

**MULTISENSOR SYSTEMS ARE THE BASIS FOR ZERO-DEFECT PRODUCTION**

## Metrology for the Future

**Electronic components such as plug connectors are getting smaller, presenting ever greater challenges for manufacturing. ERNI Electronics uses 3D CNC multisensor measuring machines to secure its manufacturing processes, one of which has mastered X-ray computed tomography. Modern metrology allows rapid process validation.**

ERNI Electronics has embraced „zero-defect production.“ The company produces a wide range of circuit boards and I/O plug connectors, backplanes, cables with plug connectors, housings, systems, and tools in Adelberg, near Stuttgart (see box, page 3). Many of the products end up in the automotive industry via supplier companies, where the installed components are subject to particularly high quality requirements.

Accordingly, the quality assurance department is professionally equipped. In the measurement lab, in addition to various 3D CNC multisensor measuring machines, there is also a coordinate measuring machine (CMM) with an X-ray computed tomography sensor. One multisensor coordinate measuring machine is even used in production in order to allow workers to rapidly check the results of their work. Oliver Jehlitschke, Head of Quality Management, explains: „The automotive industry in particular always wants to increase the packing density of circuit boards. This means that the plug connectors that we develop are continuously getting smaller. We therefore have to adapt our production and measurement prerequisites on a continuous basis.“ His department’s long-term guide and partner is Werth Messtechnik GmbH.

The company from Giessen is one of the leading providers of modern coordinate metrology and specializes in coordinate measuring machines with optical sensors, X-ray tomography, and multisensor coordinate measuring machines.

Back in 1996 a VideoCheck IP 250 was installed at ERNI, a compact machine that is used for optical measurement of plug connectors, housings, and punching strips. It has since been replaced by a newer, more precise version of the same type of measuring machine. For larger components, ERNI uses the VideoCheck FB fixed bridge measuring machine, which covers a measurement volume of (400 x 400 x 200) mm and was put into service in 1999 (Figure 1). It is equipped with telecentric optics, as well as the patented Werth Fiber Probe and a conventional 3D trigger probe.



## Computed Tomography Supplements CMMs

One highlight in the ERNI measurement lab is the Werth TomoScope HV Compact, which has been in use there since 2008. This coordinate measuring machine utilizes computed tomography to analyze or measure components without contact, at micron precision (Figure 2).

The principle is as follows: Radiographic images of the test object are taken at various rotational positions. Then a 3D reconstruction of the individual images is performed to create a complete 3D volume that describes the entire internal and external part geometry. Measurement Technician Rüdiger Teufel explains: „We use the TomoScope to measure all of our empty housings and some assembled plugs, including male and female multi-point connectors. Our delicate punching strips can also be measured with the TomoScope.“

The time saved in the creation of a reliable production process was the deciding factor for the investment in this sustainable technology. Nominal-to-actual comparisons between 3D CAD data and tomographically measured 3D data can be used to generate color-coded deviation plots from the nominal model. This can be used, for example, to rapidly determine whether the plastic in an injection mold has been properly distributed or not. Depending on the results, the mold or injection parameters are optimized until the process is reliable. Quality Manager Jehlitschke states more precisely: „We need to achieve a process capability index  $C_p$  of 1.67. This applies to the housing as well as to the contact strips that we punch.“

Rüdiger Teufel and his colleagues use the TomoScope to take micron-precision measurements: „For example, we do all of the first article inspections of our housings on the TomoScope. I can scan the components and have the entire 3D geometry available for analysis as a point cloud within a few minutes. It even measures the internal geometry of the component, such as chambers. Previously we had to cut, machine and polish the cross sections, now we can get virtual cross section images in the point cloud practically at the push of a button. This saves a tremendous amount of time. The cross section plane can also be moved to any position in the point cloud.“



Fig. 1. The fixed portal measuring machine is equipped with telecentric optics as well as a fiber probe and a conventional trigger probe.

The measurement technicians also use the volume section method, for which Werth has applied for a patent, on SKV punched strips. They do so in order to capture a dimension that is important for its function later (Figure 3). This procedure takes place alongside production, as Rüdiger Teufel points out: „We get one section from each batch. The strip is sent on for galvanic coating only if the inspected dimension is within tolerance.“

## Reliable Coplanarity Measurement

During the first half of 2015, the ERNI measurement lab will obtain another Werth VideoCheck S 400 model 3D CNC multisensor measuring machine. It is equipped with the latest sensor technology, such as the Chromatic Focus Probe (CFP) and the focus variation sensor, Werth 3D-Patch. Oliver Jehlitschke gives the reason for this investment: „The solder pads that make contact between the plug connector and circuit board must be in a constant plane within a tight tolerance in order to prevent defects in the downstream soldering process. We determine whether this has been met by taking a coplanarity measurement of all the solder points.“

One particular challenge is that the pins that protrude from the plug connector are bent to a 90° angle after assembly. This means that the bend angle and thus

the position of the solder pads can vary slightly. The longer the plug connector, the more difficult this becomes, due to shrinkage and distortion of the plastic housing. Currently this measurement task is primarily the job of quality assurance within the manufacturing process. A measurement system integrated in the production automation systems for this purpose uses a triangulation laser to measure the height. This method is – as required in production – very fast, but not as precise as the Werth VideoCheck machine that provides reference measurements and greater process reliability in the measurement lab.

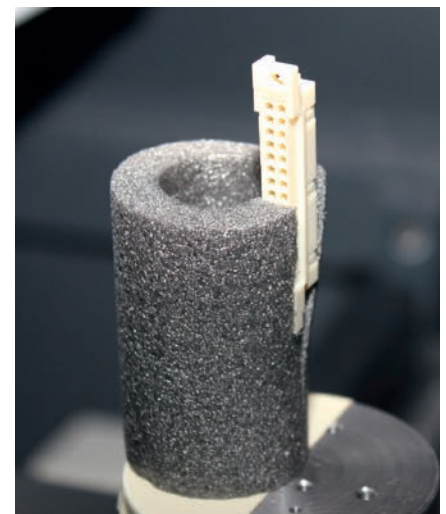


Fig. 2. The coordinate measuring machine with computed tomography measures various components without special fixturing.



### The World of Plug Connectors

ERNI International AG is a leading producer of plug connectors, backplanes, and complete systems, soldered assemblies, and finished cables, with locations in Europe, North America, and Asia. The German subsidiary ERNI Electronics GmbH & Co. KG was founded in 1956 and is headquartered in Adelberg, east of Stuttgart. The main location for development and production there is also home to a wide product range that serves not only the industrial electronics and data-com markets, but increasingly suppliers to automotive companies as well. Its portfolio of services is also impressive. Its Electronics Manufacturing Services (EMS) range from electronics development, to circuit board population using press-in or soldering technology, to inspection technology, assembly mount production, and cable plug connector manufacturing.

ERNI employs 900 workers worldwide, including about 600 in Germany. The corporate group reported total sales in 2014 of about EUR 141 million and plans to increase this by about 10 percent this year.

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Rüdiger Teufel explains: „We are completely confident in the potential that our new VideoCheck S 400 with Werth 3D-Patch and CFP will provide us. The machine has the latest digital camera technology, the Werth HiCam, which provides optimal conditions for the contrast focus variation method. We can use a standard to establish reference dimensions that production uses for comparison with in-line measurement results in order to make any needed corrections.“



Fig. 3. The Head of Quality Management at ERNI, Oliver Jehlitschke (left), discusses important inspection features with his experienced Measurement Technician, Rüdiger Teufel.

### Measuring the Surface Topography

And this is how the Werth 3D-Patch works: While moving only the axis of the camera, similar to autofocus, images are taken continuously. From these images the maximum contrast for each image is evaluated. The contrast maxima within the image stack provide the measurement points, which describe the three-dimensional component surface.

A new patent-pending focus variation method makes it possible to measure surface topographies over an extremely wide dynamic range. Dark and light areas of the same segment of the object can be captured simultaneously with optimal lighting; from this a measurement point cloud can be calculated. The highest points of the individual pins can then be captured and used to define a contact plane. This allows simulation of how the component will be positioned prior to the soldering process, and measurement of the solder pad spacing.

The chromatic focus sensor provides an alternative measurement method. This is a one-dimensional distance sensor that captures scan lines as the machine axes move it over the component. Point clouds are then calculated from these scan lines and evaluated. Due to its physical properties, this method is excellent for measuring shiny and mirror-finish materials.

Oliver Jehlitschke justifies ERNI's repeated selection of measurement technology from Werth as follows: „First, Werth measuring machines provide continuous high precision. I can confirm this from many years of experience. Second, the technology that Werth brings to the market is always fully developed and reliable. And third, our working relationship is excellent, whether in service or application support, especially for new technologies.“ □

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