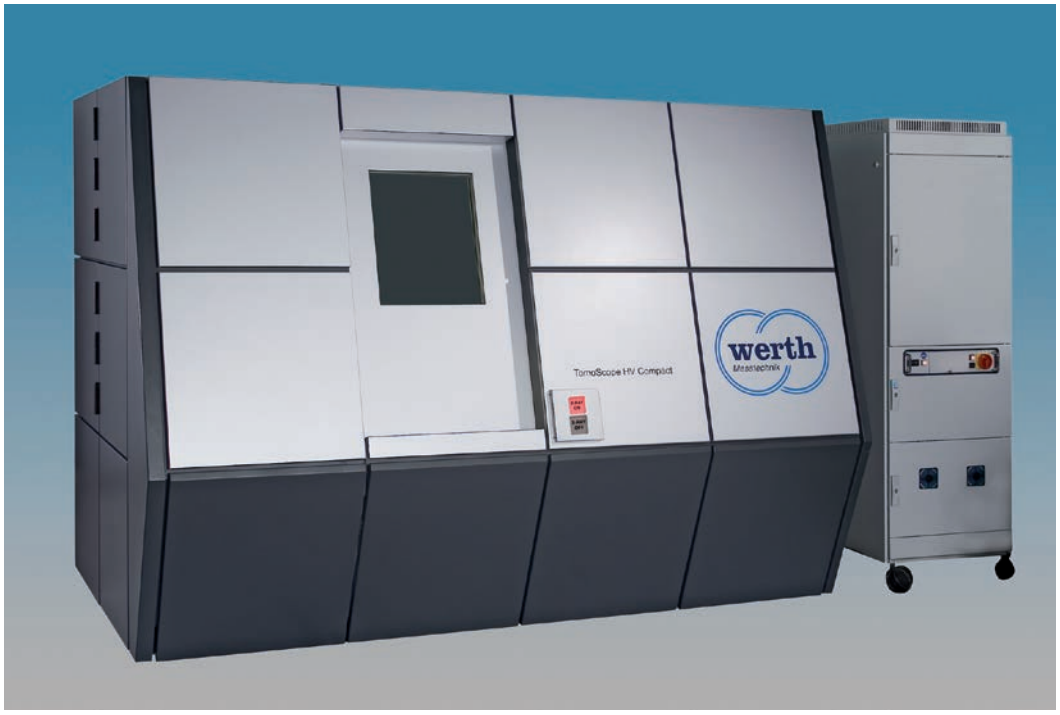
Measuring with Precision and Insight

Multisensor Systems Monitor Quality in Production

Quality assurance uses various measuring machine concepts depending on the measurement task: for production monitoring, extremely fast machines are needed and high-precision multisensor coordinate measuring machines are required for workpieces with tight tolerances. For first article inspection, however, computed tomography that captures the workpiece completely is desired.



Indispensable for first article inspection: computed tomography (here, a TomoScope HV Compact) can capture the complete internal geometry of a workpiece in a very short time.
(© Werth)

When first used in industrial applications, computed tomography was used only for non-destructive workpiece testing for cracks, voids, or similar defects. In order to capture dimensions with sufficient accuracy, however, it had to be combined with coordinate measuring technology. Werth Messtechnik GmbH, Giessen, had just presented the world's first coordinate measuring machine with computed tomography in 2005 (with a multisensor system option) when a pilot project for implementing Werth X-ray tomography in dimensional metrology began at Julius Blum GmbH in Höchst (Vorarlberg, Austria.)

The end result of this project so far has been several CT machines, with various equipment levels, that are now indispensible for first article inspections at Blum. The latest machine has a 300 kV nanofocus X-ray tube and has allowed precision measurement of steel components since 2015.

The working relationship between the companies, however, has a long prior history. "Back in 1994 we purchased our first Werth multisensor coordinate measuring machines," reports Heimo Masser (**Figure 1**), responsible for coordinate measuring technology at Blum. The number of machines in use has since grown to 30 units. "Most machines do their jobs at production locations in Vorarlberg, where they work 3 shifts a day running over 6000 different measurement programs."

Extreme Variety of Tested Parts

The variety of parts to be tested by the manufacturer of hinges, covers, and drawer systems for high-quality furniture is enormous. Dimensions vary from the size of a pushpin for plastic parts to lengths of over a meter for guide rails. Because the quality requirements for the workpieces also vary greatly, a variety of machine concepts have been selected.

In order to have the highest possible throughput for production monitoring,

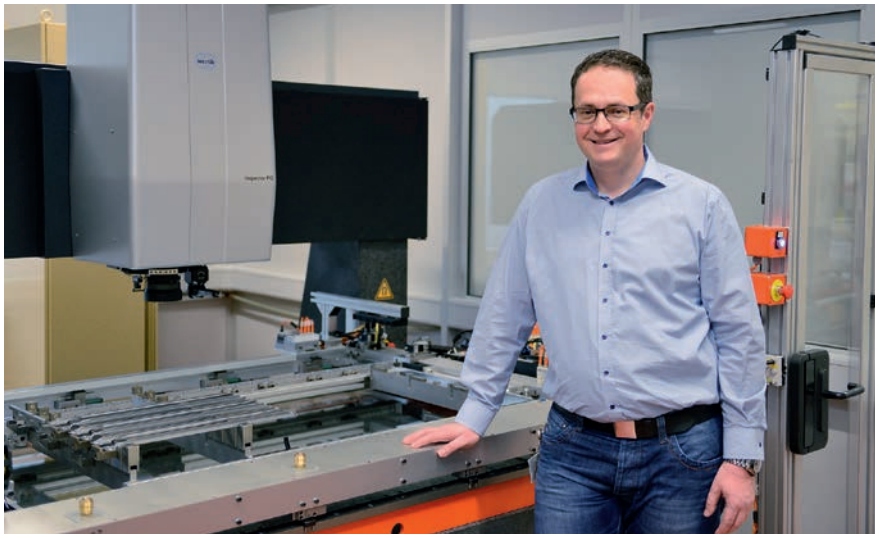


Figure 1. At the world's fastest multisensor coordinate measuring machine (according to its manufacturer): Heimo Masser (here, at the Inspector FQ) is responsible for coordinate measuring technology at Blum. (© Blum)

Werth Inspector FQ machines (**Figure 1**) with axis acceleration of up to 1 g are used. Thanks to their linear drive systems, they can reach high measurement speeds of up to five axis positioning moves per second. With the patented "OnTheFly" method, the image processing sensor records measurement points while the machine axes are in motion. This is how the measuring machine reaches up to ten times the measuring speed of conventional machines, with measurement frequencies of up to 15 features per second.

Precision of a Few Microns

Werth VideoCheck machines have air bearings and stable granite design (**Figure 2**), with a fixed bridge for high-precision measurement tasks with measurement uncertainty of a few microns. They are the core of the multisensor building block system, with maximum permissible errors in the range of tenths of microns for the highest-precision class.

TomoScope machines with computed tomography sensors (CT) are used for dimensional first article inspections and non-destructive testing. They are fully enclosed machines, so no further radiation protection measures are needed. Nearly all measuring machines use clamping fixtures developed in house, which the operator typically loads directly. The measurement data are automatically transferred to the in-house SPC system (Statistical Process Control) for process monitoring, allowing the production process to be controlled.

Measuring Machines Keep Up with the Times

When this cooperation began, it was already clear that the existing measurement programs would need to remain upwardly compatible, even after updates and hardware upgrades. Software service contracts and close cooperation with Werth software development and applications engineering have made continuous updates possible over a period from 1994 to today. The users always have access to the latest software functions.

As the software has been updated, some hardware changes became necessary as well. In addition to electronic systems, individual components such as light sources or even scale systems have been modernized. "Many machines were updated to the state of the art several times over the years in order to meet increasing requirements," remembers Heimo Masser. "These adaptations mean that today even our 'young-timers' from the 1990s are at nearly the same performance level as current machines."

Greater Speed with X-Ray Tomography

Before X-ray tomography was introduced, the company largely relied on conventional 3D metrology to obtain releases for the tool shop. This classical method, however, was very complex and often required several days. With X-ray tomography sensor systems, the measurement results were ready in just a few hours in the form of color-coded 3D images. Measuring the entire workpiece, including internal geometries, meant immense time savings, as the subsequent nominal-to-actual comparison with 3D CAD data identified problem areas on the workpiece at a glance.

"For us, the machines paid for themselves very quickly, even if they seemed to be expensive at first," says Heimo Masser. First article inspection of plastic

Figure 2. For high-precision measurement tasks: the highest-precision class of VideoCheck machines can reach a maximum permissible error in the range of tenths of microns. (© Blum)

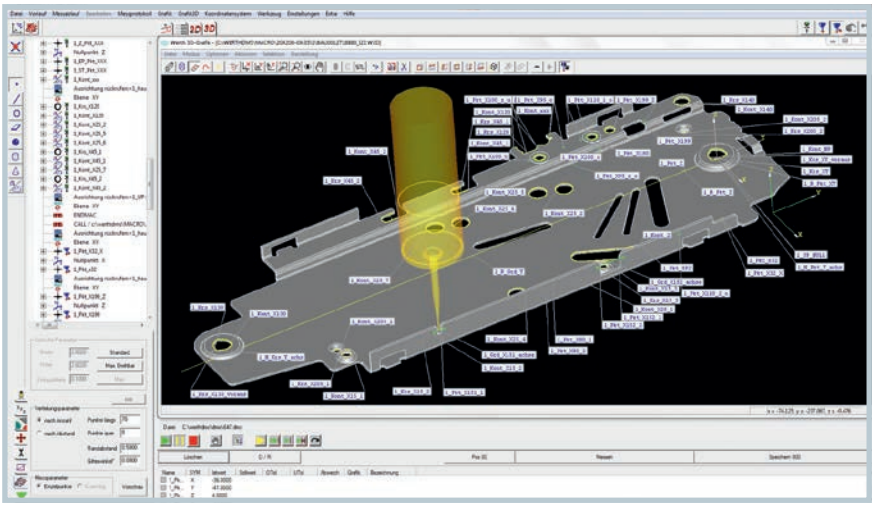


Figure 3. Create measurement sequences offline: remote programming and simulation using WinWerth measurement software. (© Blum)

parts and the associated tool releases are now the main area of application for CT machines. The current high-performance machines can measure not only plastic parts, but also steel, zinc, or aluminum workpieces. "Entire assemblies can even be measured in the assembled state, and dimensions or position deviations between the components can be determined," emphasizes Masser. "Even the installation orientation can be evaluated visually."

Radiation Protection Included

Depending on the material, size, and desired quality of data, the X-ray voltage must be varied. Werth offers a range of fully protected machines with X-ray voltage from 130 kV to 300 kV, and even specialty machines with up to 450 kV for larger, heavy workpieces. Special mathematical methods for correcting artifacts have been developed in close cooperation, in order to minimize systematic deviations in the tomography process.

A workpiece feeding system integrated in the measuring machine allows unmanned operation around the clock. Because the workpiece changeout system is integrated in the measuring machine itself, no additional precautions for radiation protection are required, such as more complex robotic applications, which means that operational reliability is increased. The automated loading process increases the productivity of the machines by up to 300 percent in comparison with conventional operations. "Today we measure over 4000 workpieces a year with our CT machines, which means they are completely utilized," says Heimo Masser.

Offline Programming with CAD Data

Today, using WinWerth measurement software, measurement sequences can be created from 3D CAD data away from the machine. Optimal measurement methods can be determined at the CAD workstation and measurement sequences can be simulated graphically. Programs are thus available prior to the start of production (**Figure 3**). This methodology minimizes the downtime of the measuring machine due to programming work. Even the lighting for the image processing sensor can be programmed using CAD data. For difficult contrasts, the lighting settings can be adjusted later in stepwise mode at the measuring machine to suit the workpiece properties.

Blum uses parameter programs for families of parts to create measurement sequences quickly. When the workpiece type is entered, they take the remaining variables from the prepared dataset and automatically generate the associated measurement sequence.

Outlook

Increasing production complexity makes it more and more critical to capture measured objects completely and rapidly using 3D sensor systems. X-ray tomography is good for this, while classical multisensor coordinate metrology is valuable for rapid SPC inspection. The measurement software emphasizes offline programmability and intelligent functions for interactive operation. Regular technical exchange of ideas is important for successful cooperation between the user and the machine manufacturer over the years. Early planning helps to incorporate user requests in the development phase, bringing benefits to both sides. ■

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Profile

Since 1952, Julius Blum GmbH in Höchst (Vorarlberg, Austria) has produced high-quality hinges, covers, and pull-out systems for quality furniture. With around 6600 employees around the world, the family-owned company is currently a supply partner for the furniture industry everywhere in the world. Blum has seven plants in Vorarlberg and additional production locations in Poland, the USA, and Brazil. In order to meet its customers' quality requirements, the hardware manufacturer has used multisensor coordinate measuring machines from Werth Messtechnik GmbH in Giessen for over two decades.

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