▶ BY GREG LANDGRAF, ASSOCIATE EDITOR

Inspector Gadgets

Multisensor inspection machines can be an effective compromise between the accuracy of touch probes and the speed of video or laser inspection.

Modern manufacturing can achieve output and quality levels unheard of a decade ago. But these heightened capabilities have created new challenges. For instance, manufacturers once could reduce throughput to meet tight tolerances—or vice versa. Now, though, they must raise both productivity *and* quality.

In an effort to upgrade inspection processes to achieve this twofold goal, more companies are turning to multisensor inspection machines.

Multisensor inspection dates to the 1980s, said Fred Mason, marketing communications manager for Optical Gaging Products Inc., Rochester, N.Y. The technology just recently began making waves, however.

Werth America

A Werth America system inspects a diesel fuel-injector nozzle using touch, laser and video probes. Mounted below the camera is the company's fiber-optic probe, one of the new probe styles recently introduced to industry.

"There have been many advancements in sensor technologies, and a new level of acceptance by the market," Mason said.

"We're seeing demand for machines that combine touch probes, laser probes and video probes," said Bill Wilde, spokesperson for Mitutoyo America Corp., Aurora, Ill.

Each type of probe has strengths and weaknesses. Touch probes are highly accurate. The best have accuracies exceeding 10µm, according to Gary Card, marketing manager for Brown & Sharpe Inc., North Kingston, R.I. Touch probes can also measure small and internal features, but they do not provide the speed of a vision system, like a video or laser probe.

Video systems effectively identify edges, and laser systems are useful for capturing information about the surface. "A vision system captures hundreds of thousands of [surface-data] points," said Card. "It gives a better understanding of the part," even though it is generally accurate only to about 50µm.

Quick and Flexible

Proponents identify numerous advantages of multisensor inspection machines. The two most significant are adaptability and speed.

Mason said adaptability is especially important now, as technology allows engineers to design more complicated parts with tighter tolerances. "That's where it really helps to have a choice of sensors on a single measurement machine," he said.

Card gave the example of a turbine blade measured with a multisensor system. A specialized video camera located coolant holes, while a laser captured surface information and a

touch probe measured the turbine root, which had to meet tighter tolerances.

The adaptability of multisensor technology speeds inspection in two ways. First, it provides options that may save time in the inspection process.

"Sometimes, you have two or three probes that can measure something well," said Art Whistler, vice president of sales at Werth America Inc., Old Saybrook, Conn. "With a multisensor probe, you can choose the one that's fastest or most accurate."

Second, for complicated parts that traditionally would have some features measured on one machine and other features on a second, the multisensor machine eliminates the time consumed by multiple fixturings.

Moreover, multisensor machines can save floor space by eliminating the need for other inspection equipment.

"An additional advantage," said Kevin Legacy, engineering manager for Carl Zeiss Inc., Maple Grove, Minn., "is that you're only working with one company for calibration and maintenance."

The Accuracy Issue

Multisensor inspection machines have been knocked as less accurate than their dedicated, single-probe counterparts. Each sensor must be calibrated separately, said Brown &

A multisensor machine in action

The dual-arm Vento inspection machine at Brown & Sharpe's Wixom, Mich., demonstration facility shows how a multisensor machine inspects an automobile body.

The two horizontal arms work independently. Each has its own rack, containing the assorted probes it needs for measuring. Also in the racks are multiple touch probes with extenders of various lengths to allow measurement of features on a car's surface and interior. The machine could have additional racks with touch probe tips of varying lengths and angles.

"Different size and shape parts need different tips," said Bob Hospadaruk, technical sales specialist for Brown & Sharpe.

Hospadaruk added that having separate tips helps to minimize the consequences if the inspection machine is programmed incorrectly. In the event of a crash, the tip might break off but the probe would likely survive.

Both tips and probes are attached using a kinematic mount system. Three prongs locate the probe or tip in its socket, ensuring repeatability.

Wrist controls are particularly important for the vision probes. Laser probes operate by reading the reflection of a laser light off of the part's surface. As a result, they need to be positioned nearly perpendicular to the surface. If the angle gets too large, the reflection misses the sensor.

G. Landgraf

A dual-arm Vento inspection machine analyzes a car body's features at Brown & Sharpe's demo facility in Michigan.

Video probes, on the other hand, project parallel lines of infrared light on a part's surface, which improves contrast. Any measurements that use a projected line require 3-axis wrist control, Hospadaruk said, because the probe needs to be able to swivel along its focal axis to project lines across a feature's edge. If the lines were projected parallel to a feature edge, they would likely miss the edge itself.

Hospadaruk noted that vision systems, which gather thousands of measurement points, are gaining value in part-feature measurement.

"The algorithms for extracting geometric features from a cloud of 10,000 points have recently been developed," he said.

—G. Landgraf

Sensor developments

Traditionally, multisensor inspection machines have included some combination of video, touch and laser probes. Sensor technology developments are expanding that list.

"Now we're seeing subcategories of probes," said Optical Gaging's Fred Mason. He cited a new "feather" probe that senses the surface with less than 1mg of force, as part of a new category of microprobes.

Renishaw

The SP600Q is one of the new breed of analog scanning probes. An analog probe contacts the part and gathers data continuously, giving a sense of a part's form, instead of just its diameter, for example.

Werth America's Art Whistler described a new self-illuminated fiber-optic probe. The probe itself does not capture any data. Instead, a video camera tracks the probe's location and uses that information to measure edges that it could not otherwise see, such as a 100µm-dia. fuel-injector nozzle.

Carl Zeiss' Kevin Legacy noted a new laser scanning probe that uses a line of laser light, rather than a point. It can measure features such as bores, a task vision systems historically have been unable to perform.

Renishaw's Barry Rogers reported a trend toward analog scanning, where touch probes contact a feature constantly instead of just at a few points. "That lets us look at the form, not just the diameter," he said.

—G. Landgraf

Sharpe's Card. "Some recent tests have shown it's difficult to calibrate all three. You can't seamlessly move among them and get perfect calibration."

"Normally, there's some loss of precision switching from one sensor to another, simply because of the calibration," agreed Whistler.

Orlando Vera, multisensor product manager for Mahr Federal Inc., Providence, R.I., said that multisensor inspection machines can be as accurate, or more accurate, than a series of single-probe machines. He noted the elimination of human error in moving parts from machine to machine. "People knew about those errors but said, 'That's not a big deal,'" according to Vera. "We're realizing that, all together, they are a big deal."

Vera acknowledged that multisensors have more potential error sources. In a machine that combines a vision and touch system, for example, jitter and photonics errors affect the vision probe, while high-frequency "noise" affects the touch probe. Robust machine design, he said, can overcome those multiple error sources.

Vera recommends against retrofitting machines with multiple sensors, because "hybrid" machines may not be robust enough. "I talked to a group of customers who'd purchased retrofitted machines, and eight or nine of the 13 were totally dissatisfied," he said.

Legacy, however, said that while old machines might be difficult to retrofit, many newer systems are able to accommodate multiple sensors even if they are shipped with only one.

The following companies contributed to this report:

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Taking the Plunge

How do potential users decide if a multisensor is right for them?

"If you have to run any product through two or more devices to scan it completely, that's a signal that a multisensor should be investigated," Whistler said. He added that a multisensor machine might also be the solution if inspection is a bottleneck.

Conversely, when "running the same part day after day, you probably don't need a multisensor," said Barry Rogers, national sales and marketing manager for Renishaw Inc., Hoffman Estates, Ill.

Mason said that Optical Gaging Products usually qualifies parts based on the user's tolerances. "Our applications engineers run the part and identify which sensors are best for which feature," he said. That information allows them to recommend the best system configuration for a customer.

"I tell customers they should look for multisensors as a standard," Mahr's Vera said. "I've come to the conclusion that the only applications where it's not needed is when one of the sensors doesn't address the customer's need."

He added that he's only seen a few instances of that, such as when a customer needed to only measure flatness.

Multisensor inspection machines do tend to be more expensive than those with one probe. Brown & Sharpe's Card said that the additional hardware and software could add $50,000 to $100,000 to the price of a machine. Depending on the size of the machine, that could add 25 to 100 percent to the cost.

Those considering the purchase of a multisensor should weigh the increased throughput possible against the projected return on investment, Card said. "If you can show a payback period of 6 months to a year, you would have the incentive to buy."

Whistler noted, "A machine with a video [probe] and a touch probe probably costs less than a pair of single-probe machines."