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The 3D reconstruction and dimensional control of the reference part

3D Rekonstrukcija i dimenziona kontrola referentnog dela

Abstract:
The paper studies the 3D reconstruction and dimensional control of a mechanical reference part scanned using the Noomeo Optinum 3D scanner, reconstructed as geometry with the help of Rapidform XOR3, now Geomagic Design X and compared with SolidWorks geometry using the GOM Inspect software.
Keywords: *Scanner, dimensional control, 3D geometry, reverse engineering*

Rezime:
Rad analizira 3D rekonstrukciju i dimenzionu kontrolu referentnog mašinskog dela digitalizovanog primenom Noomeo Optinum 3D skenera, rekonstruisanog u softveru Rapidform XOR3 (novi naziv Geomagic Design X) i upoređenog sa SolidWorks geometrijom u softveru GOM Inspect.
Ključne reči: *skener, dimenziona kontrola, 3D geometrija, reverzno inženjerstvo*

Introduction

In December 2010, the Center for Numerical Simulation and Prototyping (C.S.N.P.) came into existence at the "Eftimie Murgu" University of Resita, financed by European Union, through the "Romania - Republic of Serbia IPA Cross-border Cooperation Programme", with a total budget of 199.486 €. The project's partners were "Eftimie Murgu" University of Resita - Romania and Technical College of Applied Sciences in Zrenjanin– Serbia [1]. The paper's subject is based on the 3D reconstruction and dimensional control of a mechanical reference part scanned using the Noomeo Optinum 3D scanner [2], reconstructed as geometry with the help of Rapidform XOR3, now Geomagic Design X [3] and compared with SolidWorks geometry [4] using the free GOM Inspect software [5].

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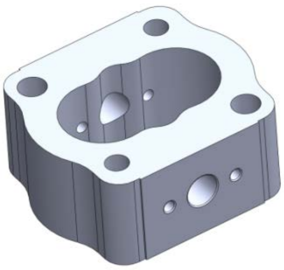
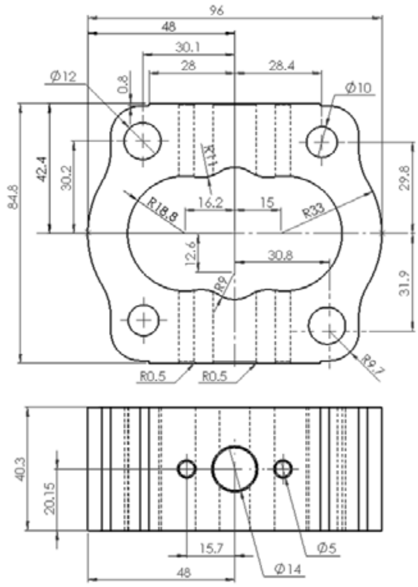
1. The geometry of the reference part

The geometry of the reference part, presented in pictures 1 ÷ 3, was generated in SolidWorks and saved in **IGES** format.

Picture 1. *The reference part*



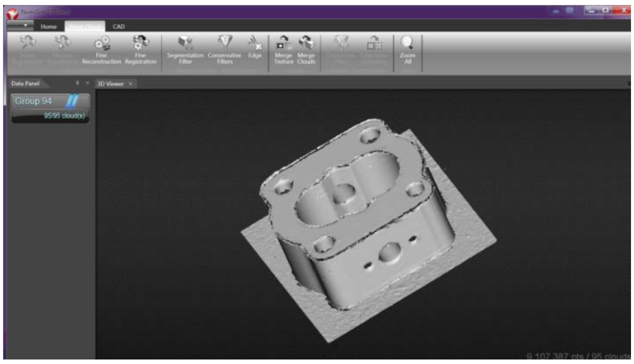
Picture 2. *The SolidWorks geometry of the reference part*



Picture 3. *The dimensions of the reference part*

2. The reconstruction of the reference part

The reference part from picture 1 was scanned using the Noomeo Optinum scanner, the result being 9.107.387 points and 95 point clouds respectively, picture 4.



Picture 4. *The reference part scanned using the Noomeo scanner*

The following steps are required to reconstruct the geometry of the scanned part in the Geomagic Design X application:

- importing the point clouds;
- removing the "noise", meaning the resulting points that have been incorrectly obtained through the scanning process, by activating the command **Point Cloud**, followed by a selection and deletion;
- creating the mesh, through the command **Scan Tools→Mesh Buildup Wizard**, picture 5;
- creating the regions, through the command **Insert→Region Group→ Auto Segment**, picture 6;
- mesh and regions alignment to the global coordinates system, through the command **Tools→Align→Interactive Alignment**, picture 7; the alignment was achieved through options **2-3-1 & Origin** and the selection of the two planes from picture 7;
- creating the entity *Plane1*, through the command **Insert→ Ref. Geometry→Plane**, picture 8; the plane was created through the**Extract / Best Fit** method; the *Plane1* plane becomes identical with the **Front** plane of the global coordinates system;
- creating the entity *Vector1*, through the command **Insert→Ref. Geometry→Ref. Vector Property**, picture 9; the option **Intersect 2 Planes** was usedto create a vector from the intersection of the**Front** and **Right**planes;
- creating the entity *Point1*, through the command **Insert→Ref. Geometry→Point**, picture 10; the option **Extract**was used to create a point in the selected plan, picture 10;
- creating the entity *Plane2*, through the command **Insert→Ref. Geometry→Plane**, picture 11;the plane was created through the **Pick Points & Normal Axis** method, followed by a selection of point *Point1* and vector *Vector1*; the new plane is created perpendicular on the **Front** and **Right** planes (since the *Vector1* axis was created at their intersection) and *Point1* will be a part of it;
- creating the entity *Plane3*, through the command **Insert→Ref. Geometry→Plane**, picture 12; the plane was created through the **Offset** method, which requires a 35 mm distance from the **Front** plane; the *Plane3* entity is parallel to the **Front** plane at a distance of35 mm;
- creating the sketch in the *Plane3* plane, through the **Mesh Sketch Setup** command; Geomagic will generate the intersection edges of the mesh with the *Plane3* plane, picture 13; over these edges, the outlines of the part and holes must be sketched, picture14;

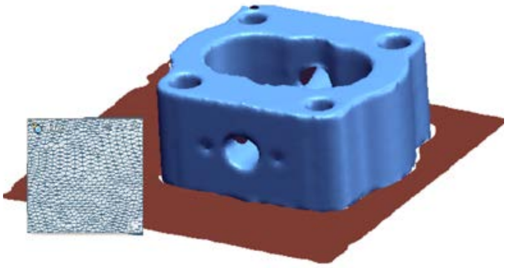
o the previous sketch from *Plane3*, was extruded through the **Extrude** command, in two opposite directions, bounded by the planes from picture 15, the result being the solid from picture 16;

o creating the sketch in plane from picture 16; the sketch will follow the intersection edges of mesh with this plan;

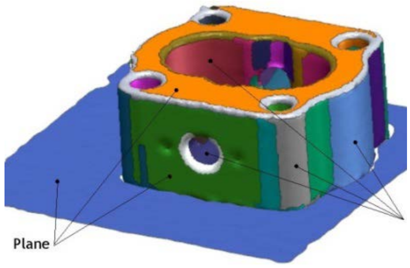
o the previous sketch was extruded through the **Extrude** command,which entails a material removal of the entire body (**Through All** & **Cut** options) and leads to the holes from picture 17;

o the last operation of the scanned part reconstruction is the **Fillet** command, which is applied to holes with a 0.5 mm radius, picture 18;

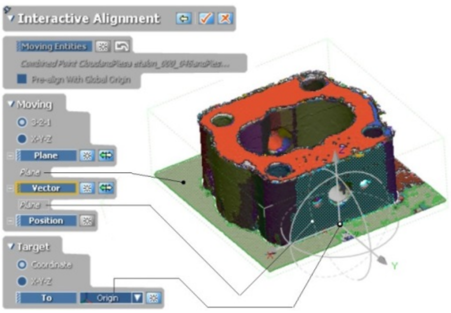
o the solid geometry reconstructed in Geomagic is saved in a **Step** format.



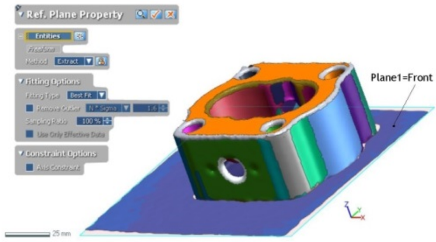
Picture 5. *The mesh*



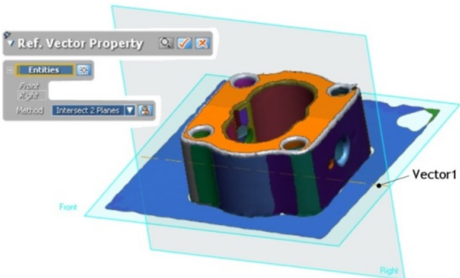
Picture 6. *The regions*



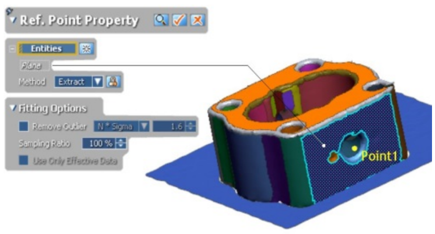
Picture 7. *The mesh and regions alignment*



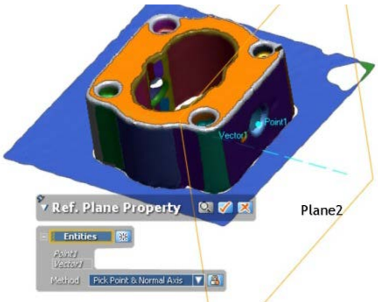
Picture 8. *The Plane1*



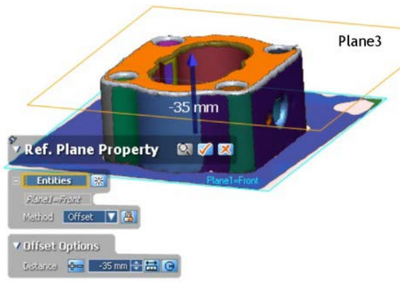
Picture 9. *The Vector1*



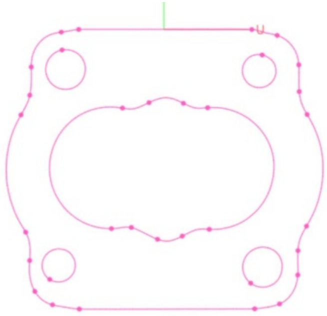
Picture 10. *The Point1*



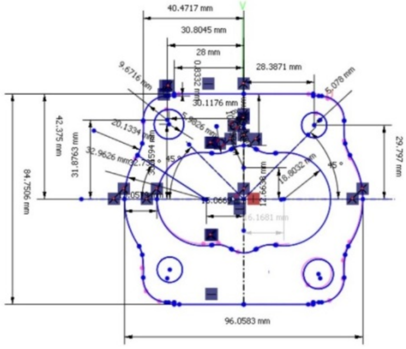
Picture 11. *The Plane2*



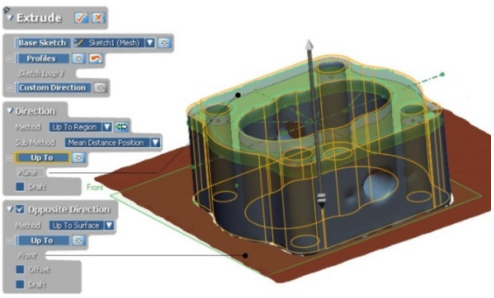
Picture 12. *The Plane3*



Picture 13. *The edges intersection of the mesh with plane Plane3*

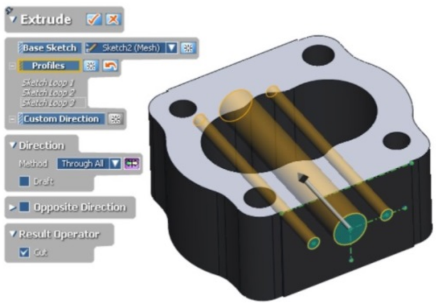


Picture 14. *The sketch created in Plane3*



Picture 15. *The* ***Extrude*** *command*

Picture 16. *The edges intersection of the mesh with the plan*



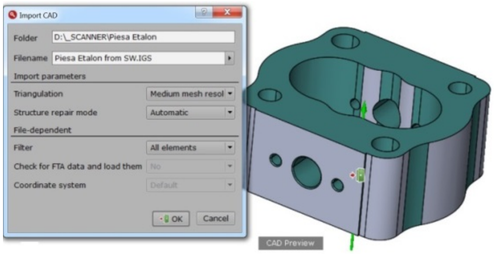
Picture 17. *The* ***Extrude*** *command*

Picture 18. *The* ***Fillet*** *command*

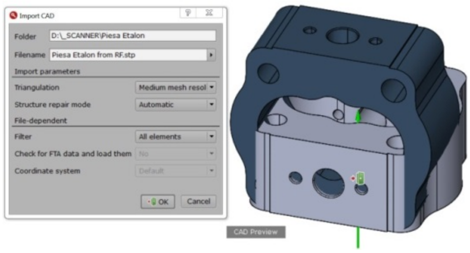
3. The dimensional control of the reference part

The dimensional control is done using the GOM Inspect software, by following these steps:

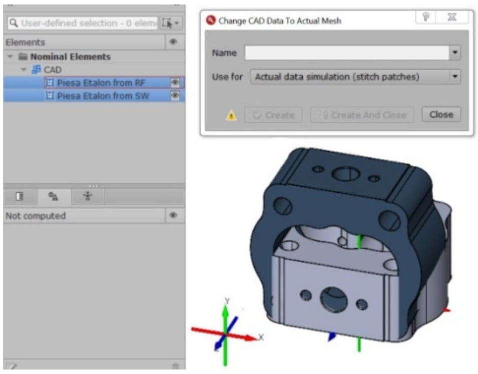
- import the SolidWorks solid geometry (**IGES** file) in GOM Inspect, through the command **File→Import**, picture 19;
- import the Geomagic solid geometry (**STEP** file) in GOM Inspect, through the command **File→Import**; both geometries are internally meshed in GOM Inspect, picture 20;
- in GOM Inspect,the scanned geometry is referred to as the **Actual Elements** and the geometry built in a CAD system is referred to as **Nominal Elements**; because, as a result of the import command,both geometries are placed in the**Nominal Elements** section, the scanned geometry(**STEP** file) must be transferred in the **Actual Elements** section, by selecting it and pressing the command **Operation→Data→CAD to Actual Mesh**, picture 21;
- the result of the transfer is presented in picture 22,where the two geometries are not aligned, because they were built in different coordinates systems; these geometries must be aligned through the command **Operation→Alignment→Initial Alignment→Prealignment**, picture 23; after this operation, the two geometries are prepared for dimensional control, picture 24;
- the first dimensional control was done at a surface level, through the **Inspection→CAD Comparison→Surface Comparison on the CAD**command, with the **Nominal Elements** surface acting as a reference; for each point of the **Nominal Elements** surface,the software calculates the distance perpendicular to it until it intersects the **Actual Elements** surface; the result of the comparison is shown in the form of color plot and a blue-gray-red legend in picture 25; the blue/red color corresponds to the points of the **Actual Elements** surface that are under/above the **Nominal Elements** surface while the gray color corresponds to points that have no deviation;
- the second dimensional control was also done at a surface level, through the **Inspection→Deviation Label** command, by placing tags that show the deviation value in the specified point, picture 26;
- the third dimensional control was done at a section level, through the **Inspection→CAD Comparison→Inspection Section** command; the inspection was done on the section for Z = + 29 mm; the results are presented in picture 27.



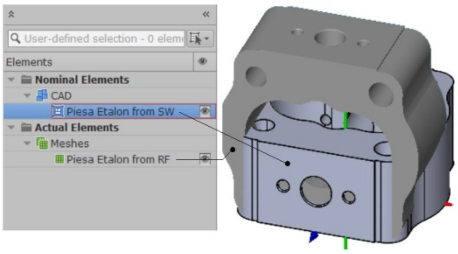
Picture 19. *The import of the SolidWorks geometry (IGES file)*



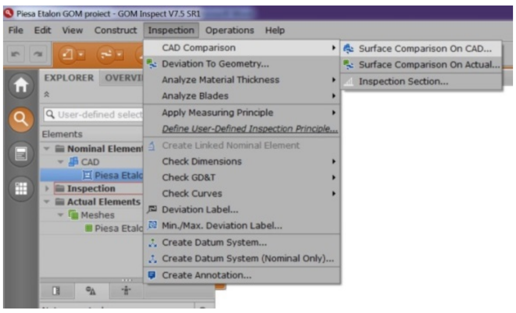
Picture 20. *The import of the Geomagic geometry (STEP file)*



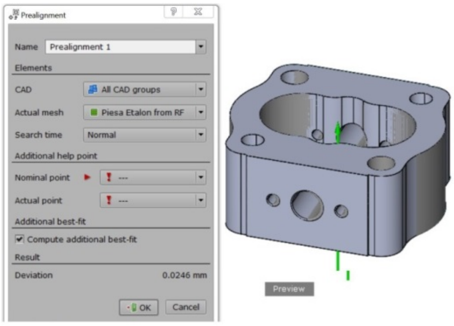
Picture 21. *The transfer of the* ***STEP*** *geometry into the* ***Actual Elements*** *section*



Picture** 22. The* ***Nominal Elements *and* ***Actual Elements*** *geometries*



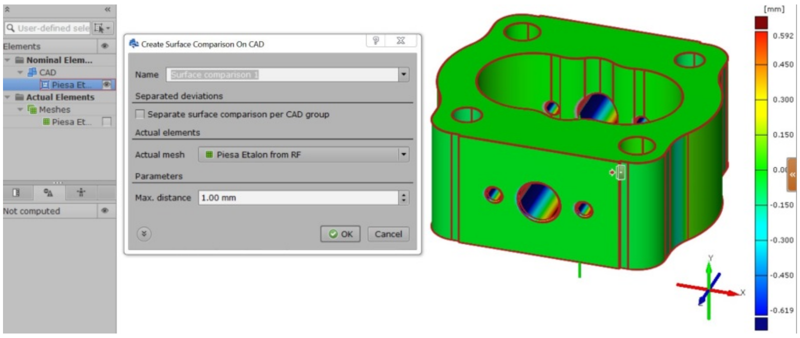
Picture** 23. The* ***Surface Comparison on CAD *command in GOM Inspect*



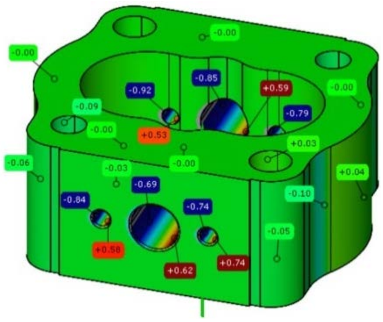
Picture** 24. The* ***Nominal Elements *and* ***Actual Elements*** *alignment*

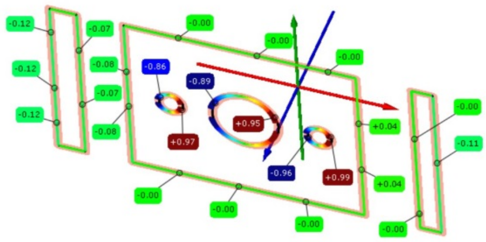
4. CONCLUSIONS

The Reverse Engineering Technology was used to reconstruct the reference part geometry with the help of the Noomeo Optinum 3D Scanner; the Geomagic (Rapidform XOR3) software was used to convert the scanned data into a solid model, which was compared to the SolidWorks version of the same part, using the GOM Inspect software.



***Picture** 25. The surface comparison on CAD*





***Picture** 26. The deviation labels* ***Picture** 27. The section control for Z=+29*

The inspection results lead to the following conclusions:

- the surface deviation of the reference part is below 0.1 mm;
- the maximum deviations are recorded in the holes located on the side wall, with a ±1 mm deviation, which means that their position was not properly obtained as a result of the scanning process; in general,3D scanners have deficiencies in scanning edges and small holes.

REFERENCES

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