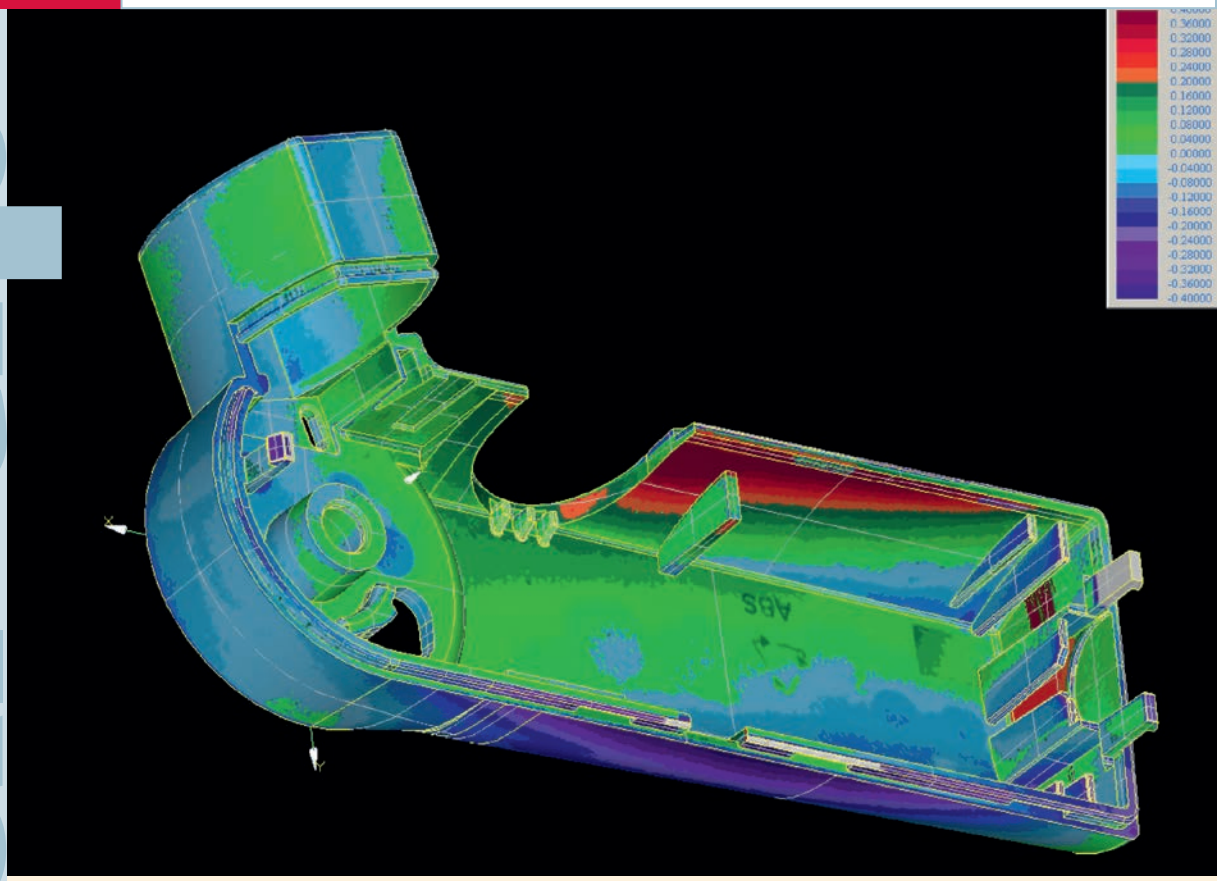
practical tip



MULTISENSORS AND COMPUTED TOMOGRAPHY

# The Application Determines the Sensor

**Selecting the right measuring equipment for dimensional measurement tasks is very important. The basic approach is: the application determines the sensor. The user needs to consider various aspects when making this decision.**

Nearly any measurement task can be solved quickly and effectively today by integrating various tactile and optical sensors with multisensor coordinate metrology (CM). Coordinate metrology with computed tomography (CT) also provides the ability to save time by easily capturing entire workpiece geometries in a single measurement run.

## Multisensor Coordinate Measuring Machines

Due to their high level of flexibility, multisensor coordinate measuring machines are used in many applications today. Several optical and tactile sensors are calibrated precisely to each other and capture even complex workpiece geometries when used in combination. Optical sensors measure without making contact at a distance of a few tens of millimeters from the measured object. They include the image processing sensor that measures laterally, as well as distance sensors that measure single points or the full 3D shape. Benefits include high measurement speed and the ability to measure workpieces that are easily deformed.

The need for tactile measurement of very small geometries at high precision is met by the Werth Fiber Probe. This sensor works with very small tip diameters, down to 20 µm, with negligible contact force (Figure 1). With all of these sensors, the measurement positions can be selected with the help of the CAD model that is input into the measurement software. By clicking on individual surface segments of the model, the measurement positions are automatically distributed, the selected sensor is positioned and the measurement points are measured.

## Computed Tomography

Measuring with computed tomography is even simpler. Instead of individual mea-

surement points or scan lines, as with conventional CMMs, the CT produces a point cloud of the entire workpiece. It also captures internal geometries and undercuts, which conventional sensors can reach only with great difficulty, if at all.

Voids, pores, and inclusions are also detected. Deviations between the measured point cloud and the CAD model can be displayed automatically in a color coded deviation plot. Clicking on the CAD model defines dimensions such as distance, radius, and angle, as well as shape and position tolerances. By inverting the deviations on the CAD model, a file can be generated for correcting the tool used in manufacturing.

In addition, there are entirely new possibilities for measuring assemblies. Up to now, this has required that the whole unit be disassembled or destroyed. Today the operator can evaluate the assembly visually or measure dimensions and offsets between the individual components.

A typical CT measurement requires a couple of minutes to a few hours depending on the size of the workpiece and the resolution required. By measuring several workpieces at the same time within one measurement run, the measurement time can be significantly reduced. With an integrated automatic loading device, the CT can tomographically scan many workpieces without operator intervention, working throughout the night, for example. If the loading device is located within the X-ray protection cover of the machine, additional setup times (switching the X-ray tubes on and off and warming them up) can also be reduced.

## Multisensors or Computed Tomography?

When deciding which machine or sensor type to use for a measurement task, many aspects must be taken into consideration. In addition to the required precision, minimizing measurement time is particularly of interest. For nearly all sensors on coordinate measuring machines, the general rule is: the more features there are to measure, the longer the measurement takes.

Due to the area sensor principle and direct travel paths between measurement positions, the measurement time per feature is much lower for the image processing sensor than for tactile probes. For the CT sensor, however, the measurement time is independent of the number of dimensions to be measured, because many 2D radiographic images must be taken while the workpiece is indexed through 360°.

As a result, the use of computed tomography is recommended particularly for measuring entire workpieces. For example, if an initial sample measurement is required for complex plastic housings that come from a 64-cavity mold, then the CT sensor provides a clear advantage. The measurement time per workpiece is about 10 to 20 minutes. The result is the point cloud of the entire workpiece, a comparison of this point cloud with the CAD model and all desired dimensions.

In contrast, preparing a first article report using one or more conventional measuring machines can take several days and may require that the part has to be cut in order to check internal features, but this is a far cry from the complete capture of the entire workpiece using CT. Typical applications for coordinate measuring machines with CT include plastics for the automotive and medical industries, plug connectors, aluminum housings, implants made of titanium or ceramics, and small steel parts such as gasoline and diesel injectors.

If, however, just a few dimensions are to be measured during the manufacturing process, then the advantage goes to the coordinate measuring machine with image processing sensor, possibly including a tactile sensor. With a machine like that, measurements take a few seconds to perhaps a maximum of one minute. A complete tomographic scan for measuring features and tolerances in the range of a few microns would take several minutes.

The typical areas of application for the CT sensor can generally also be measured using multisensor coordinate measuring machines. Additional applications for multisensor CMM include circuit boards, lead frames, printed films, aluminum, plastic and rubber profiles, and large steel and brass parts such as cylinder heads and valves.

▶ **Werth Messtechnik GmbH**
**Dipl.-Phys. Bernd Weidemeyer**
**bernd.weidemeyer@werth.de**
**T 0641 7938-0**
**www.werth.de**

*Translated by Werth Messtechnik GmbH*

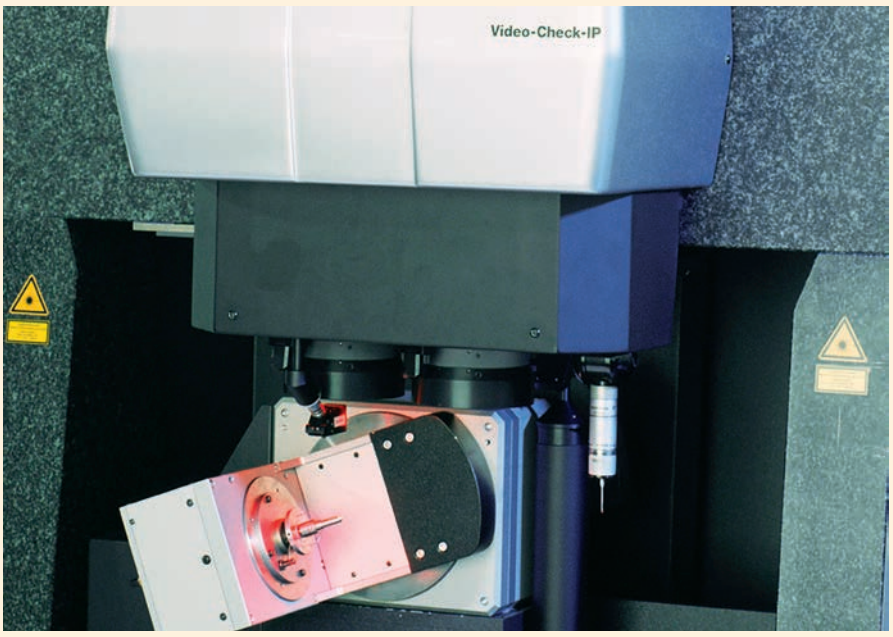



**Figure 1. Multisensor coordinate measuring machine with three sensors: Image processing, conventional probe, and fiber probe**

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