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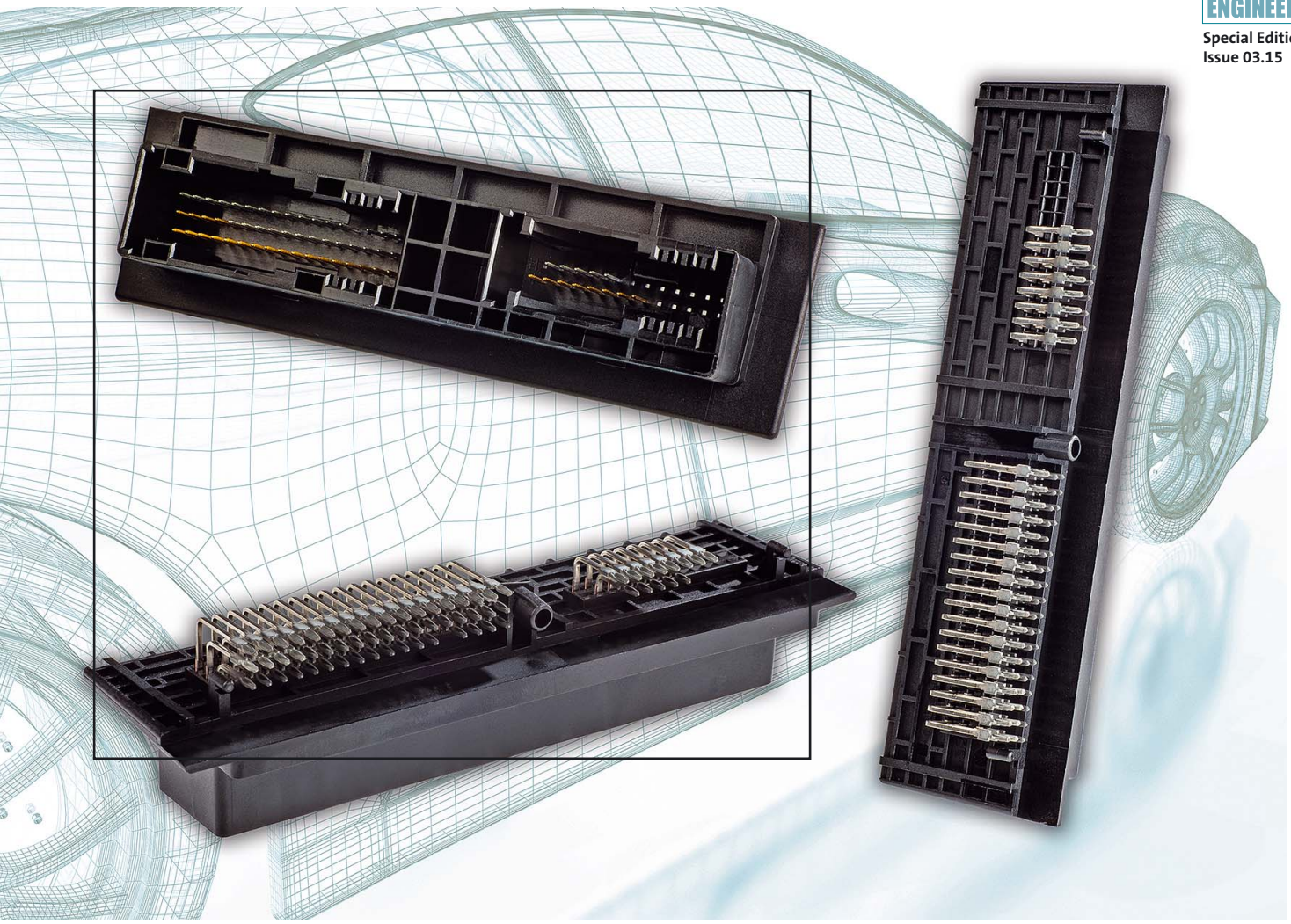


Coordinate Measuring Technology with CT Accelerates the Development Process

Faster to Market Readiness

High quality and short development times – these are the characteristic requirements of the automotive industry. The automotive competence center at TE Connectivity has used Werth coordinate measuring technology with computed tomography for two years now and has been able to reduce development times significantly.

With around 80,000 employees and annual sales of 14 billion US dollars, TE Connectivity is a global leader in connector technology. The worldwide automotive competence center is located in Bensheim. Plug connectors are developed here for use in vehicles built by every major manufacturer. The Test Competence Center (TCC) also validates products in accordance with automotive test specifications. The TCC not only covers the quality assurance of products, but is also integrated in process development at an early phase, which requires more thorough analysis. Stefan Weber, manager at TCC, uses conventional measurement and inspection equipment as well as future-oriented technology such as computed tomography (CT). In 2008 TE Connectivity was one of the first companies to invest in a CT machine.

Thilo Schnell, supervisor of computed tomography, is excited about the potential for analysis. „This lets us look inside the component without destroying it. It is ideal for evaluating the functional elements of assemblies, for example." The CT machine is also used for material inspections such as void analyses. Schnell says: „In connectors we primarily use plastic components in which

The TE Connectivity Test Competence Center (TCC) in Bensheim is responsible for validating products according to automotive test specifications
Images: TE Connectivity / WerthMesstechnik

the contacts are embedded. Gas inclusions can occur during the injection molding process and can lead to both mechanical and functional problems." Foreign material inclusions that would negatively affect the final product can also be detected using CT.

Rapid CT Analysis for Visualizing Contact Interferences

The TCC covers many tasks. One of them, for example, involves visualizing contact interference in plug connectors when they are connected. Such inspections have previously required manual resin embedding and cross sectioning. This method is used less frequently, as such inspections are much easier and faster with the use of CT. Before, we had to embed the component in resin, then cut and grind it," explains Schnell. „With a CT analysis, no embedding is needed, which saves us the curing time. It is also possible to set the sections at any desired position. And if a section does not provide a clear and useful result, we can create a new one with minimal effort and without wear."

With these positive experiences, Weber and Schnell came up with ideas and requests for additional areas of application for computed tomography. Weber explains: „The CT machine that we bought in 2008 is designed solely for analytical inspections and therefore has a limited scope of capabilities. CT provides ideal conditions for many metrological investigations. So we went looking for a coordinate measuring machine with CT from a measurement specialist that would stand up to certification, which we call Measurement System Analysis (MSA)."

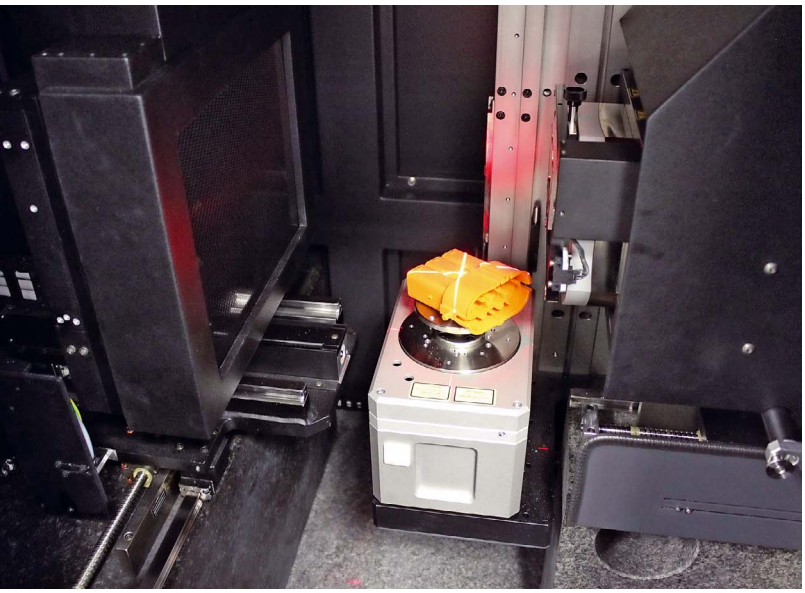
The Bensheim team found what they were looking for at Werth Messtechnik, manufacturer of multisensor coordinate measuring technology. Werth managing director Dr. Ralf Christoph emphasizes: „Werth was the first, and for some time the only, manufacturer of an X-ray tomography machine that is specified like a coordinate measuring machine per VDI/VDE 2617. We also have the only lab in the world that is allowed to calibrate a CT machine with DAkkS accreditation."

In September 2013, TE Connectivity invested in the Werth Tomo Scope 200, which is very well suited for qualitative analysis and for dimensional measurements. „TCC is mainly responsible for integration in the development process and final validation in order to shorten the time frame for development processes," argues Weber. „With appropriate measurement technology like the Tomo Scope, we can greatly reduce development effort." The Tomo Scope is a coordinate measuring machine that is able to measure connector components with tolerance of a few hundredths of a millimeter down to a few microns. The measurement system analysis demonstrates that the measurement uncertainty on the workpiece has a reasonable ratio to the part tolerances. „Typically we assume a factor of 10," explains Weber. „We can confirm this level for the Tomo Scope as well. The MSA is very important to our company in order to ensure that our measurement technology will satisfy our customers. Werth contributed to this test in a leadership role and we are very grateful for the support we received."

Thilo Schnell (left), computed tomography supervisor at TE Connectivity, in conversation with Werth president Dr. Ralf Christoph in front of the Tomo Scope 200

Werth also proposed a customer-specific solution that considered the limited space available and the lack of accessibility in the metrology lab. The compact Tomo Scope 200 was equipped with a high-powered 225 kV transmission tube with 25 W target power (now upgradeable to 50 W), which at this time was available only for larger CT machines, and a high-resolution detector with 4000 x 3000 pixels. Some background: the X-ray voltage describes the energy of the radiation, which in turn determines how hard the parts to be analyzed may be in terms of radiographic opacity. Because TE Connectivity commonly uses hard plastics with glass fiber reinforcement, the high voltage of 225 kV is necessary. Despite the high power level, the transmission tube is able to generate a very small focal spot and thus a sharp image.

The user-specific configuration of the Tomo Scope 200 also includes the raster and ROI tomography functions, as well as a laser crosshairs as a positioning aid in order to help the user center the component on the rotary table. Raster tomography makes it possible to capture the workpiece in several steps and to merge the measurement results precisely using the software – a function developed by Werth that is possible only with a unit that is built like a coordinate measuring machine. Schnell appreciates this. „We can use this to measure large connector plugs at high resolution, for example." In order to measure segments at particularly high resolution, he uses ROI (Region of Interest) tomography developed and patented by Werth. This involves taking an overview scan of the entire workpiece, then capturing the desired smaller segments separately using tomography. The software merges the scans so that the user can analyze high-resolution details.



Laser crosshairs as a positioning aid: with this additional function, the user can easily center the component to be inspected on the rotary axis

TE Connectivity has been able to use the Tomo Scope to greatly accelerate many measurement processes. Schnell indicates one example of the effort required to measure a 200-pin connector plug: „With a conventional coordinate measuring machine, programming alone takes much longer than I needed for the entire measurement with the Tomo Scope. I can program and measure this type of part with CT within a few hours."
Whenever more than ten features need to be measured, tomography is faster, says the measurement technician. Typically after 20 to 30 minutes the digital 3D data are available and can be analyzed using the software. The more dimensions need to be captured per object, the greater the time benefit. „Even a small plug connector has a huge drawing effort behind it, with a great many dimensions," adds Schnell.
For plug connectors, the chamber geometries in which the contacts and pins are inserted are also very important. Using conventional tactile measuring technology, one would have to contact several defined points or scanning paths in the chamber, and then the information would be limited to the specific points that were captured. Using CT, the measurement technician can capture the surface of the entire workpiece metrologically and visualize and analyze it in the software.
One great benefit of CT for Schnell is the complete capture of the workpiece and the associated ways to view it. „We often apply a nominal-to-actual analysis. That is, we take the 3D measurement point cloud from the CT measurement and overlay it on the CAD model. The result is a color-coded image with colors that indicate the status – with respect to tolerance, too great or too small – at a glance. Instead of having to analyze a lot of tables with measuring data and compare them against drawing nominals, we can immediately see where there may be problems."

Measurement Data Are Visualized and Analyzed in Werth 3D Viewer

In addition to the direct time savings for measurements, the interfacing departments also gain some advantages, as Weber reports: „At the end of the test we create a digital report. It consists of an analysis on paper and the data from the color-coded images. Every authorized engineer at TE Connectivity can call up, visualize, and analyze this dataset at his own computer." Werth provides a 3D viewer as a free Internet download for these tasks. This means that Tomo Scope does not just provide benefits to the CT lab and engineering. The captured data can be exchanged and discussed easily with mold makers or customers around the world.
Weber and Schnell are very satisfied with this partnership and Werth is already developing additional sophisticated software features for multiple-material workpieces, for example in order to more precisely measure plastic plug connectors populated with copper pins. ■

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