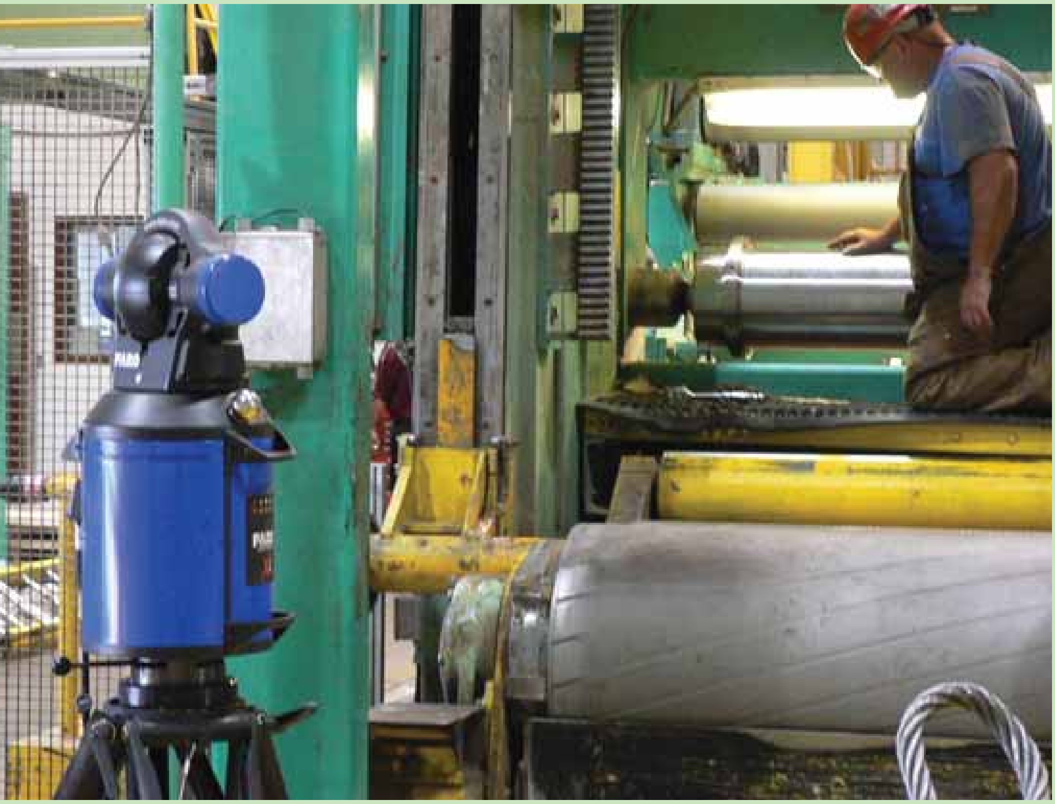
Moving-Part Metrology



Faro Laser-Tracker helps align rollers used in paper-making process.

Is it there?
Is it right?

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Metrology is growing in importance for almost every manufactured product. Because of:

- The penalties of warranty claims or products rejected by customers.
- Stiffer customer requirements for accuracy and cleanliness.
- Need to inspect raw materials and components from suppliers.

New demands are being placed on gage suppliers. One area of particular importance is automatic monitoring of manufacturing processes. This can range from a simple gage for registering the presence or absence of a part to sensors that evaluate crucial component elements.

In the simplest case, you only need to know if the part is there or not.

This task is handled by a very simple contact or light-beam-breaking device.

A more complex task is checking for the presence or absence of a part's feature. How's the surface finish? Is the setscrew there? Did the two part pieces mesh? The answers require a more sophisticated system with the ability to identify shapes. Overall, the goal for all systems is to improve a part's production speed and precision. Here's a look at some of them.

Aiding the assembly of large products, such as airplanes, or monitoring the assembly of complex machines, takes an instrument like the Laser Tracker from Faro (Lake Mary, FL)

"New demands *are being placed on gage suppliers."*

The Laser Tracker, which is designed for shop-floor operation, consists of a laser distance meter, two precision encoders, and software to calculate, store, and display the data from targets mounted on the product being measured. A beam-steering system locates the target, then the lasers lock on and take readings. Driven by two servomotors, the system updates position at a rate of 1000 times per second. The Laser Tracker, which can weigh up to 20 kg, measures objects in the 0–70-m range. Area resolution is 0.158 µm with a repeatability of 1 µm.

The data determine the distance between the Tracker and the reflecting mirror as well as the horizontal and vertical angles between the Tracker and the reflecting mirror. With this information, the reflector's position can be found in three axes (*X*, *Y* and *Z*).

Systems such as the Tracker are needed to replace the simple hand tools and instruments that are still used in the assembly and repair of machine tools. Usually the data gathered by these simple tools do not meet the standards of accuracy required today. First, the measurements may be off, plus there is no documentation to prove the measurements were made.

"Gaging for automatic process control through machine-tool compensation has been available for a number of years," explains Director of Precision Gages, George J. Schuetz, Mahr Federal (Providence, RI). When first implemented, tool-compensation software was loaded onto the machine tool controller, and operators would input measurement results into the controller manually, allowing the software to calculate machine-tool offsets. More recently, with the advent of digital electronics, the

Leica T-Mac system uses a laser detector carried by a robot.

gages are hardwired to the controller. The software gathers data on various parameters as measured by the gaging, and machine tool offsets are calculated to improve the process and manufacture parts closer to their desired size.

"Both these scenarios can pose problems." says Schuetz. "The first is that manual data entry is time consuming, and prone to input errors. The second problem associated with electronic gaging is that when a machine must make multiple dimensions, each gage requires a cable to be connected to the controller. This makes it nearly impossible when checking multiple dimensions in a machine as the cables tend to get in the way, and provide a safety issue."

In addition, taking the part out of the gage for all measurements slows down the measurement process, and can make it difficult to get the part back in the machine to the same position.

However, the new-generation hand tools and gages have wireless capabilities so that multiple gages can be wirelessly connected to the machine controller. They provide wireless data collection and free the operator to manipulate the gages in the machine for easy data collection.

"The benefits are fast data collection, positive feedback so the operator knows when the data have been collected, and instantaneous machine-tool offsets are made to improve the process. Plus, this all works seamlessly with the machine-tool controller and its compensation package," concludes Schuetz.

Mahr Federal now offers a wireless solution that provides the features that are key to making the system work. It tells the operator when a measurement is transferred successfully. Each transmitter in this system has both an audio and visual indication of a successful data transmission.

Because of the electromagnetic noise in the shop, the system has to ensure that the right frequency is used to get the transmission through the noise, ensure the transmission has been received by the computer, and that instantaneous feedback is given to the operator.

The system can handle up to 99 independently functioning transmitters, has its own identification code, and puts data into the correct area of the controlling software.

By placing the data into places in memory that are transparent to the software, it's easier to transfer to auto comp or spc programs. At the same time, the data can be stored for long-term archiving.

A tracker-machine wireless control sensor, the T-Mac from Leica (Wixom, MI) is mounted on moving robots, machines, or parts whose position is to be monitored in six degrees of freedom. This measurement device was developed for tracking tasks that are difficult or when it is impractical to have a worker hold a unit.

"The new generation of gages *has wireless capabilities."*

The unit operates the human interface element and contact probe. It has reflector nests for calibration and easy orientation, plus a mechanical interface to the calibration tool. Insensitive to environmental light, the Leica T-Mac offers operation measurement volumes of up to 30 m, and reportedly has a wider acceptance angle than comparable system: pitch 45°, yaw ±45°, and roll 360°.

Point rate output is 1000 points per second with a measurement accuracy of 60 µm in a measurement volume of 15 m. Top tracking speed is greater than 1 µsec. The Leica T-Mac incorporates acoustic process information feedback for ease-of-use, as well as visual feedback for power on, in-view and in-distance status, and for process information.

X-Rite Inc. (Grand Rapids, MI) specializes in color measurement and color management, offering hardware,

Scanner from X-Rite Inc. evaluates paint reflections to ensure the same color on all vehicle panels.

software, and services for measuring, formulating, and matching color.

One of the problems they recently solved involved the fact that auto makers have difficulty measuring the color and appearance of bumper, panels, and other exterior surfaces with coatings that contain "sparkle." This is because existing instruments reportedly cannot measure the paint's apparent different appearance under different illuminations and observation angles. X-Rite developed an instrument, the xDNA, that takes advantage of the fact that each paint has a unique, 3-D mathematical model, similar to the way that each person has a unique DNA structure.

The xDNA is said to speed introduction of new paints, improve the first-time quality of products being coated, and reduce manufacturing problems that occur on the factory floor.

The xDNA uses the X-ColorQC software package that manipulates the data with proprietary algorithms to generate graphs that show unique characteristics of a specific paint. The unit's analysis may solve problems by modifying existing equipment. And with the data generated, it's possible to develop more exact quality standards that quickly indicate when a process is going out of control.

Mahr-Federal hand-held surface inspector detects surface flaws.

The 1-kg unit has a 31-point spectrophotometer designed for use on the factory floor. Measurement time is about 1 sec, with calculation and display in a total of 2 sec. It is powered by a battery that lasts up to 16 hr, or enough power to take about 1000 five-angle measurements. The instrument can also operate from an AC adapter.

CogniTens (Wixom, MI), a division of Hexagon, has a measuring system that uses a head with three cameras and a white-light source. The company's market is heavily automotive for both setup and production operations. For example in setup, a scan may detect a flaw that is traced back to discontinuity in the stamping die.

> **"There is now a need to inspect** *raw materials and components from suppliers."*

In operation, three 1.4-megapixel cameras fire simultaneously. After a scan, the control compares the scan data with the existing CAM file and any discrepancies are recorded. Typical applications are spacing between certain features on the part such as holes, and checking die performance. Scans have an accuracy of ±0.05 mm when scanning surfaces and ±0.08 mm when checking part features.

A CogniTens unit may be fixed to check all parts or every few parts. Portable units are used for specific flaw-detection problems. The unit can also reverse engineer. When no CAD file exists the CogniTens can scan the part and generate a file.

One application was checking tiles on a NASA space shuttle. These craft are protected by approximately 24,000 individual and uniquely shaped ceramic tiles. After each mission all these tiles have to be checked for possible damage. A CogniTens 3-D measurement system, the Optigo, is used for the job. The system measures each tile in less than a millisecond. The digital shape information is then fed into a computer that creates a specific CAD file for each tile.

"What kind of equipment, or system, we supply depends on the customer's application," says Gary Scheneder, manager of new business development of Marposs Corp. (Auburn Hills, MI). "But generally the goal is to determine what kind of feedback is needed to generate the information necessary to correct any problems."

And often Marposs configures existing standard products to meet special customer needs. One example of this type is the M39S measuring system. The customer wanted a gage that would measure true roundness and concentricity on the shop floor in a nonenvironmentally controlled atmosphere. Plus, it had to measure roundness with a tolerance of 0.6 μm. According to the company, in the past, parts with this level of tolerances could only have been measured in a gage lab using a specialized roundness geometry instrument.

The M39S system can measure 100% of the parts produced without increasing process time. It can help achieve quality and productivity goals by utilizing gages out on the shop floor instead of in a laboratory environment.

Marposs M39S was designed to be easily adapted to handle a family of parts.

"That unit has opened markets not only in the fuel-injector arena but also in the measurement of gear bores, valve sleeves, spools, and other high-precision components.

"We chiefly apply electronic technology to make measurements, and one of our design strong points is the ability to mount a large number of transducers in a small space. This means a customer has more critical data about a part in a single setup. Often customers are surprised how much cost-saving information is available," he concludes.■