

# Miniaturizing Components by Reverse Engineering and Rapid Prototyping Techniques

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**ABSTRACT:** Miniaturization plays a vital role in today's modern world. Recent manufacturing trends are focused at manufacturing components in compact size. Nowadays, the size of the product are getting smaller and smaller to reduce its weight, compact in size, less power consumption, less space utilization etc. The paper aims at proposing an idea to create miniaturized components by reverse engineering and rapid prototyping techniques. Rapid prototyping is techniques used to quickly fabricate prototype or a model of a physical part using three dimensional (3D) computer aided design and reverse engineering process involves collecting the dimensions of an component from the model. In this work, the skeleton of the 3D model of the cooling fan casing is collected using Micro scribe – Reverse Engineering probe. Rhinoceros software was used to alter the dimensions in the created model. Finally, the model is imported into the UP – RPT software and the 3D model are sliced into many layers and the model is developed by fused deposition method in the RPT machine.

**KEYWORDS:** reverse engineering, rapid prototyping, Computer-Aided Design, 3D geometrical model.

## I. INTRODUCTION

Rapid prototyping and Reverse engineering can be utilized together to make manufacturing simple by reducing product development time and cost. 3D scanning is used to convert the real life components into CAD model by capturing up to 19,000 points per second [1]. Thus it is effective and highly accurate. Design changes in the CAD model can be done if necessary. Thus the component is redesigned by scaling it into a compact model.

Physical model that directly represents the component is much better than pure computer visualization. A real component helps in obtaining the necessary information for manufacturing information generation. Rapid prototyping is a means through which the product geometry is directly utilized to get the physical shape of the component [1].

The word "Rapid" in RP is a relative term. The rapid actually refers to the reduced time from initial design to the production of the final part. This is due to the elimination of extensive amounts of hand and machine work involved in making prototypes with traditional methods, as well as the ability to quickly iterate and test a design through various stages. Also, as contrasted with more complicated CAM programming and CNC machining, RP software and machines are generally simple and quick to use, resulting in significantly reduced "human time" needed to produce prototype parts. [5]

RPT is used in various applications like biomedical modeling, jewelry design, aerospace, automobile and general engineering field.

On the other hand, Reverse engineering is a method of evaluating physical properties of an object to determine its structure, size, shape or utility. Earlier methods of reverse engineering involved manual measurement of the part's dimensions and then utilize these details in CAD. However now with the invention of 3D scanning technique, we thousands of points can be measured in mere seconds. Thus, new products can be developed in short duration of time.

A 3D scanner is a device that analyses a real world object or environment to on its shape and possibly its appearance. The collected data can then be used to construct digital three dimensional models. There are a variety of technologies for digitally acquiring the shape of a 3D object. A well-established classification divides them into two types

- a. Contact 3D scanners and
- b. Non-contact 3D scanners.

There are a variety of technologies that fall under each of these categories [3].

In this work, we have planned to prepare a miniaturized cooling fan set up using reverse engineering and Rapid prototyping concepts.

## II. PROPOSED METHODOLOGY

Although several rapid prototyping techniques exist, all employ the same basic five-step process [4]. The steps are:

1. Create a CAD model of the design
2. Convert the CAD model to STL format
3. Slice the STL file into thin cross-sectional layers
4. Construct the model one layer atop another
5. Clean and finish the model

The basic methodology for all current rapid prototyping techniques can be summarized as follows:

A CAD model is constructed, and then converted to STL format. The resolution can be set to minimize stair stepping. The RP machine processes the STL file by creating sliced layers of the model. The first layer of the physical model is created. The model is then lowered by the thickness of the next layer, and the process is repeated until completion of the model.[5]

### 2.1 CAD Model Creation:

First, the object to be built is modeled using a Computer-Aided Design (CAD) software package. Solid modelers, such as Pro/ENGINEER, tend to represent 3-D objects more accurately than wire-frame modelers such as AutoCAD, and will therefore yield better results. The designer can use a pre-existing CAD file or may wish to create one expressly for prototyping purposes. This process is identical for all of the RP build techniques.

### 2.2 Conversion to STL Format:

The various CAD packages use a number of different algorithms to represent solid objects. To establish consistency, the STL (stereo-lithography, the first RP technique) format has been adopted as the standard of the rapid prototyping industry. The second step, therefore, is to convert the CAD file into STL format. STL files use planar elements, they cannot represent curved surfaces exactly.

Increasing the number of triangles improves the approximation, but at the cost of bigger files size. Large, complicated files require more time to preprocess and build, so the designer must balance accuracy with manageability to produce a useful STL file. Since the stl format is universal, this process is identical for all of the RP build techniques.

### 2.3 Slicing of the 3D model into many layers:

In the third step, a pre-processing program prepares the STL file to be built. Several programs are available, and most allow the user to adjust the size, location and orientation of the model. The pre-processing software slices the STL model into a number of layers from 0.01 mm to 0.7 mm thick, depending on the build technique. The program may also generate an auxiliary structure to support the model during the build. Supports are useful for delicate features such as overhangs, internal cavities, and thin-walled sections. Each PR machine manufacturer supplies their own proprietary preprocessing software [5].

### 2.4 Layer by Layer Construction:

The fourth step is the actual construction of the part. Using one of several techniques RP machines build one layer at a time from polymers, paper, or powdered metal. Most machines are fairly autonomous, needing little human intervention.

### 2.5 Clean and Finish:

The final step is post-processing. This involves removing the prototype from the machine and detaching any supports[1]. Some photosensitive materials need to be fully cured before use. Prototypes may also require minor cleaning and surface treatment. Sanding, sealing, and or painting the model will improve its appearance and durability.

## III. FINISHING PROCESSES

The finishing process involves the following steps if needed.

- Cutting,
- milling,
- Lathe,
- Sand blasting Coating
- Polishing Painting
- Boring, grinding etc.

## IV. EXPERIMENTAL SET UP

### 4.1 Micro Scribe G

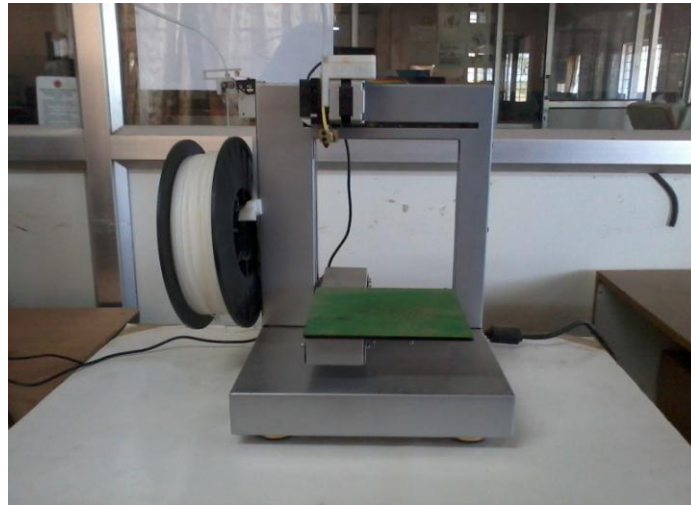
By using the probe in micro scribe G with 5 degrees of freedom, the boundary or the skeleton points of the object is collected.



FIG 4.1 Micro scribe G

Rhinoceros software was used to cover the skeleton of the drawing by skin of surfaces. Finally the drawing was converted to a solid model. By importing the created model into UP software (RPT software), the model was sliced to small layers and was added layer by layer.

The rpt machine used for 3D printing is shown below. The machine is in loaded stage of ABS wire material and nozzle arrangement in the column and the base plate is fixed in between the two columns.



**Fig. 4.2** FDM 3D Printing

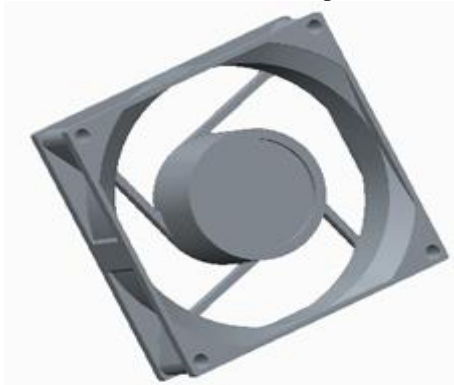
#### **4.2 Fused Deposition Modeling**

In this technique, filaments of heated thermoplastic are extruded from a tip that moves in the x-y plane. Like a baker decorating a cake, the controlled extrusion head deposits very thin beads of material onto the build platform to form the first layer. The platform is maintained at a lower temperature, so that the thermoplastic quickly hardens. After the platform lowers, the extrusion head deposits a second layer upon the first layer.

The build material is usually supplied in filament form with 0.8mm diameter, but the layer thickness and vertical dimensional accuracy is determined by the extrusion nozzle diameter and the rate of feeding of the building material, which ranges from 0.018 to 0.008 inches. in x-y plane, 0.001 inch resolution is achievable. Thermo static material is most often used which including Acrylonitrile Butadiene Styrene (ABS).

#### **4.3 PROCESS OF MAKING MINIATURIZED COMPONENTS**

Initially the probe is used for collecting data of the component and imports the component cad model in the Rhinoceros software to edit any preference change in parent component. Then it will be scaling down the diagram to our desired dimension. Then the collected data is send to the rpt machine 3D printer. After sending a command by manual, it will be starts working. Initially it takes a few minute for heating purpose at the same time ABS wire is feed by additional source in the rpt machine. After a few minutes our miniaturized component is made with the help of primary layer.



**FIG 4.3** Model of the cooling fan casing created using Microscribe and Rhinoceros software

#### **4.4 COMPARISON PHOTOCOPY OF MINIATURIZED AND PARENT COMPONENT MODEL**

The experiment shows the difference between the both components and shows its objective. Here our objective is miniaturize the components and it plays an model role in daily life with a compact one.



FIG 4.4.1 Prototype of miniaturized fan casing



FIG 4.4.2 Example for miniaturized product prototype

## V. CONCLUSION

The paper outlines an idea to miniaturizing the component size using rapid prototyping and reverse engineering to meet the needs for recent manufacturing trends to manufacture a component in compact size.

Thus our objective of miniaturizing the component size is effectively done. In future we are trying to implement this concept without any loss in efficiency when compared to the parent component by finding a perfect angle for a fan blade.

Progress is not possible without its challenges, but it is achievable. Remanufacturing companies have also build up new reverse engineering know how to find methodological innovations and they need to develop new technologies. This paper creates an innovation idea for create a miniaturized component in future.

## VI. FUTURE SCOPE

In this Journal, we prepare the miniaturized size of the casing of the cooling fan. Our future scope is to find the perfect angle for the miniaturized cooling fan blade to fulfill the usage of cooling. The efficiency will be improved by changing the angle of fan will be designed in future.

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