

Hybrid CMM makes multiple sense

*New coordinate
measuring machine
is built for
multisensing.*

By Charles Bates,
senior editor

OGP's Quest 650
multisensing CMM lets
shops measure parts
using contact, optical,
or laser scanning.

Multiple-sensing coordinate measuring machines (CMMs) typically evolve by adding other sensing capabilities to a machine originally designed for a single sensor. For instance, some traditional touch-probe-based CMMs are using video sensors. Such machines usually do not get the best performance from the add-on sensors. But now, one metrology company offers a multisensor CMM specifically designed to accommodate multiple sensing technologies.

The Smartscope Quest Series Model 650 CMM from Optical Gaging Products (OGP) Inc. in Rochester provides optical, contact, and laser-scanning capabilities through the integration of common sensing devices. These include telecentric zoom lenses, video, touch-trigger probes, contact-scanning probes, through-the-lens on-axis coaxial lasers, and off-axis triangulation lasers. Other devices include microprobing sensors, low-contact-force probes, and white-light probes. The machine lets shops do most measurements of a part on one machine with a single setup. Not only does this save time, it eliminates the need to purchase several different types of measurement machines. And operators need only learn one software.

Bill Gilman, OGP vice president of North American sales, says the Quest 650 is a step toward providing shops with a

single measurement machine for most measuring needs. For example, large parts like engine blocks aren't typically measured on video-type CMMs because the parts have complex features at multiple orientations not accessible to video sensing. The fact that touch probes and lasers can access features video cannot means many more measurements are possible on the Quest 650. With sensor data combined in the metrology software, a complete, detailed measurement analysis of the part is fast and easy.

Innovations for multisensing

What makes the Quest 650 a well-suited platform for multiple sensing are innovations in its mechanical design and software. These innovations provide better mechanical accuracy and seamless switching from one sensor type to another.

The machine measures 24 in. in X, 26 in. in Y, and 12 in. (16 in. optional) in Z. OGP uses special volumetric accuracy-calibration techniques to achieve an accuracy formula of $1.0 + \frac{4L}{1,000}$, unheard of for a machine of this size.

"We put a lot of effort into the Quest 650's X and Y axes as far as accuracy is concerned,"

remarks Ed Merritt,

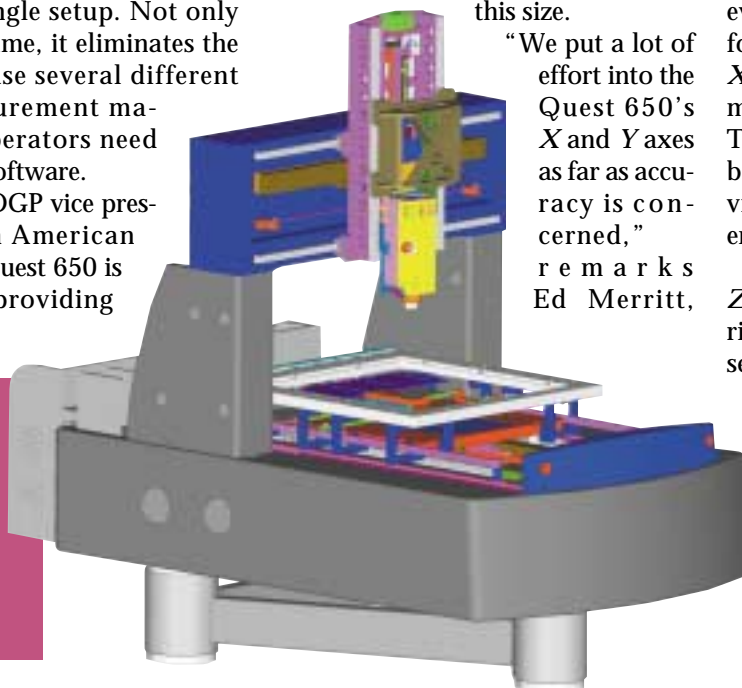
senior mechanical engineer at OGP. A big part of that effort focused on reducing the amount of thermal energy introduced by other components that would degrade axis accuracy.

OGP locates all the Quest 650's electronics in a cabinet behind the machine and away from its axes. The company also equips the CMM's X and Y axes with liquid-cooled linear motors. All this keeps operating temperatures within a few degrees of ambient room temperature.

However, the most notable design innovation for improving accuracy is the Quest 650's Z axis, which delivers straight-line, accurate motion, says Merritt. The Z axis is not a typical ball-slide setup, but, instead, uses a linear-rail-type system that fully supports the axis through its entire length. The system incorporates a coaxial mounting scheme between the bearing ways and the machine's optics to reduce the influence of angular error.

The Quest 650's patented optical-system components are made for metrology. Its telecentric zoom-lens keeps the image size the same even when the part is not at perfect focus. This feature ensures accurate X/Y-plane measurements throughout magnification and focus changes. There is no need for a focus routine before measurements, and there is virtually zero distortion across the entire zoom range.

A box structure surrounding the Z-axis optics provides support and rigidity and keeps the system's other sensors from adversely affecting performance. Usually optics mount to a ballslide, and if there are any angular errors, the mechanical system amplifies them. Since the Quest 650's optical axis is coaxial with the mechanical axis of motion, angular errors do not



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For part-fixturing needs, the Quest 650 sports a prewired panel featuring digital I/O ports for programmable fixturing, RS232 communication ports, air and vacuum ports, and other options.

translate into measurement errors.

In addition to its special design, the Quest 650's Z-axis length is substantially longer when compared to typical video-based CMMs. This increase in travel is essential to take full advantage of the Quest 650's contact-type sensing. "Touch probes require a certain back-off distance, so a long Z-axis travel is necessary for probing large parts," says Gilman. "And the large travel allows the Quest 650 to use video measurement on large parts."

To reduce measurement errors caused by vibration, the Quest 650 rests on a static, welded, three-legged support structure. Polymer damping disks between the machine's granite base and support structure isolate the machine from external vibrations. For even more vibration isolation, OGP can replace the static, three-legged support with a passive or active pneumatic system.

According to Gilman, speed is

just as important as accuracy when it comes to a CMM. "There's always pressure to drive down manufacturing costs," he comments, "so shops want as much productivity out of a CMM as possible." The Quest 650's stage speeds — 16 in./sec in X and Y and 8 in./sec in Z — contribute to high-throughput measurement.

OGP's custom-engineering group works with customers to automate loading/unloading and sorting operations. Applications typically involve robots, laser marking, and barcode scanning. Making the job easier is the Quest 650's fixed-bridge design, which opens up the platform area for interference-free,

overhead manual or robotic loading/unloading.

For automation, the Quest 650's software sends signals back and forth to any external loading devices. When the machine is done measuring a part, the software automatically activates the loading

equipment to unload it and load another.

Two other areas that OGP addressed when designing the Quest series are fixturing needs and protection from workshop environments. At the back of the machine's fixture-staging area is a prewired panel for connecting primary and secondary rotaries. On the panel are digital I/O ports for programmable fixturing, RS232 communication ports, air and vacuum ports, and other options.

To assure high-accuracy measurements in the production area, OGP can custom enclose the unit in a temperature and particle-controlled environment. Operators then run the machine from outside this enclosure.

Most enclosure applications, according to Merritt, involve the Quest 650 as part of a turnkey system. In such a situation, a touch screen replaces the machine's keyboard and mouse.

Seamless software

Tom Groff, corporate products manager at OGP, points out that, from the operator's standpoint, the integration of all sensors used on a Quest 650 is seamless. "For instance," he says, "a shop measuring a part using optics can easily make the transition to a touch probe via a 'get-the-probe command.'" All the



The Quest 650's software makes for seamless transitions so users can easily switch from one sensor type to the next.

behind-the-scenes work is automatic — maintaining offsets and nonlinear calibration.

One of the challenges OGP faced when developing its multisensing CMM was providing the ability to measure a part with all the sensors and still maintain a single volumetric-error specification. Two common ways to do this are having as little error as possible in the machine's mechanical components and applying different types of error-calibration techniques for the different types of sensors. The Quest 650's mechanical design ensures the former, while its software provides the latter.

OGP's software maintains offsets for the different sensing types. However, it also lets the company apply new nonlinear calibration-correction files throughout the whole volume of the different sensors, as opposed to a single plane. The software also oversees all the coordinate transformation that occurs when added rotary axes are in motion.

OGP can equip the Quest 650 with dual, rotary axes (*W1* and *W2*) for 5-axis measuring. This is especially useful for measuring complex 3D geometries that are not prismatic or cubic in shape, such as turbine blades for jet engines. According to Groff, shops can measure such parts/features in two ways. The first involves the part rotating under the sensor on a rotary table. This is typically the case when measuring with video or laser sensors. The second approach uses an articulating probe head to drive the sensor to the part. Regardless, the Quest 650 handles both approaches. ■

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