THE BENEFITS OF LASER SCANNING OVER TRADITIONAL TOUCH PROBE TECHNOLOGY

INTRODUCTION

This paper outlines the differences between the conventional method of inspection with the help of a fixed touch probe and today's more advanced collection of point clouds using a high-performance Steinbichler laser scanner. Using application examples and recent technology findings, the latest innovations of laser scanning techniques are revealed.

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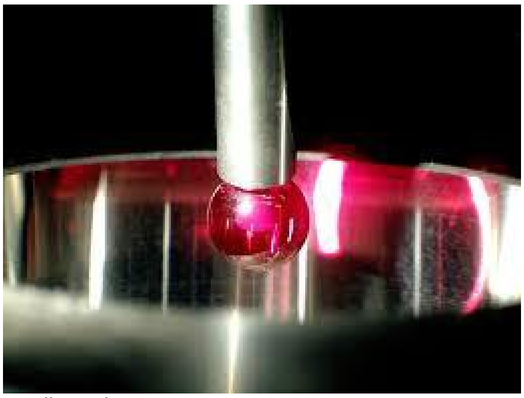
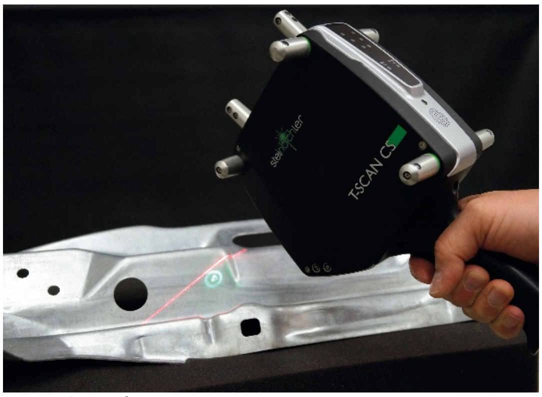
PREVIOUS METHODS – AND THEIR STRENGTHS

For decades, the measurement of components using a touch probe system was the standard solution for many metrology experts. The advantage of this method has been established as the best method to use in the industry to ensure accuracy and repeatability for quality assurance.

Touch probes are versatile, coming in all sizes to fit in small holes or to reach intricate surfaces. They are extremely accurate with repeatability to meet the highest quality requirements. They measure geometric errors such as the roundness of drill holes and overlapping areas in small fixtures. Touch probes have been regarded as the most accurate, reliable and mainstream quality inspection technique for years, until metrology experts started realizing that quality requirements are changing and production times increasing. They took a step back and re-evaluated this technology.



Tactile Probe



Laser Scanning

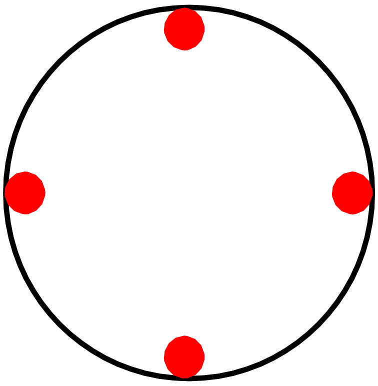
PREVIOUS METHODS – AND THEIR WEAKNESSES

The capturing of single measuring points with tactile inspection is a long and tedious process. Producing accurate results can be a challenge depending on the component and its features. Many materials cannot be inspected with a touch probe due to their soft compositions. These primarily include rubber, foam and other flexible materials. For measurements of a larger component or a touch-sensitive part, the touch probe can fail to meet the requirements needed for the job. Tactile measurement solutions are becoming less desirable to Quality Managers as they are required to do more with less and in half the time. In this new age of instant gratification and increased production throughput, Manufacturers have no choice but to become acquainted with the new generation of tactile measurement; non-contact laser scanning.

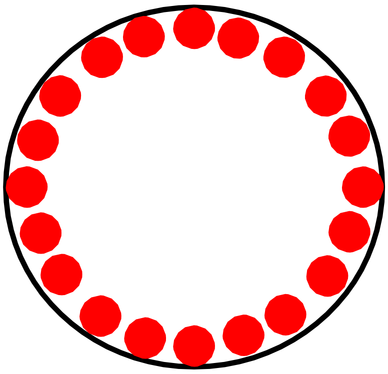
PROBLEM DEFINITION

With previous tactile measurement methods, only a limited quality overview of the component could be obtained. The problem in comparison with generating a surface scan with a laser scanner, is only select information of the measured area of the component is given and any other areas remain unidentified.

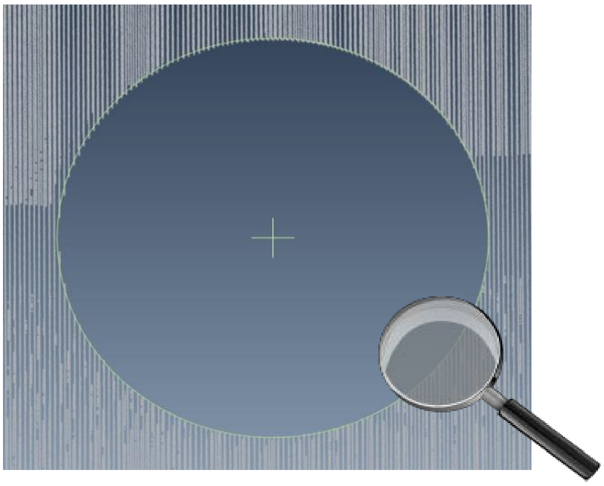
With these limitations, a complete assessment of all component areas is not possible. As a result, a quality engineer spends countless hours collecting data from a component that is unable to be processed accurately with the points collected.



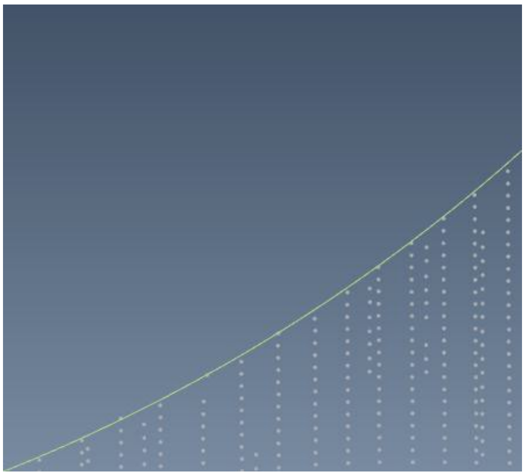
Tactile measurement of a circle



Laser scan of a circle



Non-contact scanning of a circle

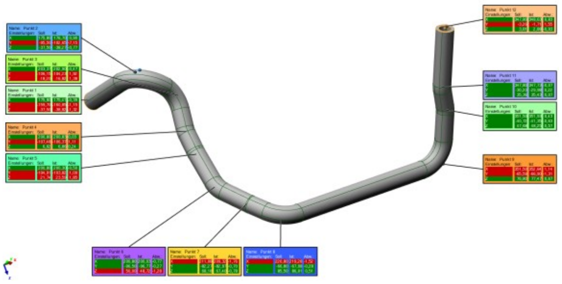


Detail inspection of a point cloud

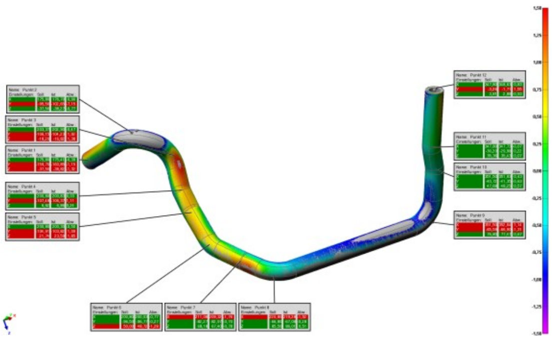
THE HUMAN INFLUENCE

Quality inspection systems only represent one half of the solution. To conduct a thorough quality inspection, a quality engineer must have the proper knowledge and training to understand the requirements to complete the task.

When using a tactile probe to collect the data, the user must have the knowledge-base to understand the point cloud data. With a laser scanner, point clouds are in the form of a weather chart. This allows for the user to read the data in a comprehensive and visual manner that decreases the chances of misinterpretation resulting in human error.



Tactile measurement with intersections



Scan data with intersections and overview for quick orientation

SOLUTION

Based on efficiency and quality of point cloud data obtained, the laser scanner triangulation sensor is the ideal solution for collecting and analyzing data point clouds for quality inspection purposes. In contrast to tactile probing or tactile scanning, the non-contact scanning of a component is considerably faster and provides significantly more information.

While tactile measurement has been a proven method for quality inspection in the past, looking to the future, laser scanning is the optimal point cloud inspection solution. The point density achieved by scanning cannot be obtained from a tactile scan. Details of small and complex structures are measureable using conventional methods, however fine textures are not detected in this manner. The essential advantage is after scanning an object, the measurement data can be edited at any time. The point cloud can still be used even when the measured part is no longer available.

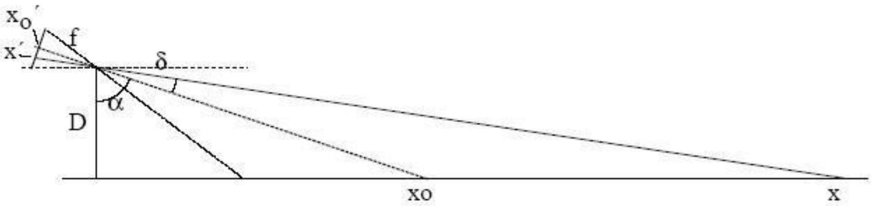
MEASUREMENT PRINCIPLE

The operating principle is the laser light section technique which is based on the triangulation principle (component set-up is described in the picture below). Here, the object itself is not measured, however the reflection of the laser line on the object's surface is represented.

With laser triangulation, a laser beam (or for less stringent requirements the light beam of a LED) is focused on the object and observed with a camera positioned next to the sensor, a position-resolving photodiode or a CCD line. When the distance between the measured object and sensor changes, so does the angle for observing the light beam, resulting in a position change of its image on the photo receiver. Due to this position change and using the trigonometric functions, the distance between the object and laser projector is calculated.

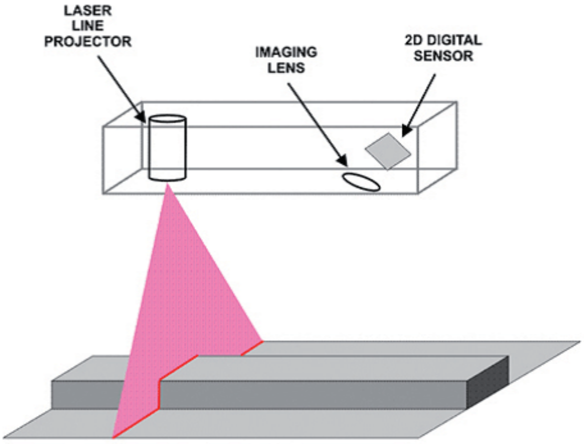
A photo receiver is a light sensitive element that determines the position of the point of light in the image. The distance between sensor and object is calculated based on this image position. One advantage of the triangulation technique is the fact that it consists only of trigonometrically connections. Consequently, the measurement can be carried out continuously and is specifically suited for the distance measurement on moving objects. To decrease the ambient light sensitivity and the influence of inhomogeneous reflective surfaces, the measurement point has to be as small and bright as possible. Therefore, such triangulation sensors often work in pulse operation.

This method is only suitable for short distances, because the sensitivity decreases in the fourth power (two-way-absorption) with the distance between the transmitter and receiver. For the most part, the laser and photo-receiver are combined in a single housing.



The above diagram shows the relations between the different distances.

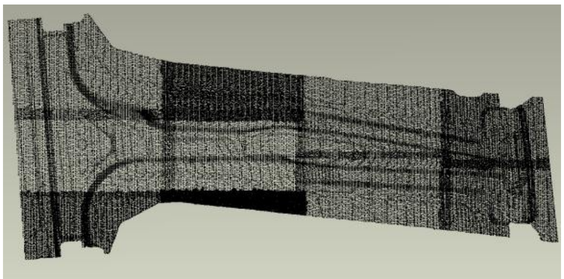
Using trigonometry determines the distance $x - x_0$ with the value of the measured distance $x' - x'_0$.



Typical set-up of a laser sensor

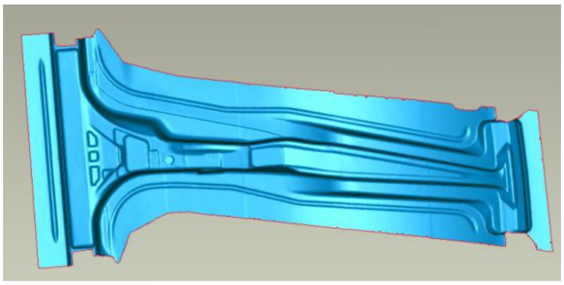
APPLICATION - REVERSE ENGINEERING

In general, reverse engineering is used for the reconstruction of unknown contours or partial contours into a CAD system. This is applied for the measurement of completely new design models or partial changes on already existing components. The unknown surface area situation is precisely recorded and then transformed in a few steps into a CAD readable format.



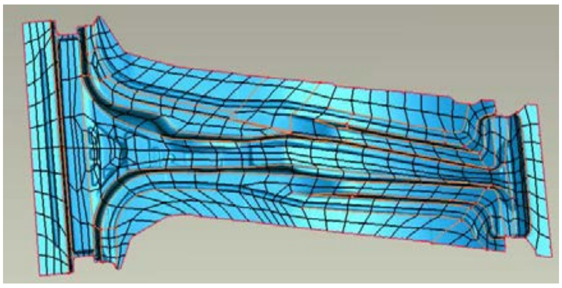
Point cloud of a component

Point cloud image of the component in a grid as narrow and precise as possible. Alignment based on a predefined coordinate system.



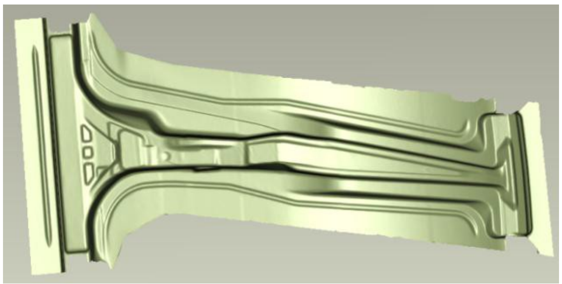
STL grid of the component

Generation of a triangle mesh (STL) based on the captured point cloud.



CAD model of single patch areas

The triangle mesh is divided into single patches (areas) in a CAD readable format.



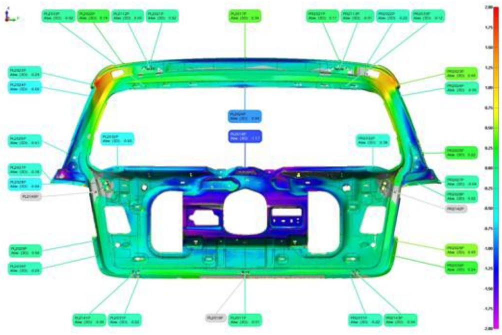
Finished CAD model (rendered)

Finished CAD model

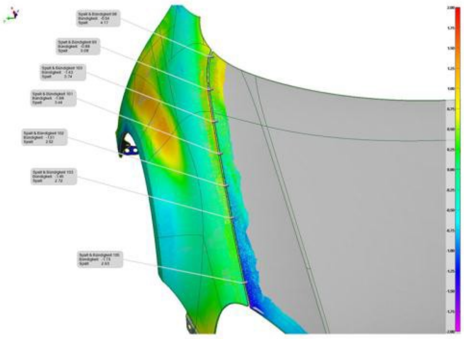
APPLICATION - QUALITY ASSURANCE

The goal of corresponding applications in quality assurance is to compare the actual dimensions of an object/part with the dimensions defined by the construction or design department and thus identifying possible deviations. Point clouds of actual/measured data are compared with the nominal data (CAD model). This method of quality control is also capable to determine form and position tolerances of geometric elements.

The result can be displayed in an area-based false color image or by methods well-known in conventional tactile techniques.

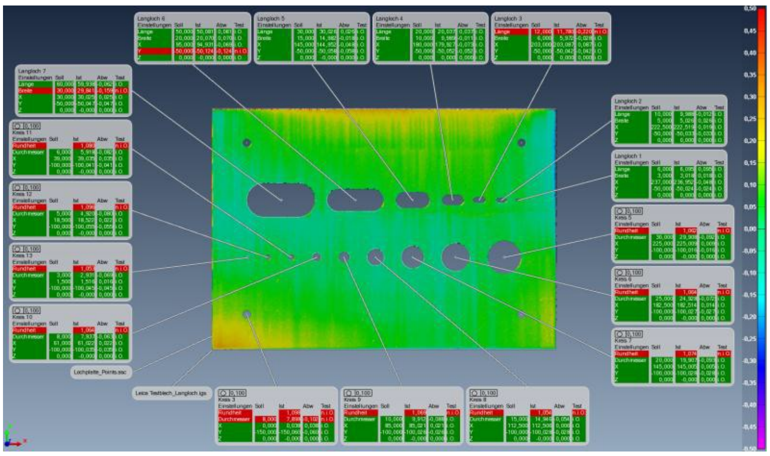


Area-based false color comparison



Measuring task:

- complete surface scanning
- comparison with CAD data
- false color representation
- calculation of gaps and flushness

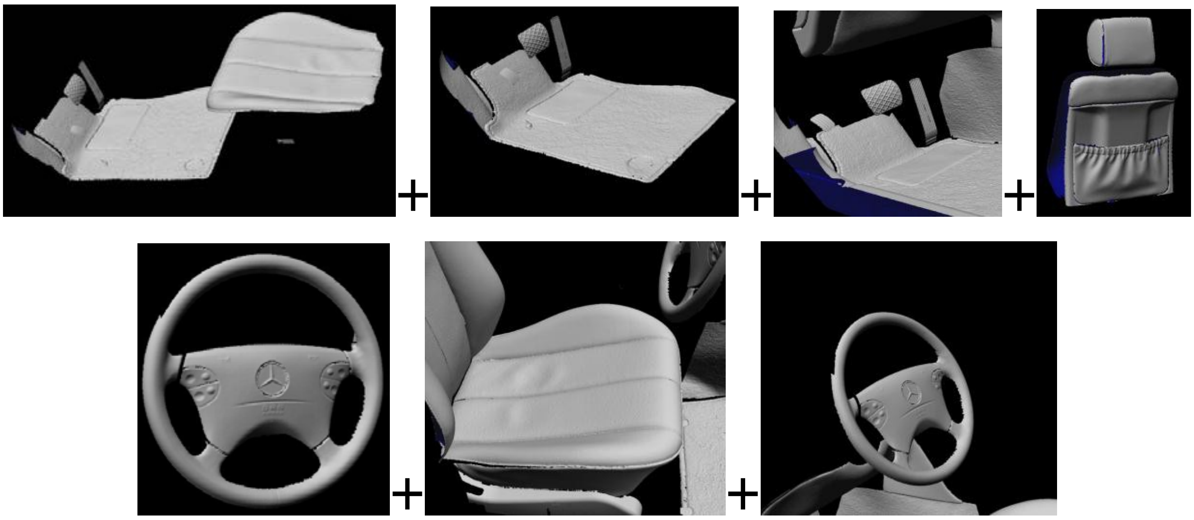


Measuring task:

- complete surface scanning
- comparison with CAD data
- false color representation
- calculation of geometry data

APPLICATION VISUALIZATION AND VIRTUAL ASSEMBLY

For virtual assembly, the actual application is measured with a laser scanning system.
In general, the data is used for documentation purposes, but also to measure the interior ergonomics of a vehicle such as seat position, usability of switch elements or just to evaluate the available space. The data can then be exported to specific software systems for further analysis.



Single scans of a car interior

Complete interior after virtual assembly

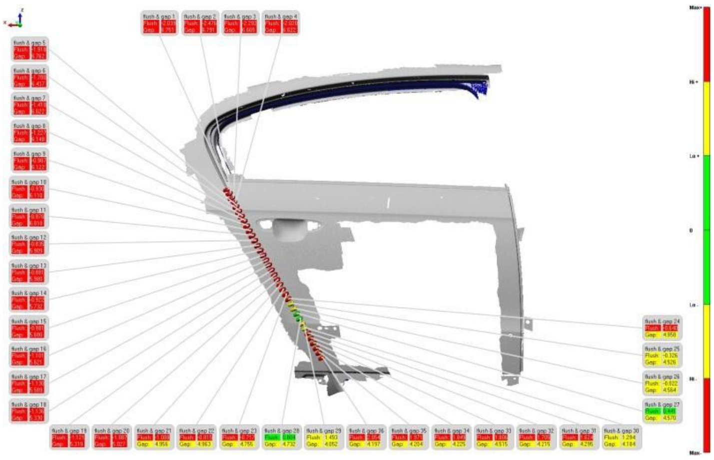
APPLICATION VIRTUAL ASSEMBLY AND BLOCK AIR CONSIDERATION

Virtual assembly also offers the possibility to simulate joining components in the run-up.
In general, the required data is scanned independently from each other at different company sites (often at locations all over the world).

After virtual assembly of the measured data, the object can be reviewed in its assembled state. The result shows the actual application. With this method, production processes can be simulated, covering much more than the real component up to complex assemblies.

Scan of a side panel frame (door area)

Scan of a door



Virtual assembly of side panel frame and door with gap / flushness display

CONCLUSION

From today´s perspective, it is definitely time to consider laser scanning systems when taking into account the costs, investments and the significance of the measurement results.

The fact that due to the full dimensional data capture - in contrast to the conventional tactile technique - every kind of evaluation is still possible, even after removal of the measured object from a CMM. Thus, a laser scanning system is nearly unbeatable, taking into consideration an economic measurement process and a high documentation security.

The combination of surface data describing the shape of the component/object and the simultaneous possibility of a high-precision geometry evaluation based on shape and position, offers enormous advantages. Soft materials can be scanned without any problems because the procedure is working absolutely contactless. The measured points are a perfect data basis for further inspections, especially in development and also for serial production.

Due to its high degree of integration, the Steinbichler laser scanner can be used on any measuring machine for both mobile and stationary devices.

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