing method has simply fabrication process and high strength of manufacturing part. We construct the printing system using multi piezo print head and it needs the heating system for lower the high viscosity of photo-polymer resin. In the result of experiment, printing system has not need the heating system because low viscosity photo-polymer resin is possible to jetting in the normal temperature. In the conclusion, we fabricate the 3D freeform part, which is suitable to the office environment using a photo-polymer curing method.

Key words: 3DP (Three Dimensional Printing), Photo-polymer resin, SFF (Solid Freeform Fabrication), UV curing

1.INTRODUCTION

Additive Manufacturing (AM) refers to a process by which digital 3D design data is used to build up a component in layers by depositing material (from the International Committee F42 for Additive Manufacturing Technologies, ASTM) . The term "3D printing" is increasingly used as a synonym for AM. However, the latter is more accurate in that it describes a professional production technique which is clearly distinguished from conventional methods of material removal. Instead of milling a work piece from solid block, for example, AM builds up components layer by layer using materials which are available in fine powder form . A range of different metals, plastics and composite materials may be used. It is also known as rapid prototyping, is a mechanized method whereby 3D objects are quickly made on a reasonably sized machine connected to a computer containing blueprints for the object. The 3D printing concept of custom manufacturing is exciting to nearly everyone. This revolutionary method for creating 3D models with the use of inkjet technology saves time and cost by eliminating the need to design; print and glue together separate model parts. Now, you can create a complete model in a single process using 3D printing [16]. The basic principles include materials cartridges, flexibility of output, and translation of code into a visible pattern. The inception of 3D printing can be traced back to 1976, when the inkjet printer was invented. In 1984, adaptations and advances on the inkjet concept morphed the technology from printing with ink to printing with materials. In the decades since, a variety of applications of 3D printing technology have been developed across several industries. The following is a brief history of the major milestones along the way. Originally developed at the Massachusetts Institute of Technology (MIT) in 1993, .3DP technology creates 3D physical prototypes by solidifying layers of deposited powder using a liquid binder.

## 2. Materials and Methods
2.1 How 3D printing Works
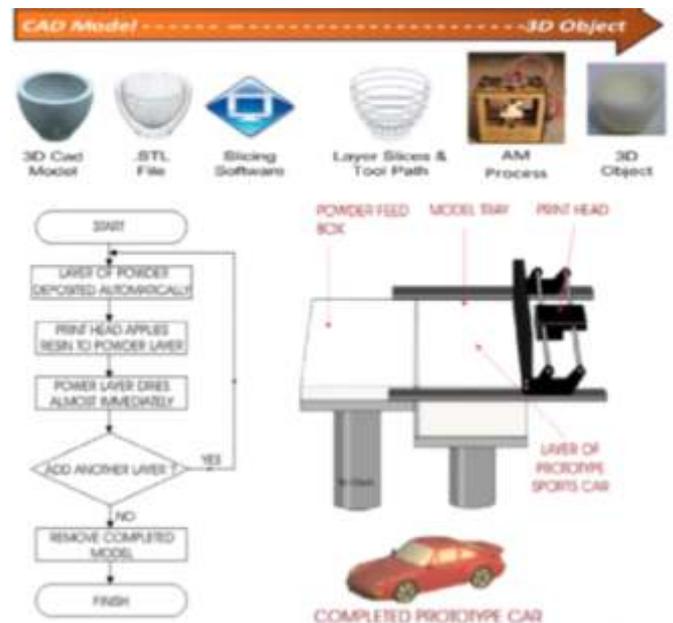
3D printers use standard inkjet printing technology to create parts layer-by-layer by depositing a liquid binder onto thin layers of powder. Instead of feeding paper under the print heads like a 2D printer, a 3D printer moves the print heads over a bed of powder upon which it prints the cross-sectional data sent from the ZPrint software. The system requires powder to be distributed accurately and evenly across the build platform. 3D Printers accomplish this task by using a feed piston and platform, which rises incrementally for each layer. A roller mechanism spreads powder fed from the feed piston onto the build platform; intentionally spreading approximately 30 percent of extra powder per layer to ensure a full layer of densely packed powder on the build platform. The excess powder falls down an overflow chute, into a container for reuse in the next build . Once the layer of powder is spread, the inkjet print heads print the cross-sectional area for the first, or bottom slice of the part onto the smooth layer of powder, bind-

ing the powder together. A piston then lowers the build platform 0.1016mm (0.004"), and a new layer of powder is spread on top. The print heads apply the data for the next cross section onto the new layer, which binds itself to the previous layer. Print repeats this process for all of the layers of the part. The 3D printing process creates an exact physical model of the geometry represented by 3D data. Process time depends on the height of the part or parts being built. Typically, 3D printers build at a vertical rate of 25mm – 50mm (1" – 2") per hour. When the 3D printing process completes, loose powder surrounds and supports the part in the build chamber. Users can remove the part from the build chamber after the materials have had time to set, and return unprinted, loose powder back to the feed platform for reuse. Users then use forced air to blow the excess powder off the printed part, a short process which takes less than 10 minutes. Z Corp. technology does not require the use of solid or attached supports during the printing process, and all unused material is reusable.

2.2 Block Diagram

The microcomputer is used to create a 3 Dimensional model of the component to be made using well-known CAD techniques. A slicing algorithm is used to identify selected successive slices, i.e., to provide data with respect to selected 2-D layers, of the 3-D model [4]. Once a particular 2–D slice has been selected, the slice is then reduced to a series of one dimensional scan lines. Each of the scan line may comprise of single line segments or two or shorter line segments. Each line segment having a defined starting point on a scan line and a defined line segment length. The microcomputer actuates the powder distribution operation when a particular 2-D slice of the 3-D model which has been created has been selected by supplying a powder "START" signal to a powder distribution controller circuit which is to actuate a powder distribution system to permit a layer of powder for the selected slice to be deposited as by a powder head device. The powder is deposited over the entire confined region within which the selected slice is located. Once the powder is distributed, the operation of powder distribution controller is stopped when the microcomputer issues a powder "STOP" signal signifying that powder distribution over such region has been completed. Microcomputer then select a scan line i.e., the first scan line of the selected 2-D slice and then select a line segment, e.g., the first 1-D line segment of the selected scan line and supplies data defining the starting point thereof and the length thereof to a binder jet nozzle control circuit. For simplicity in describing the operation it is assumed that a single binder jet nozzle is used and that such nozzle scans the line segment of a slice in a manner such that the overall 2-D slice is scanned in a conventional raster scan operation. When the real time position of the nozzle is at starting point of the selected line segment. Nozzle is turned on at the start of the line segment and turned off at the end of line segment in accordance with the defined starting point and length data supplied from the computer for that line segment. Each successive line segment is similarly scanned for the selected scan line and for each successive scan line of the selected slice in the same manner. For such purpose nozzle carrier system starts its motion with a scan "BEGIN" signal from microcomputer. So that it is moved in both x-axis direction and in the Y-axis direction. Data as to the real time position of the nozzle carrier is supplied to the nozzle control circuit. When the complete slice has been scanned, a scan "STOP" signal signifies an end of the slice scan condition.
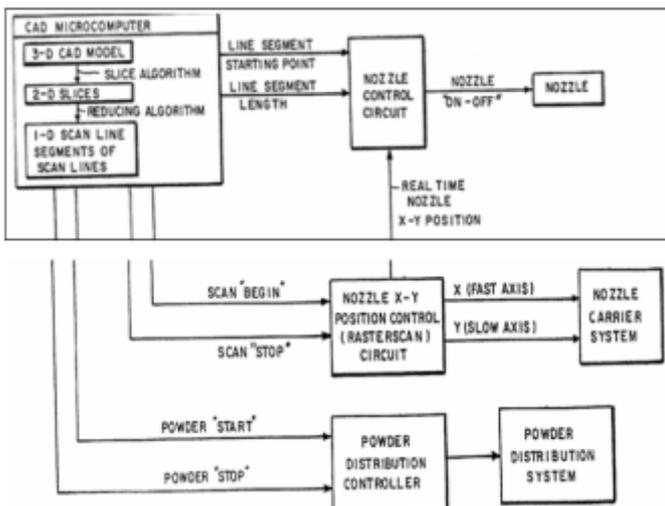
3. RESULTS And ANALYSIS

Before printing a 3D model from an STL file, it must first be examined for "manifold errors". This step being called the "fix up." Generally STLs that have been produced from a model obtained through 3D scanning often have many manifold errors in them that need to be rectified. Examples of these errors are surfaces that do not connect, or gaps in the models. Once that is done, the .STL file needs to be processed by a piece of software called a "slicer," which converts the model into a series of thin layers and produces a G-code file containing instructions tailored to a specific type of 3D printer (FDM printers). This G-code file can then be printed with 3D printing client software (which loads the G-code, and uses it to instruct the 3D printer during the 3D printing process). Printer resolution describes layer thickness and X-Y resolution in dots per inch (dpi) or micrometers (μm). Typical layer thickness is around 100 μm (250 DPI), although some machines can print layers as thin as 16 μm (1,600 DPI). X-Y resolution is comparable to that of laser printers. The particles (3D dots) are around 50 to 100 μm (510 to 250 DPI) in diameter. Construction of a model with contemporary methods can take anywhere from several hours to several days, depending on the method used and the size and complexity of the model. Additive systems can typically reduce this time to a few hours, although it varies widely depending on the type of machine used and the size and number of models being produced simultaneously. Traditional techniques like injection molding can be less expensive for manufacturing polymer products in high quantities, but additive manufacturing can be faster, more flexible and less expensive when producing relatively small quantities of parts. 3D printers give designers and concept development teams the ability to produce parts and concept models using a desktop size printer

Building Materials
➢ **Rigid opaque materials:**
• White (VeroWhitePlus)
• Black (Vero Black Plus)
• Blue (Vero Blue)
• Gray (Vero Gray)

➢ **Transparent material** (Vero Clear): a nearly colorless material (visual simulation of transparent thermoplastic such as PMMA)

➢ H**igh Temperature material** (RGD525): for advanced functional testing, hot air/water flow, static applications

➢ **Polypropylene-like material** (DurusWhite): for snap fit Applications

3.1 MODELING:

3D printable models may be created with a computer aided design (CAD) package, via a 3D scanner or by a plain digital camera and photogrammetry software. The manual modeling process of preparing geometric data for 3D computer graphics is similar to plastic arts such as sculpting. 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..

4. DISCUSSION

Though the printer-produced resolution is sufficient for many applications, printing a slightly oversized version of the desired object in standard resolution and then removing material with a higher-resolution subtractive process can achieve greater precision. Some printable polymers allow the surface finish to be smoothed and improved using chemical vapor processes. Some additive manufacturing techniques are capable of using multiple materials in the course of constructing parts. These techniques are able to print in multiple colors and color combinations simultaneously, and would not necessarily require painting. Some printing techniques require internal supports to be built for overhanging features during construction. These supports must be mechanically removed or dissolved upon completion of the print. All of the commercialized metal 3-D printers involve cutting the metal component off of the metal substrate after deposition. A new process for the GMAW 3-D printing allows for substrate surface modifications to remove.
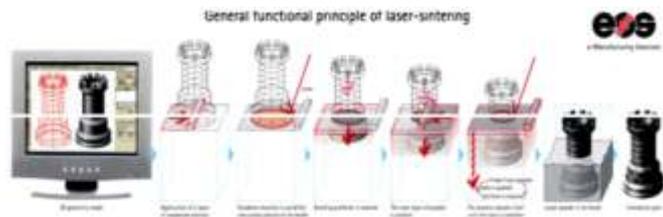
Fig.Selective Laser Sintering

Advantages of 3-D Printing in Comparison to Other Technologies

• Improved working capital management as goods are paid for before being manufactured

• According to one source, 3-D printing is cost effective with plastic injection molding on production runs of 50 to 5,000 units

• Ability to easily share designs and outsource manufacturing

• Speed and ease of designing and modifying products

Industries: Automotive, Manufacturing, Medical, Recreational Jewelry, Aerospace, Education, Dental, architecture, construction (AEC), industrial design, military, biotech (human tissue replacement), fashion, footwear, eyewear, geographic information systems, food, and many other fields.

5. CONCLUSION:

3D printing can offer benefits across the entire creation process from initial concept design to final manufacturing and all steps in between. Different applications have unique needs and understanding those application requirements is critical when choosing a 3D printer. Multiple systems may offer broader use opportunities than a single system. Thus, identifying your unique requirements

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