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SOME PROBLEMS THAT ORIGINATE AT THE CREATING OF 3D MODEL WITH DIFFICULT SHAPES WITHOUT THE PARAMETERS AND DIMENSIONS OF REAL PART

NIEKTORÉ PROBLÉMY VZNIKAJÚCE PRI KREOVANÍ 3D MODELU SO ZLOŽITÝM TVAROM BEZ EXISTUJÚCICH PARAMETROV A ROZMEROV REÁLNEJ SÚČIASTKY

Abstract

The contribution deals with some problems, which originate at the creating of 3D model without drawing documentation details of modelled part. To obtain the dimensions of such undefined real part is often very difficult, especially, if the accuracy requirement is great. The solution of these problems can greatly affect the efficiency of the part manufacturing and so considerably decrease the economic cost for its manufacturing.

Abstrakt

Článok sa zaoberá niektorými problémami, ktoré vznikajú pri kreovaní 3D modelu bez existencie výkresovej dokumentácie modelovanej súčiastky. Získať rozmery takejto nedefinovanej reálnej súčiastky je často veľmi obtiažne, zvlášť ak sa jedná o súčiastku so zložitým tvarom povrchu. Riešenie týchto problémov môže značne ovplyvniť efektívnosť výroby takejto súčiastky a tak značne zvýšiť ekonomické náklady na jej výrobu.

1 INTRODUCTION

The data digitizing is one of main characteristic nowadays and it is projecting into all kinds of industry. The digitizing of drawing documentation has an essential task within machining industry. The big advantage of such processed data is the limpidity of data archiving in the computer, the minimalization of cargo hold for the documentation in paper version and the shortening of modification proceeding time, too.

The hand-made drawing in 2D format is already archaism today and it is continual passing to the creating of 3D model by means of CAD or complex CAD/CAM systems. Through the use of modelled 3D part is possible:

- to create the drawing of modelled part in relatively short time,
- to make the various type of analysis on the modelled part,
- to simulate the machining flow with the CL data output which define the positions of cutting tool and cutting conditions during of the machining process,
- to translate acquired data into NC program for the selected NC (CNC) machine by means of postprocessor.

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The creating of 3D model can anticipate the conflicting situations not only at the machining of individual parts but also at the assembling themselves into subassemblies or assemblies, it results in the reduction of preparatory time, the decreasing in cost and the quality improvement of the machining product. One modelled part so can be the basis for it's simply modification or for another parts, which are similar by type or shape.

The advantages of the computer 3D modelling already employ many companies and firms today, but such models are mostly created following already existing drawing documentation or exactly defined parameters. The problems occur when the part already exists, it is complicated in shape and it is created by general surfaces, but drawing documentation is not around. One of the method as to obtain the data describing the shape and the topology of the real part is the digitizing by means of scanners. The scanners are equipments, which enable the transformation of real 3-dimensional objects into digital version and they are the part that encloses the loop between real & virtual world. (Fig.1)

Fig.1 Closing the loop between real & virtual world

2 THE MODELLING

The example of problems, which originate at the modelling of part with difficult shapes, can be shown on the template for the coiling of stator winding (Fig.2), which existed in the firm as real steel part, but its shape and dimensions were unknown. It was needed to create 3D model of this part in CAD/CAM system ProEngineer according to sponsor requests to obtain the CL data for the NC program generating.

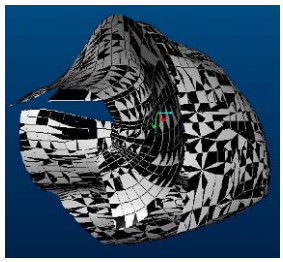
Fig. 2 The different views to real steel part

The simplest solving how to get the information about product design and dimensions could appear to cast model into the form, for example from the gypsum plaster. The material for casting should be possible to cut. The gained cross section areas could be measured and by means of these sections it could be modelled needed surfaces. The most suitable material for the casting could be for example silicon gum elastic paste with the rubber properties. The disadvantage of this material is its flexibility and therefore the limited accuracy of receives parameters.

One of the problem solutions was the using of touch sensitive unit with Rhinoceros MicroScribe G2 software. To make the exact point grid was very difficult due to complicated part shape, therefore the generated surfaces were not enough accurate and smooth. The Fig.3b shows three main

surfaces, which were created by means of Rhinoceros MicroScribe G2 (Fig. 3a) software and end consequently imported into CAD/CAM system ProEngineer.

a) The equipment MicroScribe G2



b) obtained surfaces

Fig. 3 The part surfaces scanned by device MicroScribe G2 in Rhinoceros modeller

The most effective and most accurate mode of the dimension and shape acquirement in the conditions of Faculty of Manufacturing Technologies of the Technical University in Košice, with the sit in Prešov, was the using of 3D laser scanner with the Dr.PICZA3 software, shown on Fig.4.

This integrated hardware/software system is an ideal 3D capture solution for all popular CAD/CAM and animation applications. It allows designers to capture complex data for hand-held consumer products, blister package design, hand-sculpted characters for feature animation, and face models for anaplastologists. It makes it incredibly fast and easy to generate precise 3D models, it will save designers hours of manual reverse engineering work. It uses an advanced non-contact laser sensor to quickly generate precise models. The combination of precision laser optics and motion control within a rigid enclosure lets the LPX-600 produce high quality scans with minimal surface noise.

Fig. 4 "3D laser scanner"

At the process of scanning it is necessary to solve several problems, such as for example:

1. The reflex and shiny face of real part causes that laser beam reflects back and the surface can not be scanned. In this case it is needed to tarnish the part for example by spraying, not however by black colour, because that laser beam absorbs.
2. The material, from which the physical model is made, should not be from transparent material (such as for example glass).
3. The combination of concave and convex surfaces on one part caused that laser beam is not able to recover the shape as one whole entity. The solution of this problem is repeated scan of the object in various positions and with various settings. Consequently are partial surfaces merged and the unnecessary parts deleted. The combination of planar and rotating scan modes provides the possibility to scan already objects with difficult shapes.

4. The size respectively the weight of scanned object in respect to technical parameters of scanner. This shortcoming it is possible to eliminate by the cutting of the object on minimum parts with the suitable dimensions. It is important to keep the alignment of the sections and so to preserve coincident position of individual parts of prototype in direction of vertical axis „z".

The top of steel real part had to be sprayed to achieve the dull finish, because the steel surfaces were too reflex for the laser beam. The gained data were saved into computer memory in PIX format (Fig.5) and consequently exported to format STEP or IGES. Transformed data were imported to CAD/CAM system ProEngineer (Fig.6).

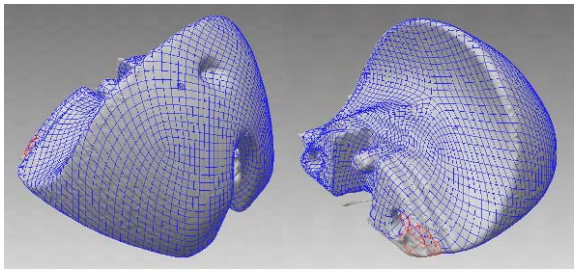


Fig. 5 The scanned model of the part in PIX format

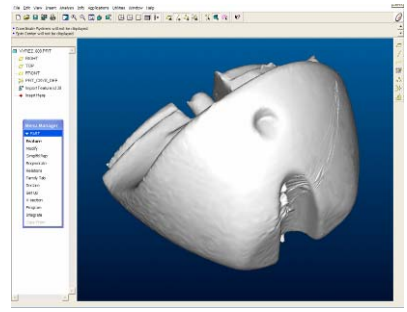


Fig. 5 The imported model of part to CAD/CAM system

This model was not accepted neither as solid nor as surface by ProEngineer and its processing was time consuming and difficult. In addition the model had number of undulations and it was not smooth.

The 3D model created in listed above software is shown on Fig.7.

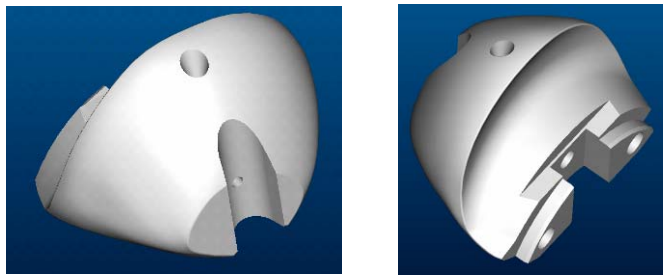


Fig. 7 The definite 3D model of the part modelled in CAD/CAM system ProEngineer

On the basis of created 3D model was made the new physical part by Rapid Prototyping method. The geometry and dimension data of model were exported from ProEngineer to STL format and they are used for the producing of silicone form. The cast plastic model (Fig. 8) was compared with the primary real part by means of 3D measuring equipment and it was examined in real condition as the component of machine. The results shows that the model is adequate to real steel part and so 3D model can be used for the generating of CL data to make new part on NC/CNC machine.

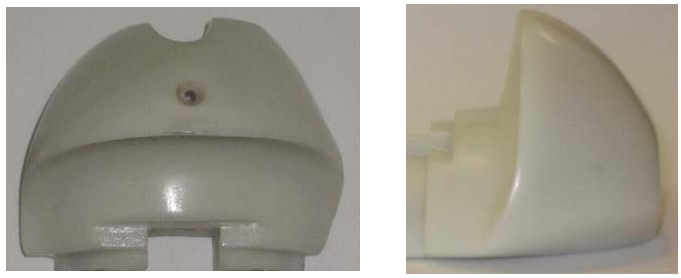


Fig. 8 The part model created by means of Rapid Prototyping

4 CONCLUSION

Manufacturers must often process the existing products by reverse manner to improve them. But reverse engineering can be complicated. Manual tasks involve technicians scanning in objects, perhaps in multiple part orientations, to get raw point-cloud or polygonal data. Technicians there scan existing parts with a 3D Alliance scanner and use the software to create accurate parametric CAD models. The company uses the models to fabricate replacement parts within strict tolerances and to improve designs to boost performance. Also, the firm ensures components get manufactured based on design intent by redesigning parts from scanned data.

The created plastic solid had needed tolerances and so it was able to make the steel part on the NC machine. Up to now the template for the coiling of stator winding was made by hand in the abroad and the average delivery time was longer then 3 month. The company uses several types of these templates and so it was reason for the making of the expensive inventories.

After the creating of 3D model and after the generating of NC program, the terms of delivery were shortened about 90 till 98 % (from 90 days on 2-5 days), the number of templates decrease about 50 % and the price of the parts made in Slovakia is backspread minimum about 60 % compared to original foreign supplier.

It means that suitable using of modern methods and technologies can greatly decrease

- delivery time of parts,
- investment quantity blocked in stores and
- costingness to its pandering.

REFERENCES

[1] ČUBOŇOVÁ, N. – SALAJ, J. – URÍČEK, J.: *Obrábanie v systéme Pro/Engineer,* Žilina, EDIS ŽU, 2000, ISBN 80-7100-620-3

[2] DALTON G.: Reverse engineering using laser metrology, Sensor Review, 18, no 2, pp 92-96, 1998

[3] MIŠÍK, L. - GOMBÁR, M. - HLOCH, S.: Matematicko-štatistický model drsnosti povrchu pri čelnom frézovaní. In: Technológia 2007 : 10. medzinárodná konferencia : Zborník abstraktov : 19.-20. september 2007, Bratislava. Bratislava : STU, 2007. s. 299-303. ISBN 978-80-227-2712-9.

[4] MEDVECKÝ, Š. a kol.: *Konštruovanie so systémom Pro/ENGINEER*, Žilina, ES ŽU, 1997, ISBN 80-7100-450-2

[5] W.B. LEE, C.F. CHENG, J.G. LI: Applications of virtual manufacturing in materials processing, Journal of Material Processing Technology, 113, pp 416-423, 2001

[6] WEYRICH M., DREWS P.: An interactive environment for virtual manufacturing: the virtual workbench, Computers in Industry, 38, pp 5-15, 1999

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