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Creating a solid documentation based on a 3D scans performed on SMARTTECHs scanner scan3D

SUMMARY:

The article shows full path of gaining solid CAD model from a real object, here a complex plastic cover from injection mold. There process of gaining 3D geometry is shown based on 3D scanning process performed on scan3D surface scanner, solid creation is made in Mesh3D and Geomagic Design X software. Quality control has been shown on Geomagic Control software.

1.Introduction – object measurement

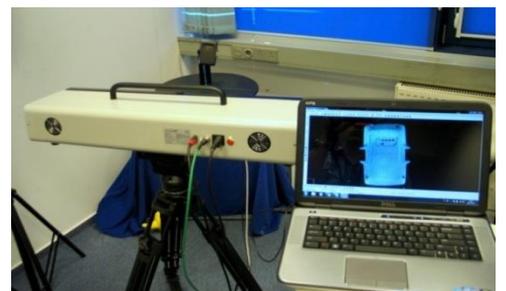
The aim of the measurement made with scan3D surface scanner is the solid preparation of documentation based on 3D scans and to develop a comprehensive solution hardware of software to enable rapid and automatic quality control of the geometric dimensions of the product. To perform a quality control you need:

- Solid CAD model from a real object
- 3D scan (geometry) of a tested object
- Quality inspection made by comparing the CAD model and 3D scan in a dedicated software

This study shows the process of solid modeling in order to reproduce the technical documentation, based on a 3D scan and to verify the actual dimensions with a standard 3D model of the enclosures which were supplied by a sub-contractor.



Pic. 1.1 Model

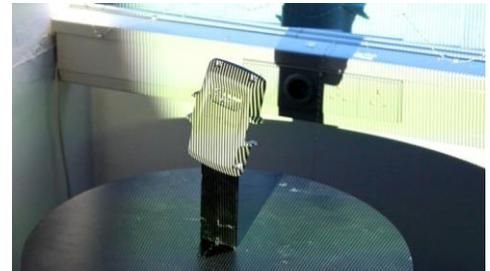


Pic. 2.1 Scanning

2. 3D scanning – collecting the geometry of the object

In the first stage the object was scanned from every side (pic. 2.1). Scan was performed with a scan3D surface with a 5Mpix detector and a resolution of 0,4 mm and 0,2 mm, with accuracy of 0,06mm, connected with a rotary stage.

The result of a single scan is a cloud of points (each point is described by a coordinates X, Y, Z). Eight measurements were made, all of them were connected automatically in the Mesh3D software.



Pic. 2.2 Scanning

3. Work in Mesh3D software

In the second stage program combined individual clouds of points. Thanks to the rotary stage that was used during the scan It happened automatically. Pic. 3.1 shows the combined clouds of points. Features in the Mesh3D software allow you to remove noise from cloud of points that may occur during scanning. Also the areas where clouds duplicate can be removed to minimize the number of points.

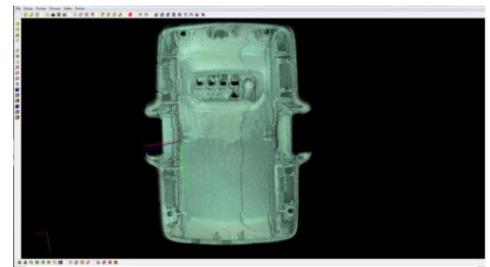


Pic. 3.1 Connecting clouds of points(front) [Mesh 3D]

In Mesh3D you can also create a triangle mesh from cloud of points.

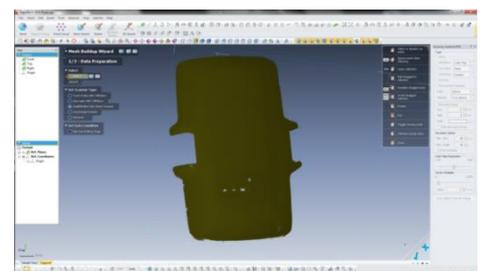
4. Creating a solid model - reconstruction of a technical documentation in the Geomagic Design X

First stage when working in Geomagic Design X is to import every individual cloud of point from the scanned object and to connect them in one cloud if the rotary stage was not used(Pic. 4.1).



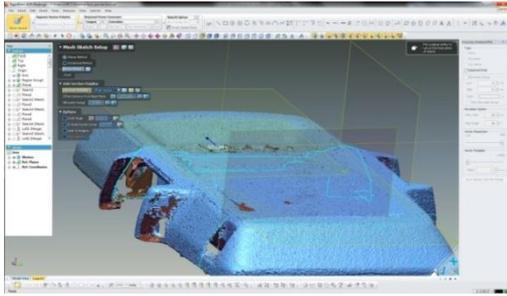
Pic. 3.2 Connecting clouds of points (back)[Mesh 3D]

Second stage is to define the plane on which the sketch will be created. The great advantage of the program is the ability to do cross-section through the cloud. The result of this section are lines, arcs and circles which are then defined by the user (Pic. 4.2-3).

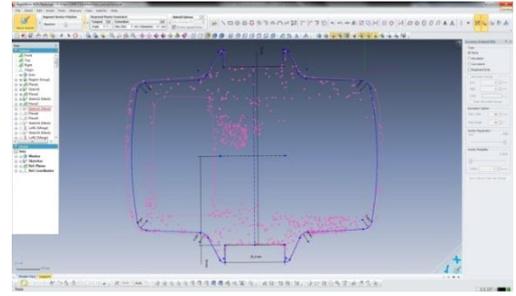


Pic. 4.1 Cloud of points import [Geomagic Design X]

On the resulting sketch, you can perform all the same operations as in every other CAD program. In this case, the outline is reached (Pic. 4.4).



Pic. 4.2 Making sketch based on a cloud of points [Geomagic Design X]



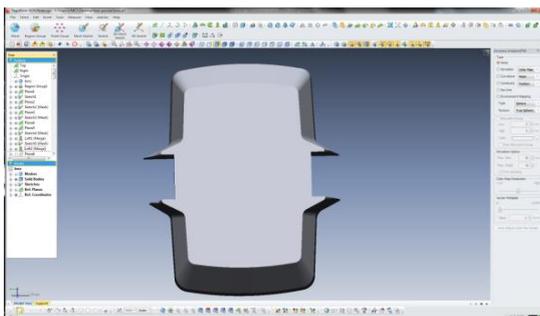
Pic 4.3 Defining lines, arcs and circles on sketch [Geomagic Design X]

Geomagic Design X has many features and enables modeling based on a selected region geometric figures, cylinders, cuboids, cones, circles.

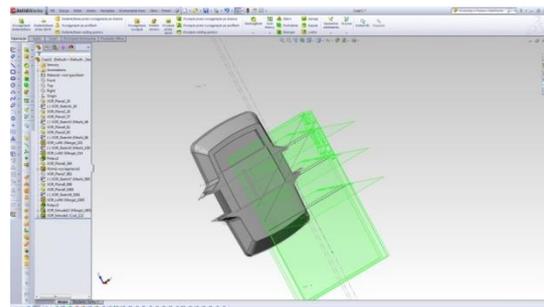
An important advantage of this program is the ability to copy a tree of operations to other CAD programs like SolidWorks, CATIA, NX(Pic. 4.5).

The essence of CAD modeling based on cloud of points is that in a real time, we have the ability to display colored map of deviations. This map illustrates the solid model resemblance to scan and gives the ability to control if all scan components are properly presented in the solid form(Pic.. 4.6). For a more detailed model analysis is used Geomagic Control which is discussed in the next section.

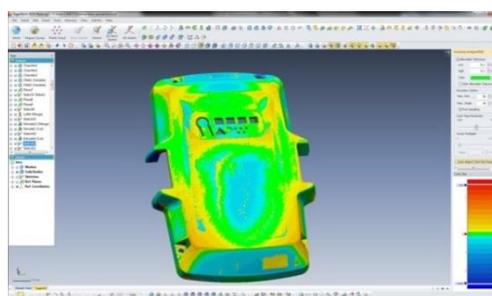
The final block can be saved in a multiple formats for example iges, parasolid, step (Pic. 4.7).



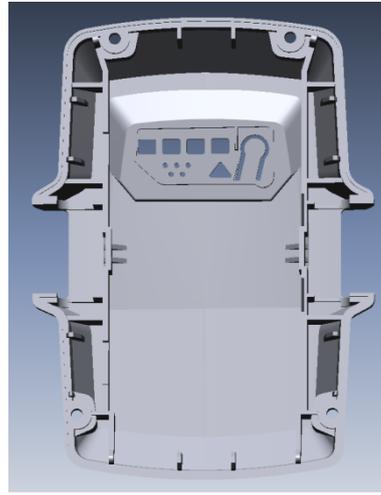
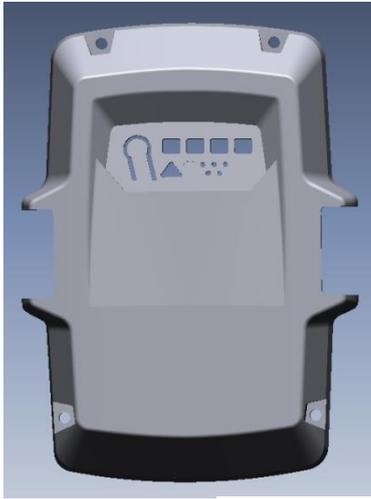
Pic. 4.4 Operation - sketch[Geomagic Design X]



Pic. 4.5 Copied tree of operations [SolidWorks]



Pic. 4.6 Map of deviations [Geomagic Design X]



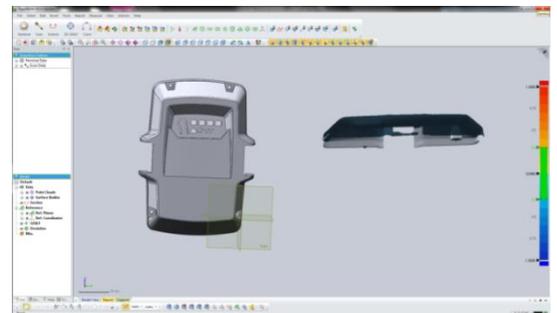
Pic. 4.7 Finished cover [Geomagic Design X]

5. Inspection - controlling geometric dimensions by comparing scanned elements with standard model CAD

To allow revision of the scanned cover it is necessary to have a standard CAD model. Comparison will be performed in Geomagic Control software.

The advantages of the program are:

- Complete verification of the part in just 4 steps
- A simpler and more secure particle control
- Importing data from a 3D scanner and CAD software or scanning in Geomagic Control
- Automatically adjusts 3D scan to a CAD model
- Making map of deviations, control the dimensions and tolerances (GD & T)
- Automatically generated reports make it easy to present the results (PDF3D)
- Repeating the process for another part in just two clicks



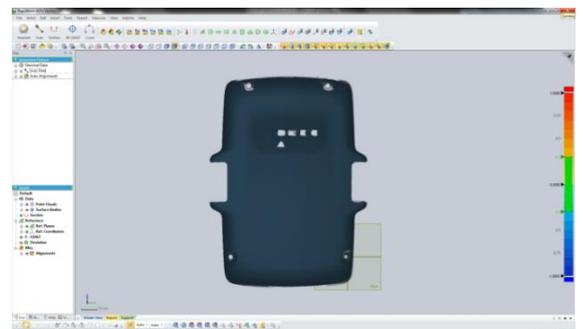
Pic. 5.1. Scan import and CAD model [Geomagic Control]

Taken two cases:

- a) detail with the correct geometry (dimensions within the tolerances)
- b) an incorrect geometry detail, shifted two holes and changed the width of the side handle (dimensions do not fall within the tolerances)

Work with software begins with import of a scan and its CAD model.

As it can be seen on pic. 5.1. scan and model do not fit. To impose both scan and CAD model there



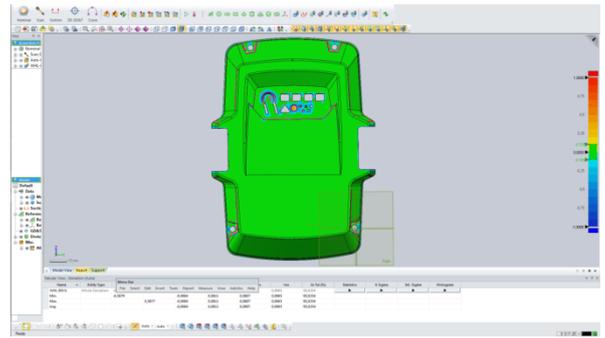
Pic. 5.2. Scan import and CAD model [Geomagic Control]

should be used auto alignment.

Alignment lasts about few second and the result is finished comparison. (Pic. 5.2.).

- a) detail with the correct geometry (dimensions within the tolerances)

After starting the "Accuracy Analyser™—deviation type" mode relative to the reference CAD model deviations are visible. As you can see on Pic. 5.3. everything is green - which is within predetermined tolerance of 0.2 mm.

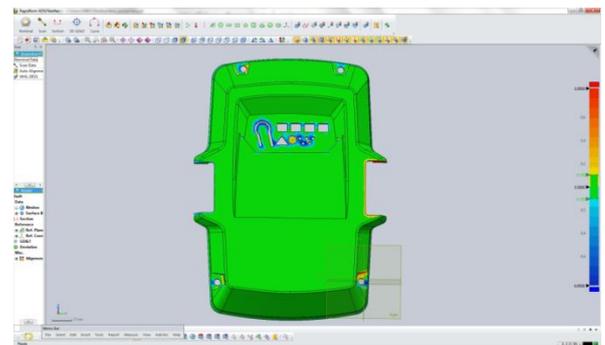


Pic. 5.3. Comparing scan with CAD model (on the right side is tolerance scale +/- 0,2) [Geomagic Control]

- c) an incorrect geometry detail, shifted two holes and changed the width of the side handle (dimensions do not fall within the tolerances)

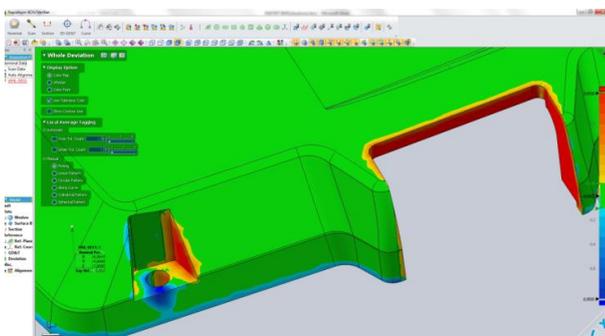
As you can see in Pic. 5.4, width of the holder on the right does not fit, also the position of the lower right and upper left hole is not equal.

After you close up (Pic.5.5) you can see the displace of the holes between scanned data and its reference model CAD. The value is displayed when you point the mouse over the corresponding point.

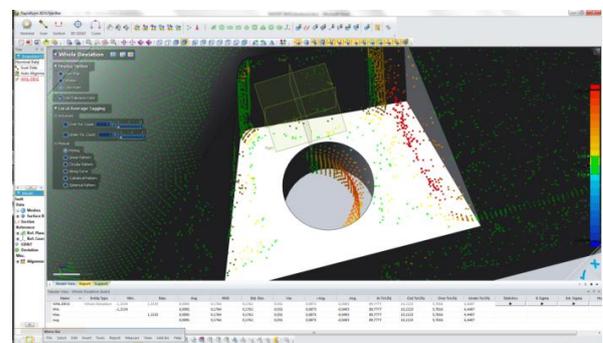


Pic. 5.4. Compared incorrect geometry object (scan 3D) with model CAD [Geomagic Control]

As shown on the Pic. 5.6 object is marked red in some places - so that means that the scan is outside the predetermined tolerance of 0,2mm.



Pic. 5.6. Places marked red are outside the tolerance [Geomagic Control]



Pic. 5.5. Comparing incorrect detail with its reference CAD model [Geomagic Control]

6.Summary

The measurements show that the use of a 3D scanner scan3D surface with the matrix of 5Mpix resolution of 0.3 mm is quite suitable for the quality control.

In order to make an inspection of geometrical dimensions of the product, it is not necessary to have CAD documentation from the original manufacturer. Thanks to specialized software like Geomagic Design X, it is possible to restore self-documentation (CAD model) based on 3D measurement made by SMARTTECH scanner.

Generated CAD model can be used also to:

- redesign the detail
- make a new injection mold for the object(in case the original one is damaged or old)

Geomagic Control software gives the tools for quality control. Manually setting the tolerance range (color scale deviations) enables a very fast verification of the tested product. It is visualized on a color map of deviations. It also enables an automatic control of important areas (indicating the distance from point to point).

A short time control allows the examination of a series of supplied components. The results of inspections can be presented in a PDF report, where the casing with the correct dimensions are marked as PASS and those which are not correct are marked as FAIL.