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REVERSE ENGINEERING AT THE UNIVERSITY OF MISKOLC

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Abstract: An industrial project will be presented in this paper about reverse engineering. We have to reproduce the blades of a mixing turbine without drawing. After 3D scanning and model creating we generated toolpath using CAM software to produce the component, and manufacture the workpiece.
Keywords*. 3D scanner, free form surface, reverse engineering*

1. The problem

After long hours of run in harsh environment components may suffer from different defects such as distortion, impact dents and wear. Components with freeform surfaces are nearly impossible to reproduce without the original documentation. If we can scan the part using a 3D scanner, we can get an 3D model which can be modified in order to get the desired and repaired shape of the problematic component.

In this case the problematic component was the blades of a mixing turbine which is used in acidic environment. The original blades was worn out, and have to be replaced, but there was no data about the shape of the blades except the complete turbine itself. After we obtain a surface model we can use it as an input for a CAM software to generate the toolpath for freeform surfaces [1], [3].



Figure 1. The damaged turbine blades

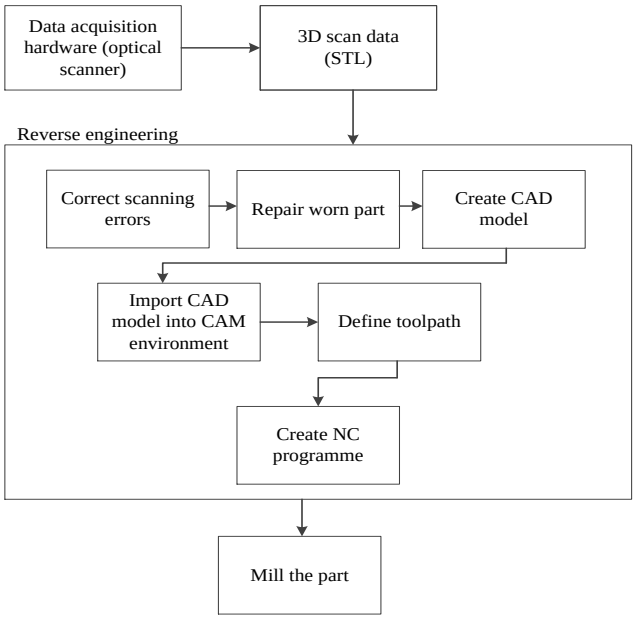


Figure 2. Flowchart of the revesre engineering process

2. Hardware and software

In the following sections we present the software and hardware that we used during the reverse engineering process.

2.1. 3D scanner and related software

The scanning device which is used for the procedure was a Breuckmann Smart Scan 3D-HE mobile optical scanner with Optocat 2009 data acquisition software, which provided us an STL file [2].



Figure 2. The optical scanner

The scanned surface can contain defects like spikes and holes. To correct these we used Geomagic Studio, where we can use different options to repair different defects to get a smooth surface [1].

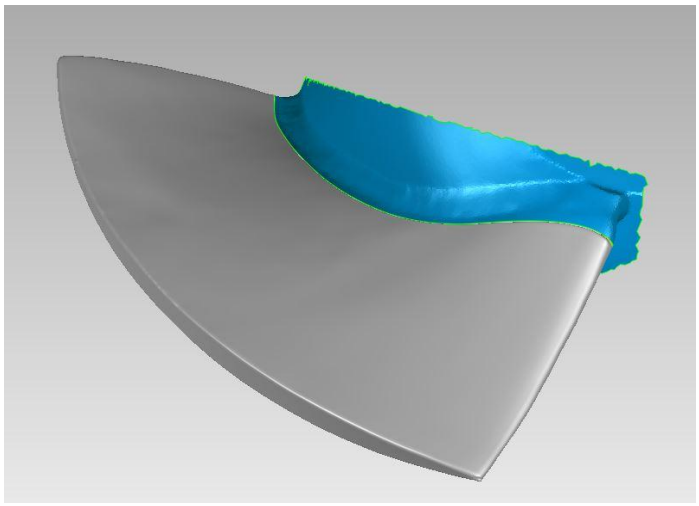


Figure 3. Trimming the welding in Geomagic Studio

After the model repair we cut off the welding joint from the surfaces and created a closed body by filling the hole. Eventually we created a CAD file in STEP format, containing NURBS surfaces, which is slightly modified in NX to align the inner and outer radius of the blade. Finally we had a CAD model which was adequate for the CAM software.

2.2. CAM software

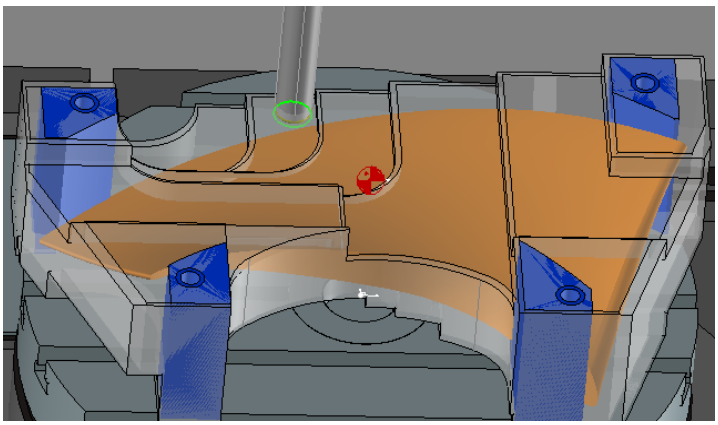


Figure 4. Position of the workpiece on the machine table in CAM software

We have used Topsolid 2012 which is an integrated CAD-CAM software suite. Additional supports had to be drawn for the fixture on the table of the milling machine. Because of the small workspace of our machine we had to divide the entire model into four segments. The machining processes in each segment consisted of a 2,5D roughing and semi-finishing followed by a 3D finishing process. After the milling process is defined, we created an NC file, using the post processor which is fitted to our milling machine [4].

The milling machine was a DMG DMU40 monoblock 5 axis milling machine with a workspace of 400x400x450 mm. The tools was a Walter F4041 shoulder milling cutter and Korloy FMRS 2000 toroidal milling cutter.

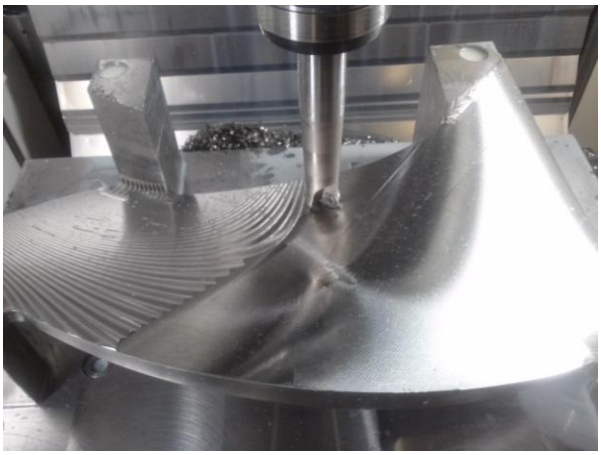


Figure 5. Machining of the blade

When the machining process was finished the mounting supports had to be machined off from the blade. These supports were removed manually. At the the end four blades were welded on the turbine hub.



Figure 6. The finished turbine

3. Comparison of the model and the machined part

After the first part was machined, made of plastic (PA6), it was scanned again and compared with the CAD model. This comparison was made with the Geomagic Studio Software. The scanned model was corrected from scanning errors then aligned with the original model. The standard deviation from the CAD model was around 0,233 mm [2].

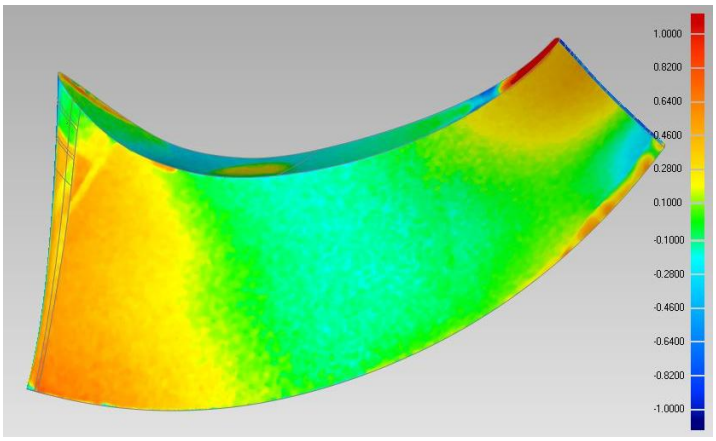


Figure 7. Comparison of first side

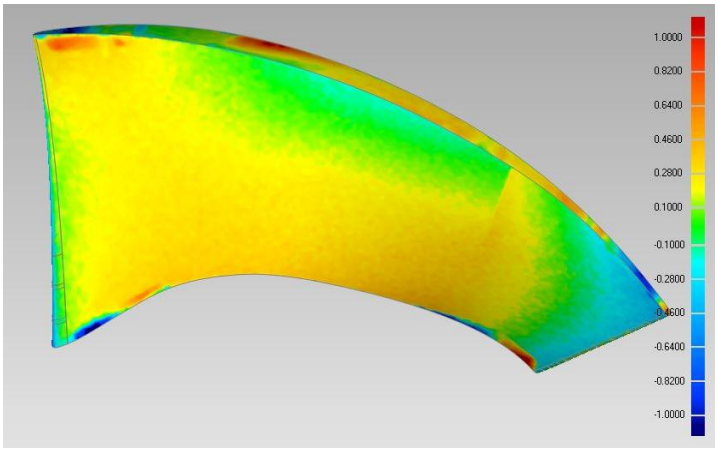


Figure 8. Comparison of second side

4. Summary

During completing the project it revealed that the available tools and hardware together with the needful software are suitable for reverse engineering application and able to produce the required quality.

5. Acknowledgement

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