Technology

Walk-Up Metrology Strolls into Machine Shops

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There are many times when a machinist, while cutting a few parts or getting ready for an initial run, needs to check a few parts or a few critical features. Surfaces need to be spot checked, roundness or concentricity confirmed. Sometimes a hand gage will work, but with parts increasing in complexity and schedules getting tighter, more capable machines are often needed.

“There may be a toolmaker who is grinding a cutter or making a special form tool who just wants to measure a radius,” said Mark Arenal, general manager for ***Starrett Kinemetric Engineering*** (Laguna Hills, CA). In that case, he needs a walk-up metrology instrument that is both adaptable and capable of running a wide range of measurements. “Many of the instruments that we make work nicely for ‘walk-up metrology’ on the shop floor,” he said. Good examples are Starrett’s AVR and MVR line of 2D vision systems. These range from manual to full CNC. The toolmaker can walk up, place his part on the unit on the stage, image the radius of the cutter and quickly take a measurement, according to Arenal. “Very simple. One feature, one measurement, he gets some data, writes it down and walks away,” he said.

The key to the concept, especially for CNC machines, is as much in the software as in the machine itself. “The system software makes it relatively simple to use in that scenario, with minimal training. You can actually touch the feature that you are seeing on the screen and measure it,” he explained.

However, to be truly cost-effective the machine must also be adaptable for higher volume production. “For example, you may have an inspector who wants to perform a first article inspection at 100% on several parts—say, 10 or 20 parts. That inspector can write a part program on the same machine and create a measuring sequence to measure the first part, with all the needed data and report formatting. When done, the user can save the part program and subsequently measure the rest of the batch of parts,” he said. “This equipment will be more valuable to a company if [it can accommodate] multiple users and their jobs can be inspected.”

A particularly productive device from Starrett, according to Arenal, is the HVR100-FLIP, released in 2017. This benchtop vision measurement system can be used in either a vertical or horizontal orientation, and features high-resolution digital video and precision optics for accurate field-of-view measurements of up to 90 mm, according to the company.

Ease and Accuracy

Another compelling reason behind the use of vision and multi-vision systems is explained by David Wick, manager, product management for ***Carl Zeiss Industrial Metrology Technology*** LLC (Maple Grove, MN). ”People that want walk-up metrology are not typically after the last tenth of a micron,” he said. Usability is usually more important than accuracy. “This is a change in the paradigm. What is important is the ease of use and repeatability,” he said. He noted walk-up metrology requires a system that can recognize common features like circles, radiuses and slots. “So, you could click the button, quickly establish a measurement, type in a dimension and a tolerance, and away you go,” he said. He agreed that vision systems, such as the Zeiss O-Select line, are ideal for walk-up metrology. Zeiss vision systems include a full suite of capable software for identifying common features and creating parts programs.

Consistency is also important. “You want the machine to give good measurements no matter who has touched it,” said Wick. This means, in his opinion, adherence to ISO standards and the ability to capture routine measurements in a parts program. “The O-Select is calibrated to the ISO 10360-7 standard,” he explained. “It automatically focuses, illuminates, and can handle multiple copies of the same part,” he said. Reusability is also important. “Let’s say yesterday you built a quick program to measure five dimensions on a new flat 2D object, and today you came along with six prototypes. Put them on the machine, press a button and the machine would measure all six, one after the other,” he explained. “We see that often.”

Tim Moriarty, senior VP for ***QVI*** (Rochester, NY), agreed that newer video systems are easier to use. He noted that for shop-floor use they are competing with hand tools, such as micrometers or even more advanced tools like optical comparators that require little to no training. Therefore, the emphasis is on simplicity. “Some of our measuring systems allow anybody to literally walk up, put the part down in any position without a fixture, push a button and instantly get a series of measurements on the part—even a first article or in-process part,” he said.

Moriarty agreed with others interviewed for this article that such ease of use leads to easy data transfer for process control and record keeping. The advantage of easy-to-use video systems is that they are inherently accurate and fast compared to other walk-up devices. “We are trying to improve on the experience of picking up a pair of calipers or putting the part on a comparator,” he said, by providing both faster and more accurate measurements. He noted that video measurement systems, such as the QVI Snap series, easily deliver accuracy to 0.0001–0.0002″ (0.00254–0.00508 mm).

“Our new range of Snap large field of view (LFOV) video measuring machines meet this demand,” he said. Snaps feature a 100-mm FOV, feature extraction, automatic parts ID, and better than 0.0001″ accuracy, according to the company. Models range from the benchtop Snap100 with a FOV of 100-mm diameter and no moving stage to the large capacity Snap 350 with over 350 × 350 mm of measurement range.

The Third Dimension

There are times when a fuller measurement in the third dimension is desirable or required, even in walk-up metrology scenarios. For that Moriarty points to the company’s QVI Fusion 400, a LFOV multisensor measurement system that automates 3D measurement. It has a 350 × 250 × 250-mm measurement volume and is multisensor-capable with video measuring and available trigger and scanning probes. It includes a TeleStar Plus interferometric TTL laser.

While vision systems are ideal for two dimensions and multisensor systems based on vision are ideal for two-and-a-half dimensions, sometimes measuring in full 3D is necessary. “That is where blue light scanners are ideal for this walk-up metrology concept,” said Wick. Zeiss offers its Comet line of 3D scanners based on blue light technology. “You can put your 3D workpiece or part on its rotary table, press a button on a laptop and it will turn the rotary table, scan the workpiece, and create a 3D model of it,” he said. Measuring critical dimensions and tolerances does require an available CAD model. However, if one is available, it may be the ultimate in a walk-up metrology concept.

“We see a clear trend with operators that have to inspect closer to the point of production, with production engineers and operators having to make good measurements at intermediate steps in the production process,” said Dan Brown, director, product management for ***Creaform Inc.*** (Lévis, CA). He heartily agreed that capturing 3D measurements requires a 3D device, such as Creaform’s HandyScan 3D, HandyProbe and MetraScan 3D devices. He noted that there is great demand for 3D metrology measurements in the 25–75 µm range of measurements, the ideal accuracy range of these devices.

“Calipers are very good, but are not sufficient to quickly measure complex parts in 3D,” he said. CMMs are accurate, but require a parts program—usually—and considerable expertise to operate adequately.

That makes the typical ease-of-use and portability of scanners ideal in applications where midrange accuracy is required. Speed provides its own ease-of-use. 3D optical scanners, including blue light scanners such as those from Creaform (and others), usually collect high rates of data, from 100,000 to 1 million points per second—much faster than a typical CMM and providing walk-up utility.

Another key point, as he sees it, is portability. "Some of our customers have a designated spot for using the scanner, where they bring the part to it," he said. "But they sometimes bring the device to the point of use." It is in a sense walk-up metrology in reverse. The advantage of keeping the device in a central location is that it is in a controlled environment. The advantage of being able to move it is flexibility.

Brown pointed to another universal issue that walk-up metrology has in common with metrology in general—the interplay between training requirements and technology that is easy to use and understand. "I would divide any metrology operation into two parts, measurement and inspection," he explained. Measurement is taking 3D points in getting those into a computer. What you need is inspection software to extract information to the features you want to measure. His point is that in any manufacturing operation you need people trained in both aspects measurement and inspection. Even better are both measurement and inspection systems and software that are equally easy to use. "Trained metrologists are hard to find," he stated, explaining Creaform's emphasis on developing easy-to-use inspection software and measurement equipment.

Another device that provides 3D measurements is the XM series hand-held CMM from ***Keyence Corp. of America*** (Itasca, IL). "It is designed to be used anywhere in any environment and to allow a user to walk up to it and get quick answers," said Steve Chirichella, regional product sales director for Keyence. The company pitches it as a portable CMM. A camera captures near-infrared light emitted from seven different markers on a hand-held probe to determine position of a stylus tip. "There are no moving parts," he explained. "We got rid of the encoders or anything else that wears down, making the machine durable and eliminating the need for maintenance and recalibration." Parts are placed on a movable stage. It should be noted that the system is designed for parts in the range of 3 × 2 × 1⅓ (0.9144 × 0.6096 × 0.3048 m).

While not requiring specific part programs to make measurements, the device can capture programs using augmented reality. It includes a small camera at the probe tip that can display not only the external appearance of the target but also a description of the measurement and the measured value. The software includes the ability to produce reports with the accompanying photos taken from the probe tip camera. For every measurement point, the device displays the element name and number as well as the measurement results in real time, on a picture captured by the camera displayed on the monitor in front of the operator. "Sometimes our customers put the XM device on a cart instead of a central location, bringing the device to the workplace," he said. It is especially useful in machine shops producing complex parts in small volumes with a high mix.

Alternative Concepts

Chirichella also noted that the Keyence IM video measurement system might also fit into the walk-up concept. The system is designed to replace the optical comparator or take the optical comparator into the 21st century, he said. Unlike other devices pitched as walk-up capable, the IM series requires the parts program to be written for it. "The machine is built for speed and almost painful simplicity," he explained. There is also a feature called "automatic measure" where operators place the part on the stage, draw a box, and it measures everything that more handily fits the walk-up paradigm. Chirichella told of one company that uses its quality lab to write programs for six or seven machines scattered around the plant, allowing users quick access to validated part programs.

Other tried-and-true devices, such as the manual CMM, also fit the walk-up metrology concept, according to Gene Hancz, product specialist for CMM at ***Mitutoyo America Corp.*** (Aurora, IL). He agreed that the trend is away from relying solely on inspection departments and more on making metrology

devices accessible to check their own work. He noted that the majority of CMM sales today are CNC controlled, where the manual CMM provides value for simple, single-dimension measurements. “Manual CMMs can be used two ways,” he explained. “One is where part programs are used for very specific checks that are used quite often. The other is where there is no program whatsoever, with somebody coming up to do a single, or two or three-dimensional check, and they’re setting things up manually.” That fits the very definition of walk-up metrology.

A good example is the Mitutoyo Crysta-Plus M Series 196-Manual-Floating Type CMM, which measures parts up to 700 × 1000 × 600 mm. Hancz said it is ideal for daily tasks, such as setting up a machine tool to check an initial part.

Finally, the simplest of tools should not be ignored in the context of walk-up metrology. “Height gages and surface plates are the most common items in the shop,” said Mike Creney, vice president of sales for Mitutoyo. “Most do not require power or air and with some decent math skills anyone can measure, examine and evaluate a part for tolerance acceptance. The old way still works with height stands, test indicators and it’s still the least expensive.” The best thing is that hand tools are easily taught to the most novice user. New developments in hand tools from Mitutoyo include the QuantuMike, a high-speed micrometer, and the MDH micrometer with 0.0001-mm resolution. “This brings the world’s best resolution to the shop floor,” he stated.

Creney also pointed to other tried-and-true devices, many of which Mitutoyo provides, such as profile projectors and surface roughness devices, though they do require some additional knowledge to operate. An automated CNC device should not be entirely ruled out in a walk-up scenario. “A typical way is to use a CNC system with a quick jig or fixture mounted to the measuring device,” said Creney. “If you are using multiple lathes, you may have a roundness system in a central location. In the monitoring stage you can have a dedicated mounting fixture to center the part and simply place the cylindrical workpiece into the fixture, hand tighten and press a button. In a matter of minutes you can evaluate the roundness and offset or modify the setup of the lathes.”

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