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THE DIE RECONSTRUCTION OF THE STERILE INFLATABLE NASAL TUBES FOR HAEMORRHAGE PREVENTION

Abstract: This paper presents the reconstruction process of medical devices designed for prevention of the haemorrhage in the nasal cavity. The DEMED company (the medical parts plant) turned to authors in order to start a scientific project concerning the problem of elements reconstruction in case of lack of technical documentation. The additional problem with original parts resulted from the original parts manufacturing technology – parts were handmade. The economic purpose from DEMED company angle was to increase the production volume thanks to accessibility of greater number of moulds designed and produced on the basis of reconstructed parts geometry. The proposed in the paper solution is based on hybrid model and selected cross-sections transfer into 2D CAD software in order to prepare technical documentation. In the reconstruction process the 3D scanning was used.

1. Introduction

In the figure 1a the final product it is a medical probe for prevention of the haemorrhage in the nasal cavity is presented. The main part of the probe is a latex blister manufactured with mould which is characterized by a specific shape. The forming process is done in a furnace heated to a specific temperature whilst the product is manufactured by keeping it into the furnace for strict amount of time in order to get the desired product shape. The original product was made from unknown aluminium alloy so that at the stage of technical documentation reconstruction it was necessary to reselect it. The main surface of the original model has some imperfections on it and also the shape regularity of the model is distorted in some areas (see: the figure 1b). After the initial examination it has been noticed that the original part model was created by casting technology and some kind of finishing treatment relying on grinding and polishing were applied. So as the product manufacturing technology the casting process was chosen. Cylindrical parts of probe are responsible for breathing tube guidance and also play role of the mounting element in the technological process of the latex blister forming.

In order to reconstruct the original model geometry the 3D scanning technique was applied. During the scanning process the element was coated with a special substance according to procedure described in patent submission p. 396529/2011. The coating made on the external surface of the model minimized the reflectivity of the scanned element[2]. The scanning process was realized with application of the structured light (SCAN3D DV scanner) and the model was scanned form different positions which guaranties that the all surfaces were digitized into particular points cloud.

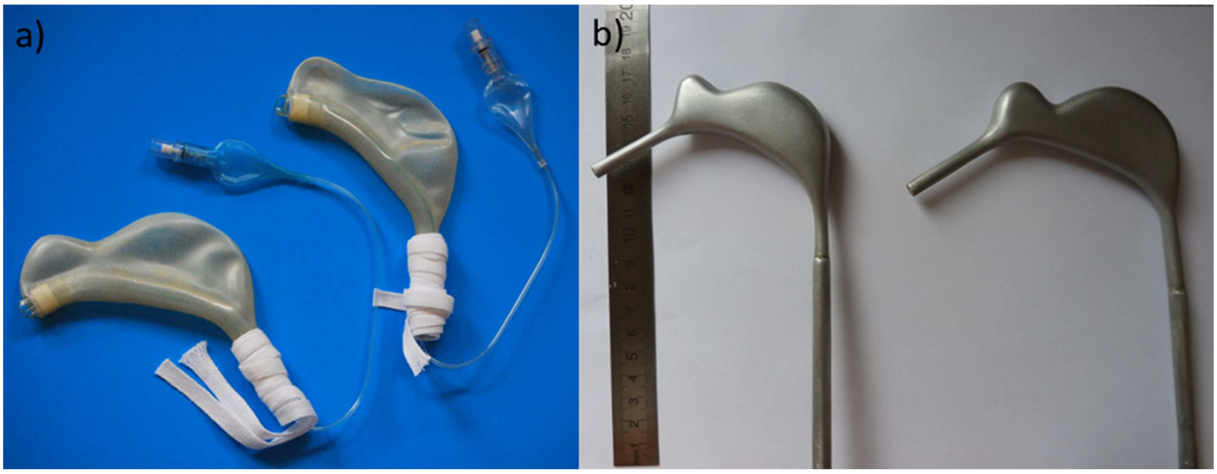

Fig.1. The final product of medical probe for the haemorrhage prevention in the nasal cavity (left) [1] and original models (right)

2. Processing form points cloud to hybrid triangular model

The master models were scanned with accuracy ±0,04mm and scanning volume 210x300x200mm. During the scanning process the 14 scans from different directions (see: tab. 1, exemplary data of the singular scan for the scan shown in the fig. 3) were made.

Tab. 1. Rough scan data: CID – cloud identification, PQ – points quantity

No.	CID	PQ	Side
1	1_000_B	557840	Back
2	1_001_BB	850092	Bottom Back
3	1_002_BF	914967	Bottom Front
4	1_003_BL	330129	Back Left
5	1_004_BR	449520	Back Right
6	1_005_BT	249029	Bottom
7	1_006_F	570769	Front
8	1_007_FL	455400	Front Left
9	1_008_FR	412073	Front Right
10	1_009_L	214897	Left
11	1_010_R	236620	Right
12	1_011_T	263383	Top
13	1_012_TB	669904	Top Back
14	1_013_TF	1107932	Top Front

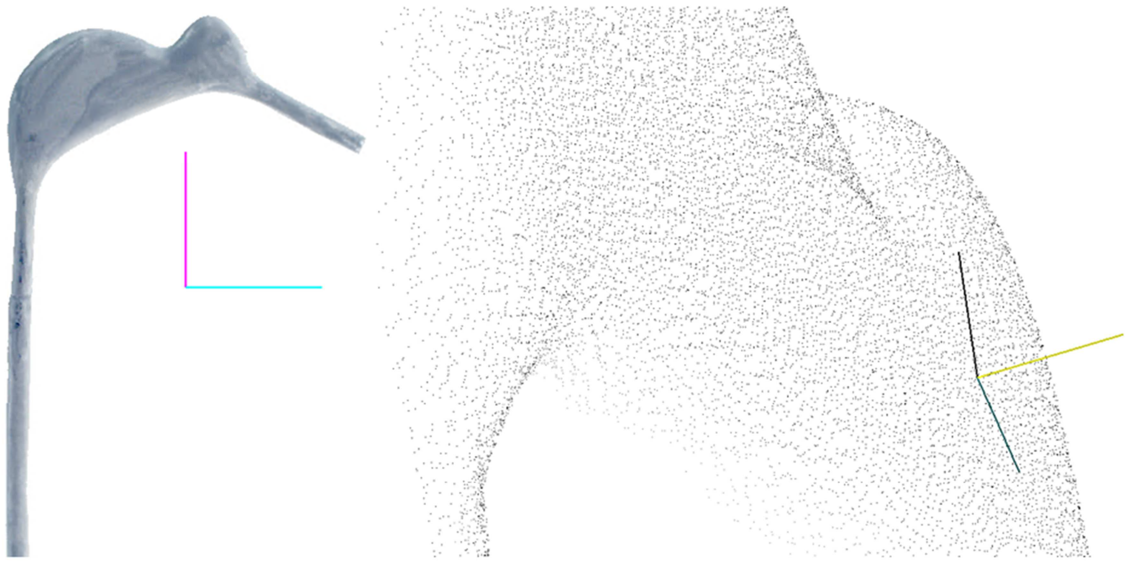

Fig. 2. Points cloud (front scan)

In order to assure the correct processing to the triangular model the global registration fitting of all clouds of points was executed. At the beginning the 1_000_B points cloud was set as fixed one (the main cloud) and the rest of the contiguous points clouds were one by one fitted to it. Finally all clouds of points are fitted together at one global registration process. The average distance between clouds of points is 0,039mm and standard deviation of fitting is 0,024mm (fig. 3).

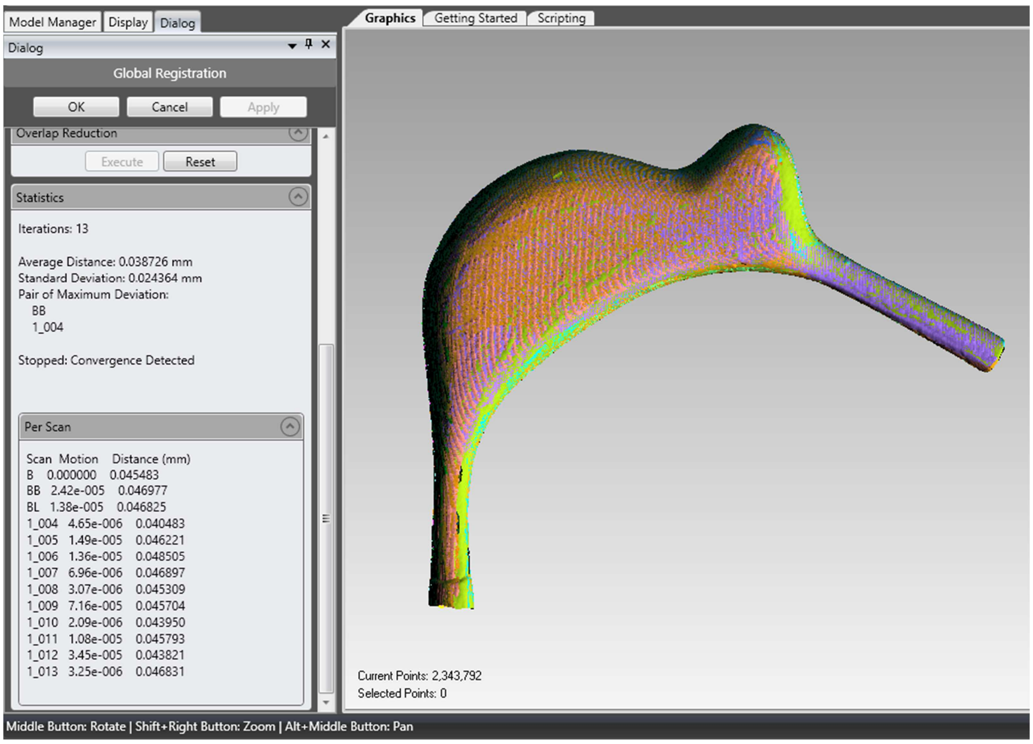

Fig. 3. Processing of the points cloud – global registration

The overlapping of points clouds was reduced with deleting of the superimposed areas in selected points clouds. Next the features such as cylinders and datum objects were added in order to reconstruct properly the model and set it in proper orientation according to the global coordinate system[3]. The plane 4 (see: the figure 4a and 4c) was placed in the middle of the model just between the two planes denoted in the figure 4 as 2 and 3. These planes 2 and 3 were placed on the opposite flat sides of the model. So the plane 4 is the model bisector plane. In the figure 4b the process of connection making between the reconstructed model an cylindrical part of the complete model is shown. The gap between model and the cylindrical part was filled by making the bridge between them next the newly created trespassing was smoothed by further processing.

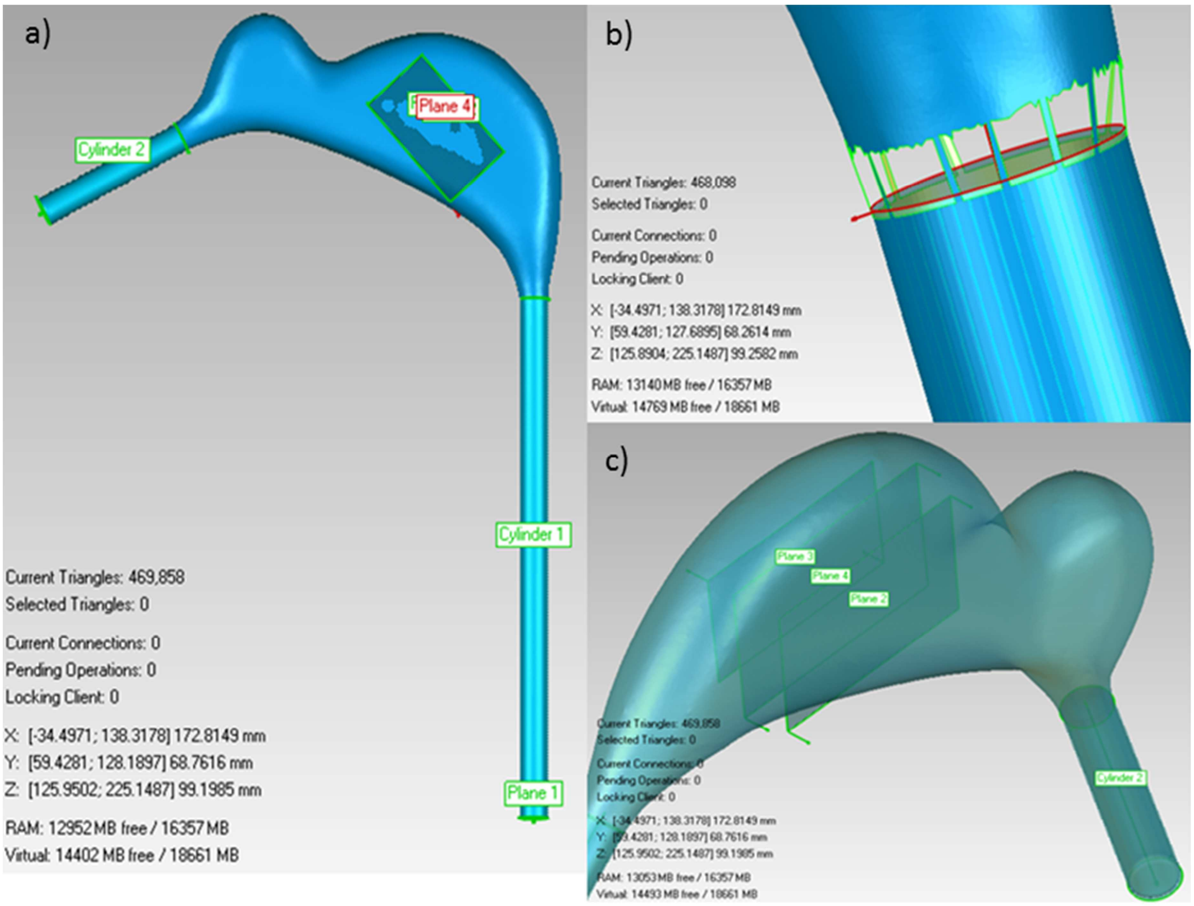

Fig. 4. Triangular model cylindrical parts reconstruction with features: a) hybrid model, b) bridges connectors, c) planes with bisector positioning

In the next stage the reconstructed model was sectioned with planes parallel to the plane 4 in order to get the model cross–sections. In each section the border curves were extracted. These curves were used in order to retrieve point sets. Next point sets were exported from Geomagic software to ZW-CAD software by means of *.dxf file and used for simplifying the model geometry with circles and lines in order to prepare technical drawings of elements (see: figure 5). Finally the triangular model could be used for casting process simulation and

3D printing[4] of the reconstructed model element used as master model in moulding box formation. After 3D printing process the model is being chemically smoothed[5].

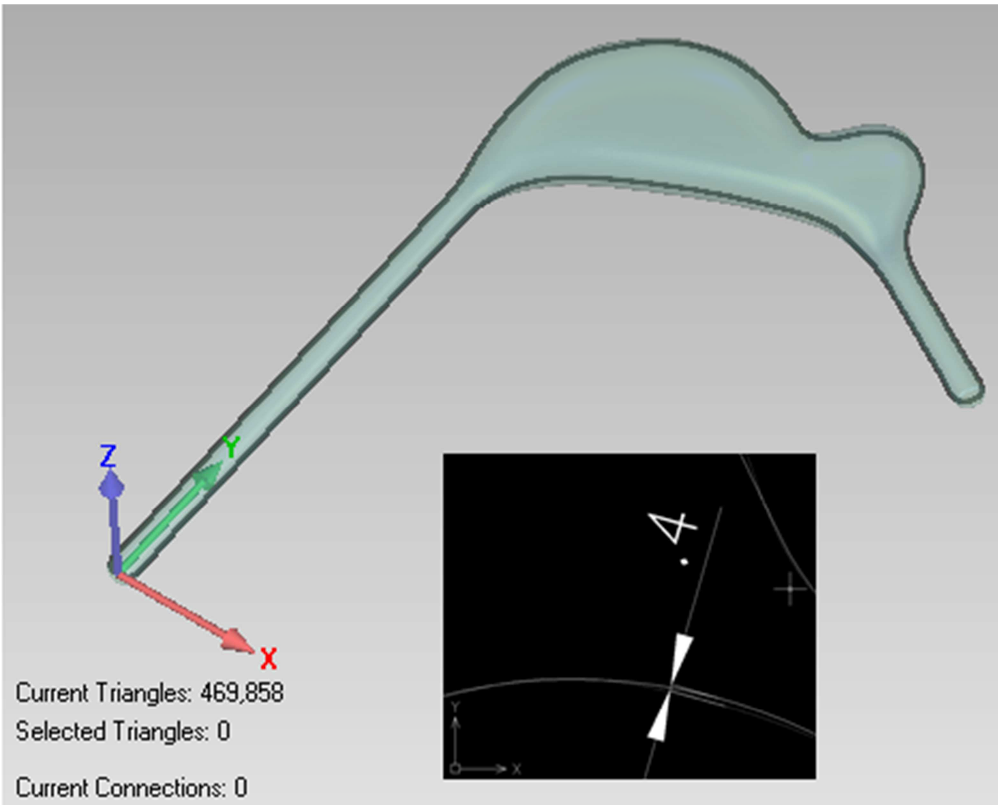

Fig. 5. Curve line retrieved form combination of triangular model and section plane.

3. Summary

In the paper the reconstruction process of the medical probe was shown. The reconstruction process needed the following things to be done: the reselection of the reconstructed element material, scanning pre-processing it is the model external surfaces coating, 3D scanning, points clouds processing and technical documentation preparation. Having these stages of the project done it was possible to prepare master models of the reconstructed elements for casting technology. These master models were made with 3D printing realized on the Stratasys FDM 360 MC machine. The elements were reconstructed as a part of scientific project for DEMED Company, which was arranged by Innovation and Technology Transfer Centre. The similar method could be used for preparation of design used for refurbishing process in comparison between worn out and pattern element based on prepared design. That is needed for preservation relations in assembly[6]. Especially in case when die has complex design[7] (see fig.1).

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