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OPTIMIZATION OF THE PRODUCTION PROCESS OF THE PLASTIC INJECTION MOLDING ENGINEERING WITH THE TECHNOLOGY OF REVERSE ENGINEERING APPLICATION

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Abstract: The publication focuses on the issue from the field of reverse engineering. The theoretical introduction contains basic information from the reverse engineering and describes the process of reversing as such. It consists of the procedure of component production, its calibration and setting the device used for reversing, scanning of the given object, scanned data connection, creation of 3D model of scanned data and evaluation of divergence of the modelled sizes in comparison with the real sizes of the component. The basic anticipated benefit from the implementation of reverse engineering application is obtaining 3D data from real components and their further using in creating the molds for plastic injection.

1 Introduction

Today, the reverse engineering in the field of engineering industry offers many ways of use. The main reason for this is the fact that reverse engineering functions as an intermediate step towards obtaining models and missing 3D data for further processing and use in production process where it can be optimized. Obtained 3D data can be used in the creation of construction and technological documentations; it speeds up the production process and actual finalization of the construction of molds for plastic injection.

The time needed for making the construction of the product is a significant indicator of a successful production company. From the given 3D model, shape particles are created to make the form and reach the accurate dimensions in tolerance of a pressed part which has a particular function. The companies offering construction molds for plastic injection also offer service and reparation of the molds. If a customer requires a repair of some shape particle consisting of different 3D shapes which are hard to measure just with the optical gauge without using the 3D coordinate measuring devices, the reverse engineering is applied to obtain a particular shape used for subsequent scanning and getting the 3D model.

2 Characteristics of reverse engineering

The reverse engineering (RE) has its origins in the analysis of hardware for commercial or military purposes. The aim is to deduce the procedure of the original production from the final design of the product based on a small amount of information or no information at all. The same techniques are examined and used in software to replace inaccurate, incomplete or otherwise unavailable documents.

It is necessary to obtain NURBS (Non-uniform rational basis spline) surface from the given model that can be further processed in CAD/CAM/CAE software. Physical object is measured by 3D scanning technology like CMM, laser scanners, digitizers or industrial CT scanning devices. The obtained data is represented usually as clouds of points, triangular nets, NURBS surfaces or CAD model.

3 Characteristics of reverse engineering

Many factors affect the quality of scanned objects. They are:

- Scanner and scanning technology used in RE
- Projector, its settings and calibration
- Camera, its settings and calibration
- Surface of the scanned object
- Size of the scanned object

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Figure 1 The projector and camera calibration with laser scanner DAVID

During the calibration, it is important to pay attention to the appropriately chosen calibration area according to the size of the component and the distance and scanning angle of the scanned object, to get the best scanned data possible (Figure 1). These are later connected and create required output in the OBJ format. Angle between the camera and the projector should be between 15° and 25° (max. 10° - 35°) (Figure 2). The smallest calibration area is used for scanning the component details to obtain a detailed scan.

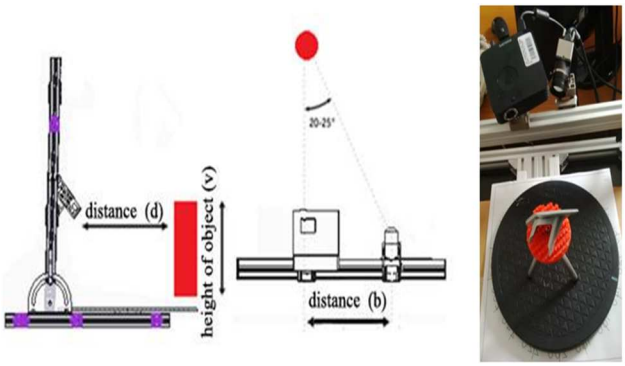

Figure 2 Process of scanning model [4]

Orientation settings of the scanned object are shown in the following table (Table 1).

Table 1 Orientation settings of the scanned object

Height of object (v)	Calibration area	Distance between lenses of camera and projector (b)	Distance between object and scanner (d)	Possible achievable accuracy (approximately 0.1% of object size)
<30 mm	30 mm	cca. 60 mm	cca. 90 mm	< 0.05 mm
50 mm	60 mm	cca. 60 mm	cca.120 mm	cca. 0.05 mm
70 mm	60 mm	cca. 65 mm	cca. 180 mm	cca. 0.08 mm
90 mm	120 mm	cca. 80 mm	cca. 220 mm	cca. 0.01 mm
120 mm	120 mm	cca.110 mm	cca. 300 mm	cca. 0.013 mm
150 mm	120 mm	cca. 125 mm	cca. 350 mm	cca. 0.15 mm
200 mm	240 mm	cca. 160 mm	cca. 450 mm	cca. 0.2 mm
300 mm	240 mm	cca. 250 mm	cca. 700 mm	cca. 0.3 mm
500 mm	240 mm	cca. 400 mm	cca. 1200 mm	cca. 0.5 mm
Normal values	**About the objects**	**Angle between them 15°-25°**	**Object should fill the camera screen**	**about 0,1% of scanning object**

It is necessary to adjust the surface of the object while scanning by spraying a layer of light and matte colour, so that the scanned area is transferred to the software in the best way possible. The ray can reflect from dark and shiny surfaces and scan the object imprecisely. The individual scanned areas are one by one cleaned from redundantly scanned parts in the object surroundings that are used for its attachment and are afterwards connected either by automatic rotation functions and individual edges recognition or by manual turning of the models to required position and creating a tie by using the texture of details alignment and they create the whole object represented by NURBS surface (see Figure 3 and Figure 4).

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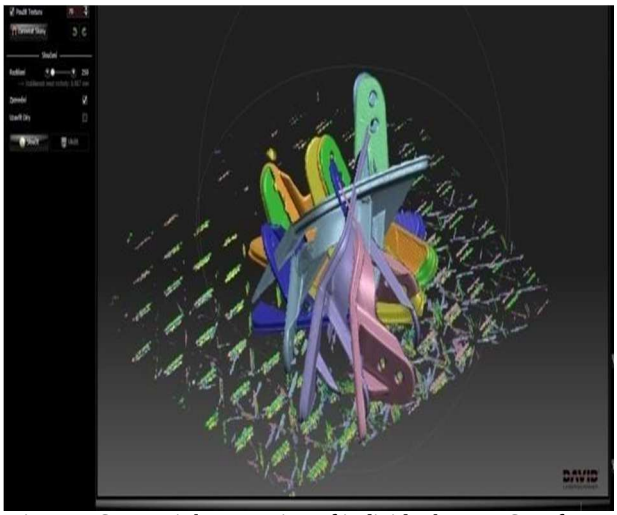

Figure 3 Sequential connection of individual NURBS surfaces

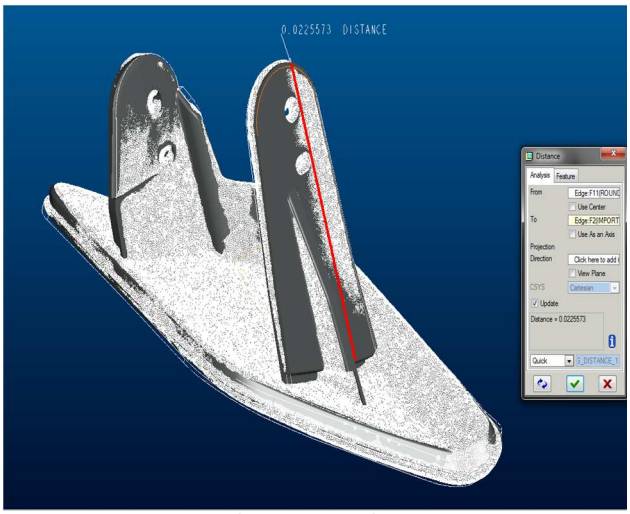

Figure 5 Comparison of divergences from scanned and created 3D model

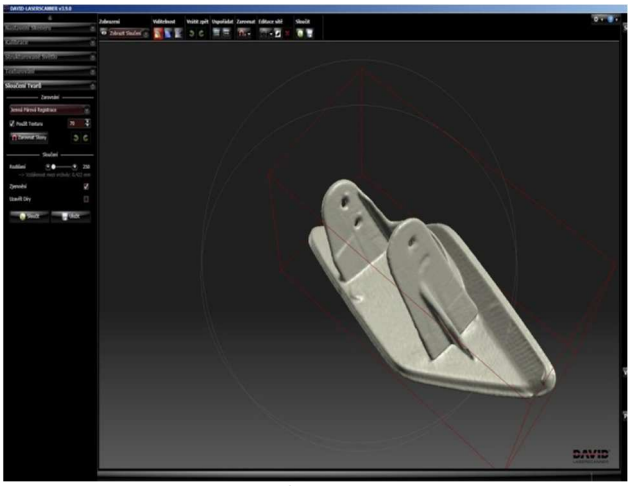

Figure 4 The final NURBS model

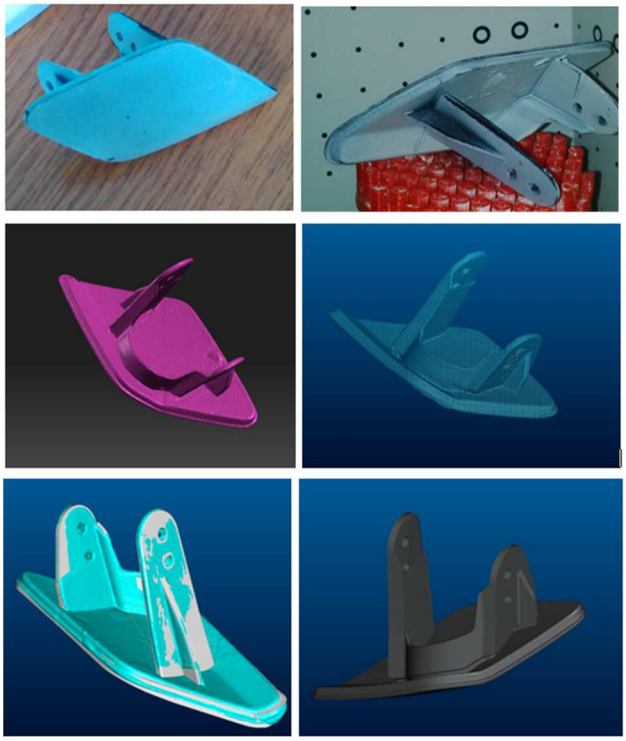

Figure 6 Progress of reverse engineering from real object to created 3D model

NUBS surface is then saved in .OBJ or .STL format and imported to CAD software where it is used as a base for constructing a specific 3D model. Construction is executed by the functions which the software offers through domains creation, cuts through surfaces, sketches of individual levels of the object and smoothing of the surfaces. A model created in this way can be used for further drawings or technological operations for CNC machining.

While creating a model via the technology of reverse engineering, 100% accuracy is never guaranteed and also in this case, at final comparison of the 3D model and the model from scanner, divergences of 0,1% of the components size occurred as guaranteed by the manufacturer (Figure 5, Figure 6).

Conclusion

Many manufactures want to use modern, innovative technologies and resources for development and rejuvenation of their manufacturing process from the initial idea to the final product given to the customer. One of the methods of speeding up the 3D model creation and drawing the manufacturing process for its improvement is the technology of reverse engineering

Considering the price/performance ratio, laser scanner DAVID, is one of the best options of how to to introduce the department of reverse engineering into the factory and use it to improve the manufacturing process for those components which lack the 3D documentation. With the right settings and calibration of camera and projector and quality scanned real model, obtained 3D data with the divergence of 0,1% of the components size are used as a foundation for further construction and technological processing.

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