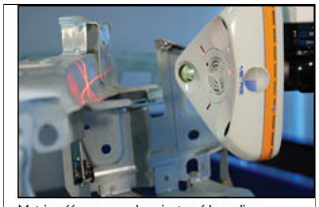
Measure It Fast

In metrology, speed on the floor requires not only fast and accurate measuring devices, but a total system design that minimizes operator involvement

By Bruce Morey
Contributing Editor

Fast metrology means more than fast collection devices when viewed from the perspective of the user, explains Jim Clark of Metris (Brighton, MI). Speed means measuring devices that minimize operator tweaking. Speed means software that minimizes setup and interpretation of results. Speed ultimately means ease of use, and to Clark that is a layered issue. Devices, systems, software, and integration all play a part in delivering speed.

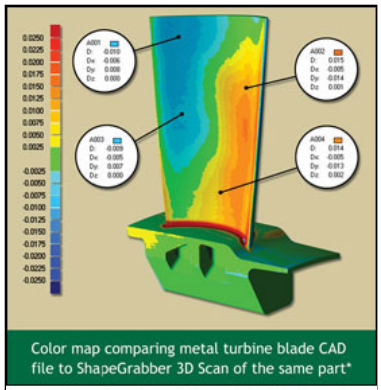

Metris offers several variants of laser-line scanners, such as the new XC65D with advanced processing capabilities, for integration with CMMs.

Devices available today for metrology include touch probes, scanning analog probes, laser scanners, and vision systems. One of the fastest units available is the laser-line scanner. Lasers are capable of data collection rates of tens of thousands of points per second (pps), but with speed comes some limitations. The most accurate laser-based systems still cannot achieve the accuracy of a touch probe mounted on a CMM. "For the majority of applications, the difference is minimal and likely irrelevant to the task at hand," says Clark, pointing to the need to match capabilities to the job.

The typical laser system, which uses triangulation, does not like a shiny surface that can reflect all light away from the camera. And it does not like a dark surface that absorbs all incident light. Objects with varying degrees of reflectivity, and/or bands of light and dark, throw off the readings taken by such systems. Using a laser on these objects requires operator intervention, or coating, before measuring. Coating and intervention slow the process no matter how many pps are claimed in the device specifications.

New digital laser sensors from Metris, including the LC60D single-line scanner, XC65D triple-line scanner, and XC65D LS long-standoff variant, solve some of these problems. Equipped with third-generation "enhanced sensor performance" (ESP3), these laser scanners adapt dynamically to shiny surfaces or surfaces that present varying surface finishes, darkness, and color to the device. The scanners vary the output of their lasers within each detected pixel. A digital camera then selects the reflected radiance that is easiest to convert into a measurement from the many within each pixel.

While not perfect—in a demonstration, a scanner needed one to two pixels to adjust when the laser crossed from a dark band to a light ban—this approach requires less improvisation by the operator. The "D" scanners also boast wider laser lines (60 and 65 mm), and a collection rate of 75,000 pps, according to Clark. The XC models also provide the ability to move between single and multiple-line modes for even faster scanning. Ultimate accuracy achievable to one sigma is 0.0006"(15 µm) for the LC60D and XC65D models, and 0.0008"(20 µm) on the XC65D-LS model. This technology offers seamless retrofit with most leading CMM brands through a PH10M(Q) motorized indexing probe head from Renishaw (Hoffman Estates, IL).



Because they collect data quickly, providing a big-picture view of the metrology of a part, laser scanners such as those made by ShapeGrabber offer more complete coverage.

Faster measuring devices are one thing, operating them in a system is another. Laser metrology offers easier setup, because a laser scanner often does not require a highly accurate fixture in the CMM. To make things even faster, Metris has also upgraded its Focus Scan software to version 5.2 for planning, scanning, and interpreting the results from laser scanners. Off-line, users plan how best to use the line scanner with a new point-spray feature that simulates a point cloud as if it were measured on the CMM. The

program is adjusted, if necessary, after examining coverage. Additionally, point-spray enables users to efficiently set up and automate the part program's downstream analysis and reporting workflow. It imports all common CAD formats.

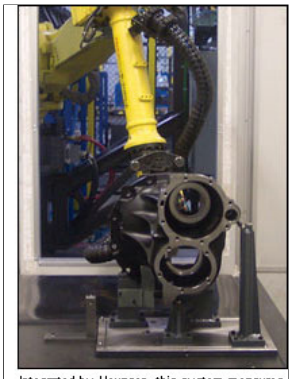
Brian Gudauskas, national applications manager for Hexagon Metrology (North Kingstown, RI) also looks at speed as a property of a whole system. His specialty is integrating metrology systems that feature CMMs, both for quality-control departments and for in-line manufacturing.

In many cases, the driver for an in-line CMM, paradoxically, is to reduce cost to deliver more accuracy. "You need to compare the cost of a relatively inexpensive CMM to what may be an expensive upgrade in machining capability. If the process is in-control enough to adjust based on metrology information—without scrap—you typically save money," Gudauskas explains.

Matching the needs of the process with technology for optimum speed is important, according to Gudauskas. "Sometimes you can overload people with data." He also emphasizes that delivering speed requires a speedy CMM—with high acc/dec rates. For instance, the ultra-highend PMM-F 700 from Leitz (Wetzlar, Germany) is capable of 650 mm/sec speed with an acceleration of 3000 mm/sec^2, while the more mass-market Global from Brown and Sharpe (North Kingstown, RI) has speed of 866 mm/sec and acceleration of 4330 mm/sec^2.

There are different levels on the value chain. If they have a highly capable machining process, some shops only need to put the first, middle, and last production piece on a CMM. On the other end of the spectrum are highly automated CMM systems. Articulated-arm robots feeding a CMM are useful for small parts. Pallet-loading systems fed by a turnstile are another option. Gudauskas also points to the need for flexible, easy-to-use software for off-line programming of software that can also address automation equipment, such as robots.

From his perspective as an integrator, he observes that touch probes and scanning analog probes continue to dominate most installations. Lasers and video are coming along, however. "Using lasers seems to be gaining some traction," says Gudauskas. Brown and Sharpe offers their ScanShark laser scanner with a collection speed of 23,040 pps and a measured accuracy for the V4ix laser scanning probe of 0.00094"(24 µm) at two sigma.



Integrated by Hexagon, this system measures critical features of parts, and prints labels that help workers select the proper components for assembly of a differential.

Turnkey off-the-shelf systems are another option. That's what ShapeGrabber (Ottawa, Ontario, Canada) offers with its line of laser-based automated inspection systems. "Our claim to fame is ease of use coupled with speed of inspection," says Pierre Aubrey, the company's CEO. While proud of the 3-D laser scanheads his company offers, Aubrey emphasizes the complete turnkey solution available from ShapeGrabber. "We decided to focus on automation, to make it as fast and easy to use as possible," he explains. "We strive for a one-click solution. You place the part on the scanner, you hit go, and the part gets inspected."

ShapeGrabber is inherently easier to program than today's typical CMM, according to Aubrey. "One only needs to have the part in hand. You tell the scanner the height of the part, the number of scans, and the rotation angles," explains Aubrey. Extracting information for inspection is done with third-party products from Geomagic Qualify (Research Triangle Park, NC) or Polyworks Inspector from Innovmetric (Quebec City, Quebec, Canada). Time required for setting up the project the first time may vary from 5 min to several hours. Thereafter, the time required for running the inspection project on the same part is reduced to minutes. "Special fixturing is not needed," says Aubrey, "because precise part position is not required."

Measurement volumes on the company's larger Ai810 systems are up to 48 x 30 x 27"(1250 x 800 x 700 mm), their Ai310 scan system's volume is a cylinder 12" tall by 7" in diam (305 mm x 180 mm)." The 3-D volumetric accuracy at two-sigma for our products ranges from 0.001 to 0.006"(25–150 µm), depending on the scan head used and the situation," explains Aubrey. The system collects from 18,000 to 100,000 pps.

Flexibility provides speed of its own. In its latest bid to replace hand gaging on the shop floor, Carl Zeiss IMT (Minneapolis) offers its DuraMax system, a form of turnkey CMM that offers more flexibility than handgaging. "Think of DuraMax as a flexible gage, not as a CMM," says Mark Busha, application engineer for Carl Zeiss. "It's intended for collecting a lot of data quickly." Equipped with a Carl Zeiss Vast XXT probe, DuraMax also has an option for a probe changer so the system can use multiple probes. The Vast XXT probe delivers both singlepoint and scanning capability. In scan mode, it collects up to 500 pps. DuraMax is designed for parts that weigh as much as 100 kg and fit into a 500 x 500 x 500-mm volume. The machine is fully shop-hardened, and measures to about 2µm of accuracy.

The DuraMax from Carl Zeiss IMT is a turnkey CMM used to replace hand-gaging for flexibility, speed, and accuracy.

"Rather than how many points per second the system can measure," explains Busha, "the real emphasis is on answering the question: 'Does the part perform as the engineer designed it?' For years, with hand-held or dog-house gages, we used to measure features like holes to a Gaussian algorithm. In the US, however, to meet the ANSI standard for roundness on a print, I need at least 350 data points. To do that sort of check, I need a scanning machine to do it in a reasonable amount of time. "With a scanning probe, I can do the measurement in a few seconds rather than hours."

Like any other CMM, DuraMax requires part programs to operate; they are provided by the Zeiss Calypso software. "Parts programs are typically changed in the Calypso software relatively quickly and off-line." Busha describes this process as getting easier all the time, with GD&T data embedded in many CAD programs. "The time-consuming portion of programming for a part was looking through the prints with a yellow marker to find datum reference frames or tolerances, usually on different pages. With the tools [and data] we have today, extracting GD&T is quick."

Multipurpose, multisensor metrology systems offer their own sense of speed. This assessment includes multisensor systems like

the Galileo AV 350 from The L. S. Starrett Co. (Athol, MA.) "It delivers throughput by providing a variety of measurement techniques on one machine," states Mark Arenal, managing director of Starrett Kinemetric Engineering Div. He points to aerospace and medical applications that often need 100% inspection as being particularly applicable to both in-line and off-line inspection using multisensor metrology.

The AV 350 is an evolution of Starrett's video-based multisensor platforms that use a traveling *X*-*Y* stage and independent *Z* axis. The AV350 offers a square 14 x14"(350 x 350-mm) *X*-*Y* work area and *Z*-clearance at 8"(200 mm). It offers vision, contact probe, and laser scanning. Probing options include a Renishaw PH6 contact probe with TP20 module and a Mark III Laser Probe from Optimet (Jerusalem, Israel).

This article was first published in the July 2009 edition of *Manufacturing Engineering* magazine.