

USING REVERSE ENGINEERING IN OBTAINING SPARE PARTS FOR AN IMPELLER

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ABSTRACT: One of the most modern design techniques that reverse engineering refers to, allows to use information about a product in order to reproduce the original product (spare parts) or to get a new product with improved performance. Current methods of manufacturing are based on the 3D model of the product which must be realized. The aim of presented case is to obtain a 3D model of a pump impeller starting from worn impeller that will be replaced. Taking in account the complex shape of the impeller, the paper approached the main steps which were followed to obtain the 3D model using reverse engineering techniques.

KEYWORDS: impeller, reverse engineering, 3D model

1. INTRODUCTION

In general terms, Reverse engineering is the process where by an existing product for which there is no documentation or drawings can be reproduced [1].

Physical model reproduction of the existing product begins with its measurements and reproduction of its components [2].

Determination of dimensions can be achieved through traditional methods or using modern techniques and methods such as coordinate measuring machines or 3D scanners [3], [4].

The 3D scanners even are lower accurate than coordinate measuring machines, are sufficiently accurate for many fields of activity and provides the advantage of a lower price and much higher productivity [5].

Reverse engineering allows the use of digital data of an existing product to obtain a modified product with the best functional parameters. [7]

Reverse engineering is used in several areas of activity such as automotive, aerospace, jewelry, consumer goods etc [6].

In automotive industry car models made by designers in clay, plaster, wood or foam rubber, are scanned and transformed in virtual CAD model.

This model is used to design the component elements which are analyzed in terms of behavior in functioning, using finite element analysis, manufactured using CAM applications etc.

Using a platform to integrate all departments of a company such Teamcenter reduces time and cost of product development.

The use of reverse engineering [6]:

- Needs a replacement part, but its manufacturer is unknown or no longer exists
- There is the manufacturer, but it no longer makes product.
- There is no documentation for the part needed to be replaced.
- It needs to develop a CAD model of a complex shape part to be processed
- Is required to achieve at a specific scale, an existing object (ex. construction, reproduced artwork).
- In the medical field for the achievement of protheses.
- In archeology to restore an object based on some of its pieces.

The main steps which are involved by design process using reverse engineering techniques are shown in Figure 1.

In the following case study is presented the process of obtaining a virtual 3D model of the impeller from a worn physical product.

The 3D digital model will be used to create a physical model of the impeller as spare parts.

The processing may be performed in the first phase through rapid prototyping and after validation can proceed to process on CNC machine tools.

By scanning can be captured a large quantity of data in shorter interval.

Part to be scanned is shown in Figure 3.

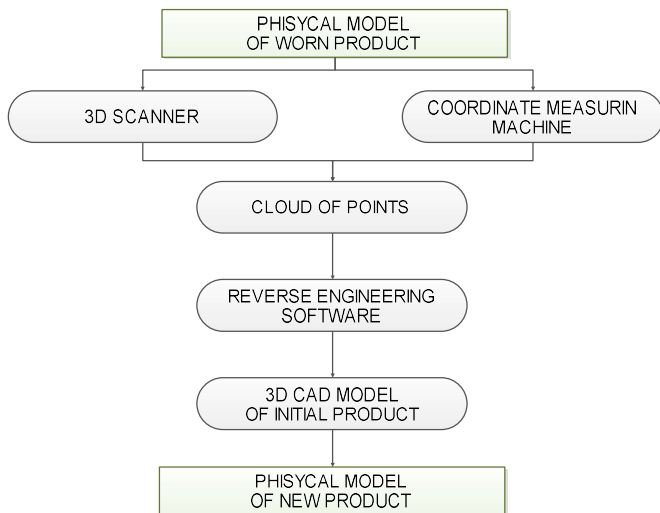


Figure 1. Schematic diagram of the reverse engineering process.



Figure 3. The worn impeller.

2. STUDY CASE

In Figure 2 is presented the scanning system that was used to acquire digital data. The system was acquired under the project „POSDRU/161/2.1/G/133930 "Support for a Successful Career in Reverse Engineering" [9]

In figure 4 is shown the data obtained by scanning. For the most accurate representation are made more scans.

After each scan is done the cleaning, that consists in the removal data points that do not belong to the scanned object, but belong to other objects in the visual area of the scanner.

The data obtained after scanning are aligned in order to obtain the cloud of points that will be processed through reverse engineering (Figure 5).

Eliminating the parasitic points, multiple scans from different angles and alignment data are designed to reduce errors and work performed during processing point cloud, so that reproduction will be as faithful. The obtained cloud of points is presented in Figure 6.

Obtaining the 3D CAD model from the points cloud of initial product is a complex activity which requires specialized software that is able to filter spatial points and generate surfaces which are approximately as closely as possible to the scanned object.

Most of usual CAD applications are not designed to manipulate the large amounts of points and do not include algorithms for generating surface or solid model from points cloud [6].

For representation are used non uniform rational B spline (NURBS) surfaces that can accurately reproduce any form, no matters how complex it might be.



Figure 2. The 3D scanning system

The scanning system consists of an optical scanner OPTIM II, rotary indexing table and reverse engineering Shiningform XOR software [8].

In the process of data acquisition the optical scanners use light, on which the shiny surfaces of scanned object may be affected.

These surfaces must have prepared before scanning by a fine matt coating so that light cannot be reflected.

This makes the NURBS surfaces to be a standard used for importing and exporting data among different CAD-CAM CAE.

The cloud of points is represented in ASCII format which contains information about coordinates x, y, z of each point or through a polygonal network of triangular surfaces (stl) containing the coordinates x, y, z of the three peaks and normal vector on this surface [6].

For the presented case study, the cloud of points in stl format is imported into reverse engineering software XOR Shiningform in which it is processed, in order to obtain the initial object geometry.

In the first step, the cloud of points is aligned with reference planes of the reverse engineering software, and then it is divided into regions which are joined to form a portion of the object as well defined (Figure 7)

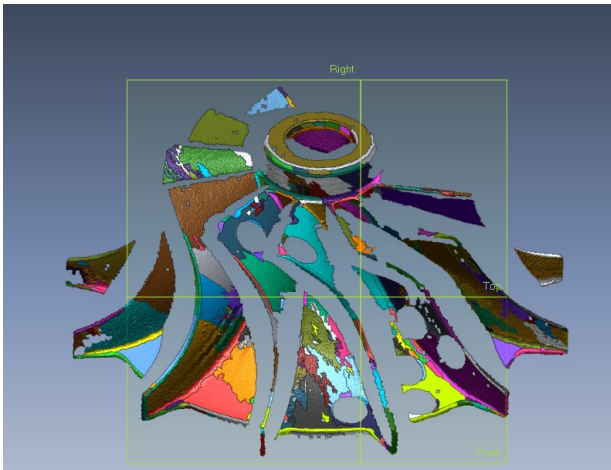


Figure 7. Regions of the scanned object.

This region is used to create drawings that define the various features of the initial object (figure 8).

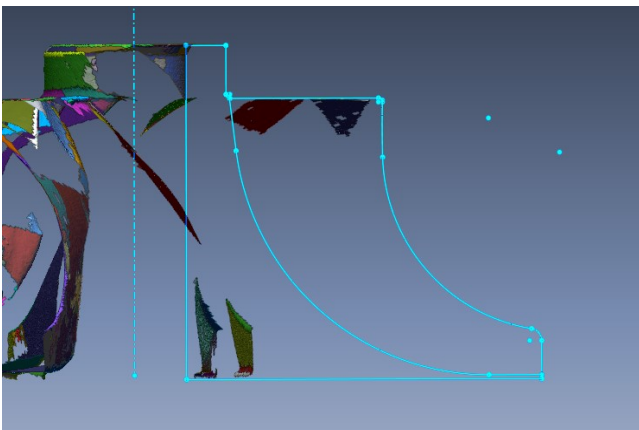


Figure 8. Sketches used to reconstruct the initial object.

The sketches are used in protrusion or revolve operations in order to rebuild the features of the initial object. Figure 9 shows the body of the impeller.

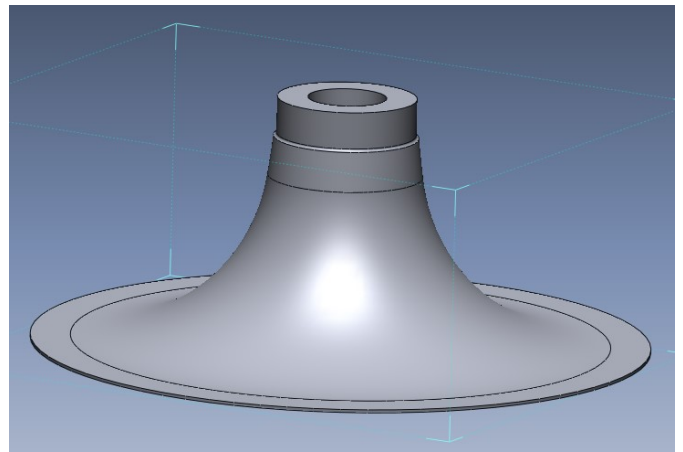


Figure 9. The body of the impeller.

Using imported cloud of points, cloud is created the surface of a vane (Figure 10).

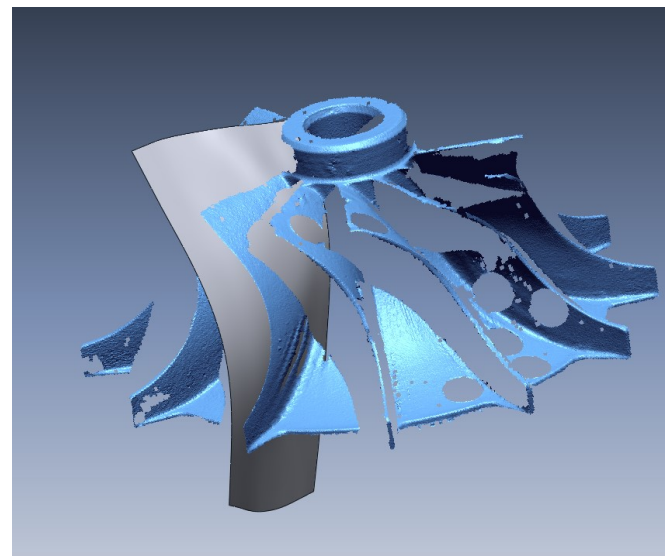


Figure 10. Surface of a vane.

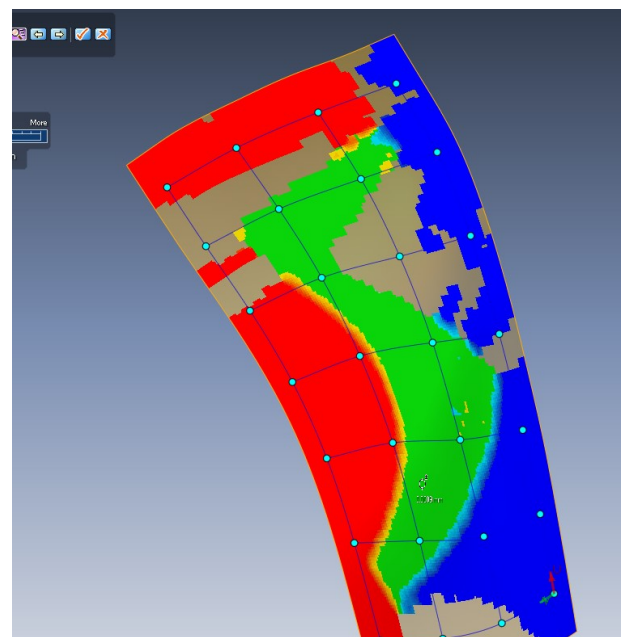


Figure 11. The surface deviation.

Shiningform XOR application allows determining deviations of vane surface and also deviation measurements in different points (figure 11).

The green area is situated in a field of tolerance of ± 0.05 mm and match with the scanned region of impeller vanes (figure 10).

The surface created in figure 11 is intersected with surface formed by the sketch of vane (figure 8) to give final feature of vane.

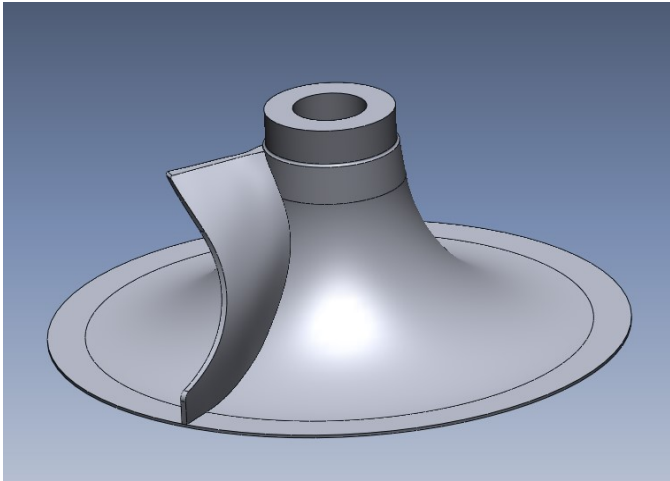


Figure 12. Impeller body and vane feature.

Using circular pattern command is obtained CAD model of the impeller (figure 13).

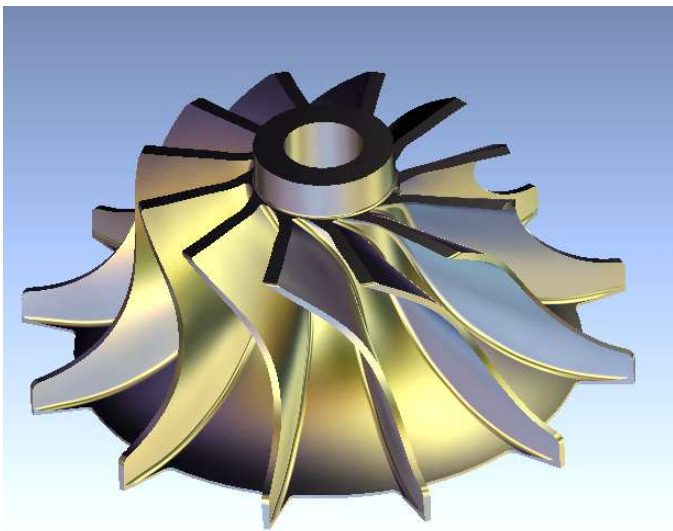


Figure 13. The 3D virtual model of the impeller.

3. CONCLUSIONS

Reverse engineering is a technology that is in a permanent development and can be applied in various fields.

In mechanical engineering, reverse engineering technology can be used to obtain a new product by using digital information about an existing product, or in the production of spare parts, when documentation or the manufacturer no longer exist.

The paper presents the main steps of obtaining a CAD model of complex parts (impeller).

The obtained CAD model is going to be physically realized in order to obtain spare part for the worn impeller.

Reverse engineering shortens the time and effort to design a product.

4. ACKNOWLEDGEMENTS

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