Computed Tomography (CT) Enhances Coordinate Measuring Machines

Into the Future in Three Dimensions

A multisensor coordinate measuring machine, combined with the process of computed tomography, allows components to be analyzed with micrometer precision without contact. Deviation analysis between the tomographic data and the CAD model can identify problem areas on the component without requiring that specific measurement points be taken. All deviations are indicated by color coding, making them easy to identify.

pictures: Harting / Werth Messtechnik

HARTING in Espelkamp, a manufacturer of high quality connectors for energy, signal, and data transmission for machine connections, network components, and systems cables, uses the TomoScope HV 500 from Werth Messtechnik, Giessen. It helps them ensure the quality of their products by performing geometric measurements and material analysis. The coordinate measuring machine with computed tomography is used for non-destructive testing and metrology applications to optimize production. Dr. Stephan Middelkamp, from the strategic technology development team, oversaw its introduction to the company. „We use computed tomography to give our existing metrology some relief. This method is also sometimes faster than conventional coordinate measuring technology and provides additional information. Over the long term, we want to convert our entire process to 3D data structures. This will also apply to quality assurance. The required three dimensional investigations can be performed using X-ray tomography. Primarily, however, the measurement precision of the machine was the de-

► Measurement with computed tomography is recommended for high-quality plug connectors of all shapes and sizes.

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ciding factor for procuring it. It has to provide precision on the order of a few micrometers. We have checked this both with standards for calibration, and with our own components in test measurements. This means that the company can measure very delicate plug connectors (<1 cm) as well as large housings for railroad jumper cables, nearly half a meter long."

Designed for Measurement and Analysis

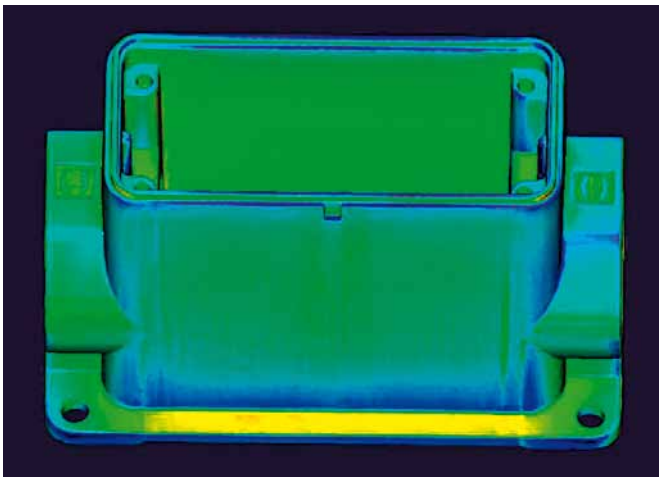
The measuring machine is currently used two-thirds of the time for measurement, and one-third for analysis. „Measurement" mean that the surfaces of housings and plug connectors are captured and the associated dimensions (i.e. lengths, radii) are determined. Previously sliced sections were ground to capture the dimensions of internal chambers, now virtual section images can be produced that reproduce actual sliced sections. This means considerably less time and effort. The section plane can also be shifted digitally. „Where previously, due to the effort involved, only one grinding plane would be used for quality assurance, we can now measure in as many planes as desired with no additional measurement effort. The only additional work is in the post-processing of the information," explains Middelkamp. Within the company, „analysis" primarily means tests during development, where the whole part is observed non-destructively. Examples include testing leak and testing of the progression of casting compounds. By using a CT scan, it can be determined whether the filler material has been properly distributed, or whether there are voids in the plastic or aluminum casting. Depending on the results, the mold shape or injection parameters can be optimized.

The computed tomography system is used for geometric measurement tasks and material analysis.

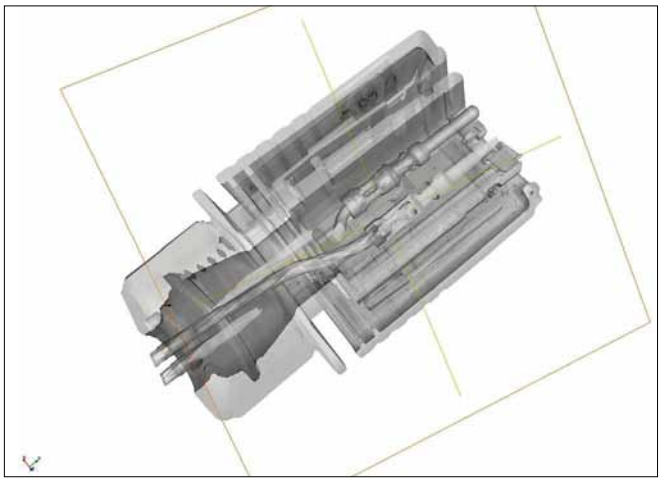
Simple Operation and Analysis

The measuring machine is simple to use. The operator does not need to do any setup, just place the workpiece directly on the rotary table, which is located between the X-ray source and the detector. The user then selects the desired magnification, using the WinWerth software package, and selects rastering, if needed, whereby partial images of the workpiece are taken and then combined into larger volumes. Rastering is used for long connectors, for example, which have a just a few rows with a large number of poles. They are set up vertically, scanned in segment by segment, and then precisely merged together. This provides very high resolution and precision.

When the operator starts the X-ray process, a user-defined number of x-



Deviation analysis: The CAD model is merged or „Best Fit“ with the tomographically captured data and deviations are plotted in color.



Example of analysis: The section view of the assembled plug clearly shows the cable and insulation displacement terminals.

ray images is taken at precise rotary positions. A 3D reconstruction of the images is then performed, to create a complete 3D volume that describes the entire internal and external part geometry. The result is a set of measurement data with precision in the micrometer range that shows every detail of the workpiece and can be analyzed in various ways.

Ideal First Article Inspection Reports

One typical area of application is the first article inspection report for releasing a product. Product developers provide a pre-production sample with drawings and CAD data, as well as inspection reports. After scanning the component, a deviation analysis is produced from the data, with a color-coded plot and void analysis. The test dimensions are then measured and the result is documented in a first article inspection report. The developer then needs to evaluate the dimensions and release the part for production if the results are positive.

In addition to measurements that provide exact values, the software also provides the ability to run the deviation analysis, including color-coded deviation plots. This name comes from the use of color to represent the deviations between the target geometry and the actual geometry. The CAD model is imported into the measurement software and merged or „Best Fit“ with the tomographically captured data. The deviation of every point is shown in a color code, so that the user can see sink marks or other problem areas at a glance without doing special measurements. This plot can be used as the basis for correcting the injection mold. This method is also useful for quickly inspecting housings that have dimensions with large tolerance ranges, such as radii, where the precise dimension is not critical to the function.

Modern Measurement Technology Pays for Itself

„From my point of view, the greatest benefit has been that we can obtain significantly more information than before about the entire component with the new machine, by quickly measuring in several different planes. I can use this to get better quality,“ says Middelkamp. But he is also counting on other long term benefits, for example, when measuring large die cast housings, where the dies need to be replaced relatively often due to wear. The same housing is submitted every year or two for a new complete first article inspection when a new die is used. Once the measurement program has been written, it can be reused whenever necessary. „Naturally, this saves time,“ says Middlekamp. „For plastic insulators, we have other positive effects as well. We need to capture the dimensions and positions of a large number of internal chambers. With the X-ray, this measurement process can easily be duplicated. The injection molds also often have four or eight nests each, for which one measurement program can be repeated several times. ■

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- link to operator: www.harting.com
- link to the measurement technique provider: www.werth.de