Design of Cream Separator Machine Using Reverse Engineering Techniques

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Abstract: ***In various industries where original design details of the product are not available, any modification or development in the product becomes a challenging task. In such cases reverse engineering can be used to develop functional 3D CAD models of the existing products. These models are feature based and give us the flexibility to duplicate or modify the existing product and find out the alternative design solutions for the product development problem. This paper describes the use of 3D scanning, metrology and instrumentation to extract the design information from an existing model of cream separator to design` a modified model. The project was done in Separators (India) that is located in New Delhi. To prepare the 3D models, assemblies and drawings we have used CATIA program. As a result of the project we have observed that development of new products by modification in existing products using reverse engineering saves considerable time and reduces the cost of product.***

Keywords: Reverse engineering, cream separator, catia

1. Introduction

Product development in recent times is a challenging task. The designs of the products have to be continuously improved. Better features, capacity improvement and improvement in quality have to be done constantly. This calls for frequent and faster changes in the products. Any industry that does not change itself according to the market needs cannot survive. And this change has to be rapid. If the time taken to modify the products is higher the industry will lag behind the competitors. Innovation and development of new products is very important but such a competitive environment we need techniques that are faster, accurate and easy. [2], [8], [12].

Development of a new product by the application of scientific and mathematical principles is called the Forward engineering. In this products are developed based on new concepts. The designer needs to look towards the design problem with a new perspective. But this process is time consuming and needs lot of resources in terms of money, material, skill and technology. When we need a faster solution to the design problems we need to search for the alternatives already available in the industry. It may be a competitor product or it may be an old variant of the product available in the industry. By slighter or larger modification in the existing products we can get a new product. This technology of moving in the reverse direction of forward engineering is called Reverse Engineering. In this the product is developed without the original design. This technology is very useful for developing a copy of the product, new variants of the products, new modules, scaled up or scaled down versions of the products and introduction of a new product in an industry [8] [9] [12].

The project is done at Separators (India) a company based at New Delhi. An existing lower capacity model of Cream Separator that the company is already manufacturing is used to develop the new model. But the problem faced by the company is that the basic drawings of the base models of separators are not available. This makes it difficult to develop new models. Also as the products have to manufacture physically even at the first trial this involves higher cost. So, we will use reverse engineering to solve this problem. Basic steps of reverse engineering involve identifying the requirement, disassembling the existing product into basic components, taking photographic images, dimensioning, preparing 3D CAD models and CAD Drawings, and finally prototype production. The dimensioning needs use of advanced tools and techniques. Reconstruction of part geometry needs 3D scanning to obtain the cloud point data which is the collection of x, y, z coordinates. The basic relevant parameters of the helical gear can be measured with the help of gear tooth vernier and gear micrometer. For the development of 3D CAD models and CAD Drawings CATIA V5 R16 has been used to develop the cad models, drawings and assemblies. The assemblies can be checked for the fitment problems. [1], [3], [6], [7].

2. Design Procedure

The design procedure of cream separators in reverse engineering consists of taking the measurements, creating CAD models, checking the assembly for fitment virtually, creating CAD Drawings of the components and assemblies and production of prototypes [10], [11].

The main parts of a cream separator consist of the body, gear gox, bowl body, bowl hood, skimming discs, distributor, top disc, cream spouts and supply can. For the measurements of the body that is a casting we can use the 3D scanning to get the point cloud data. A 3D scanner takes images of the component. The marker centers are created on the part. Images from several orientations are combined together to get an accurate point cloud of desired density and resolution. This can be exported to CATIA in IGES format. This data in the IGES format is used as the reference data to develop the exact parametric and editable feature based model of the casting. This body is the main housing for the gear box, and bowl body of the separator [3], [6], [7].

Figure 1: Body of the Cream Separator and the Catia model developed from it.

The cream separator blades rotate at a speed of more than 7000 r.p.m. So, we need a gear train consisting of a helical gears and worm gears. The helical gears of the machine are measured using gear tooth vernier and the gear micrometer. We obtain the number of teeths on each gear and the pitch circle diameter using the measuring instruments then using the standard formulae we can find the other parameters.[4],[5],[6].

Figure 2: Gear tooth vernier.

Figure 3: Gear Micrometer

Proportion of Helical Gears recommended by the American Gear Manufacturers Association is:

Pressure angle in the plane of rotation $\propto = 14^1/_2°$ to 25°
Helix angle, $\beta = 20° - 45°$
Addendum = 0.8 m (maximum)
Dedendum = 1.0 m
Minimum total depth = 1.8 m (maximum)
Minimum clearance = 0.2 m
Thickness of tooth = 1.5708 m

Here, 'm' is the Module is the ratio of pitch circle diameter in meters to the number of teeth. After taking the measurements and making the calculations we have prepared the cad models of the gears of the cream separator. For instance we can see one type of helical gear used in the machine in Figure 6.

Figure 4: Gear of the Cream Separator and the Catia model developed from it.

In the same manner the measurements of the worm gear are taken and the cad model is prepared. This worm gear is connected with the gear train on one end and the separator blade on the other end [4], [5], [6].

Figure 5: Worm Gear of the Cream Separator and the Catia model developed from it.

The other main assembly of the Cream separator is the Separator Bowl. This consists of the bowl base, bowl top, top disc or partition, skimming discs or plates and the O ring.

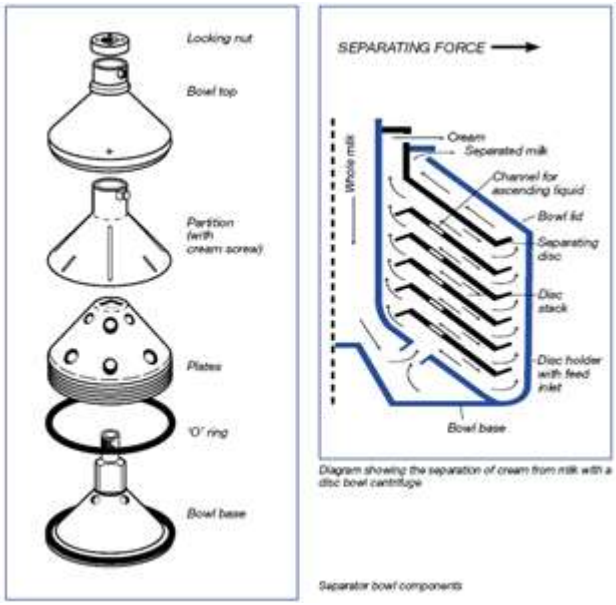

Figure 6: Separator Bowl Components

Figure 7: Bowl top, skimmer discs, top discs and bowl base.

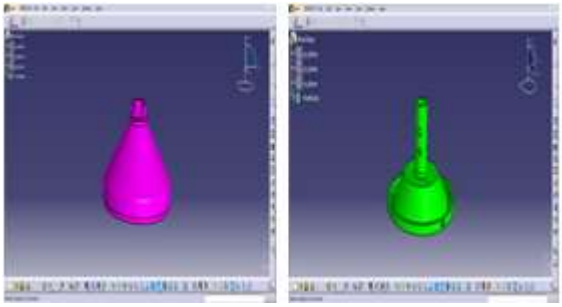

Figure 8: Catia model of the Bowl top and Bowl Base

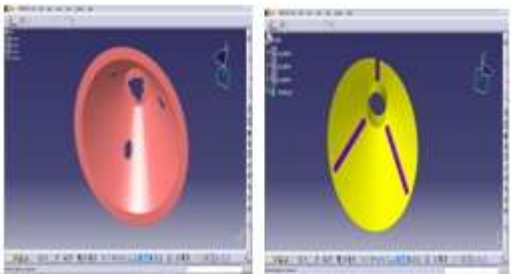

Figure 9: Catia model of the top plate and the skimmer disc

After the cad models are prepared the cad drawings of each component can easily be prepared. These drawings show the section views and details of each component and assembly. The assembly fitment and the clashes, interference and clearances can be checked easily.

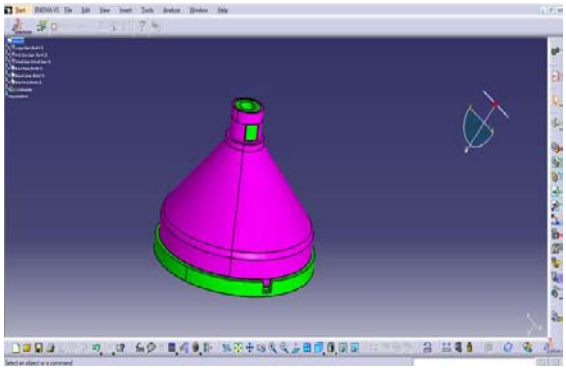

Figure 10: Body of the Cream Separator and the Catia model developed form it.

We have checked the assembly of the separator Bowl with the sizes obtained through the physical measurements and found that the measurements are correct and these can be used for the drawings that can be further used for the manufacturing [1],[3],[9],[13].

3. Conclusion

We have seen that with the help of reverse engineering we can create cad models from existing physical parts. This technique is very useful in the concept development phase of design cycle because starting research from the scratch is a costly affair when feasible design solutions are already available in the market. Other common problem is that it is difficult to visualize the design ideas in physical form and it is very costly to make different physical models for each design. The cad models are parameter based that means that the dimensions and other features of the models can be changed which makes it easy for the designer to assess multiple design alternatives in less and better accuracy. These models are then used to create drawings that get automatically updated if there is any change in the product. And same is reflected in the assembly model. This way Reverse engineering has been used for the company Separators (India) to develop the new modified capacity Cream Separator. Also, this design data once developed can be preserved and used for any purpose in the future.

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Author Profile

Vikash Kumar received the B.Tech in Mechanical Engineering from Maharishi Dayanand University, Rohtak, Haryana, India in 2009. He worked in industry for two years as a Production Engineer where he learnt about the CNC Machining and Manufacturing of Automobile parts. He is a student of M. Tech, Machine Design, at P.D.M. College of Engineering, Bahadurgarh, Haryana since 2011.