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Precision Technology:

**Versatile
Measurement**

HMC:

**New Horizons
In Machining**

Plasma & Laser Cutting:

**Making
The Precise
CUT**

Precision Technology:

Versatility Personified

Parts of different shapes and sizes require a more multi-functional approach to measurement.

By **Kelly Ho**, GM, Optical Gaging, Singapore

Most manufacturing companies have some number of measuring devices available from the day they start operation. They range from hand gauges, micrometers, and calipers, up to a CMM and maybe an optical comparator. Those tools are purchased to support a particular level of manufacturing with its associated tolerance and accuracy requirements.

Over time, new manufacturing equipment may be purchased to machine more complex parts that need to meet tighter tolerance requirements. It can be tempting to do all the new measurements with the available tools already on hand. However, it is easy to reach a point where the measuring capabilities simply cannot keep up with the latest requirements.

Even if the existing measuring tools are determined to be capable of the new measurements, there can be cost implications. Certain measuring devices are good at particular measurements. Verifying

all the necessary dimensions may require using several measuring devices that may be located in different parts of a shop, or in use for other parts, or that require a particular skilled operator who may not be available.

Shops striving for lean operations can encounter bottlenecks in any of those places. Time wasted in moving a part to different measuring machines or waiting in a queue until a machine is available contribute to the total cost of that part. In addition, the delay in getting the measurements may increase scrap if the process continued and the delayed measurements determine that the process was out of control.

All In One

The true value of multisensing (dimensional measurement that utilises two or more sensors to measure features and surfaces of a part) can be explained by using a golf analogy. A round of golf requires the use of a variety of clubs, each capable of hitting the ball different distances. Although it is possible

to play a round of golf with a single club, the score would probably not be very good.

The same concept applies to measuring devices. Think about a CMM. Although it uses one measurement technique (touch triggering), it supports probes of different lengths and tips of different sizes. Such a CMM can be considered a golf bag with a set of clubs. And that may be all you need – until the rules change.

Introduce parts with increased complexity, tighter tolerances, critical depths, edge positions, and angular relationships and that set of clubs (probes) may no longer be adequate.

Instead of a CMM, consider a video measuring machine. Video excels at measuring edges it images with its magnifying optics. A zoom lens allows measurements at different magnifications. Software tools can measure single points, edges, arcs, diameters and more. These capabilities are the set of clubs in the video golf bag.

A limitation of video is that it can only measure what it 'sees'.



A critical bore perpendicular to another surface may be inaccessible for video measurement. However, a multisensor video system can use the touch probe to probe the perpendicular bore while using video on the top surfaces and get data from the part for all the necessary measurements.

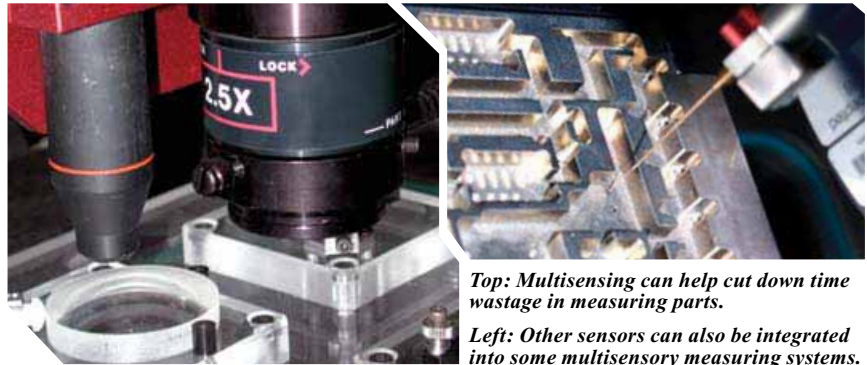
Measure All At Once

The motivation behind multisensor measuring machines is cost reduction for the people who use them. Doing all the necessary measurements in one setup on one machine cuts total costs in many ways: the part is handled less so risk of damage or loss is reduced; potential bottlenecks while queuing at several machines are eliminated; fewer fixtures are required; utility costs for one machine can be less than for two or three separate machines; personnel costs are reduced with training for one machine versus the knowledge needed to operate different machines; and service and calibration costs are lower and spares for one system cost less than what might be needed to support several systems.

Measurements performed on a calibrated multisensor measuring system are more reliable than cobbling together diverse sets of measurements done on several different machines.

A typical multisensor configuration includes a touch trigger probe, video/vision measurement, and possibly a laser. Referred to as sensors for simplification, the former requires contact with the part while the others are non-contact. Other sensors can also be integrated into some multisensor measuring systems.

Some micro-probing technologies provide access to intricate features or details that are simply too small for touch trigger probes. White light scanning probes provide an alternative to lasers with small spot sizes and very high resolution. And to make it interesting, some sensors can be used in different ways.



Top: Multisensing can help cut down time wastage in measuring parts.

Left: Other sensors can also be integrated into some multisensory measuring systems.

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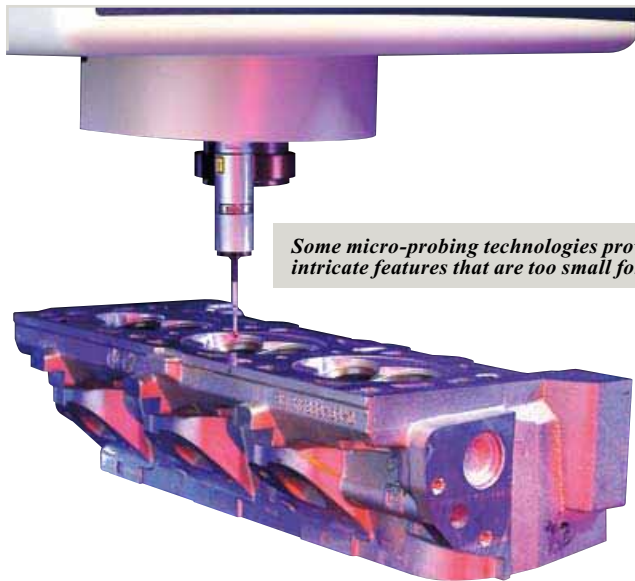


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Some micro-probing technologies provide access to intricate features that are too small for touch trigger probes.

For example, unlike touch trigger probes which acquire a point at a time, there are scanning touch probes that acquire data points from surfaces continuously as they are scanned across. Typically, lasers and white light probes can also be scanned, or provide single points from surfaces. Good metrology software products handle the deployment and use of all the sensors, and use their data equally for measuring the most complex feature relationships, distances, and angles. **MEN**

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Multisensor Metrology: Measuring What's Important

Multisensor metrology are pushed into the lime light with the arrival of more intricate parts

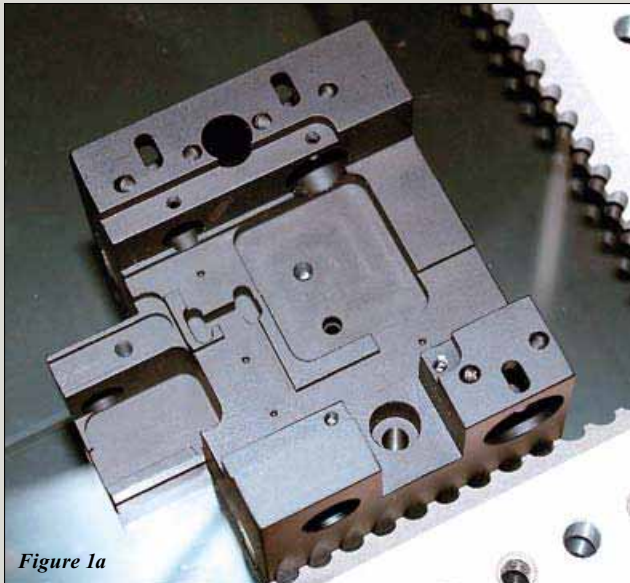


Figure 1a

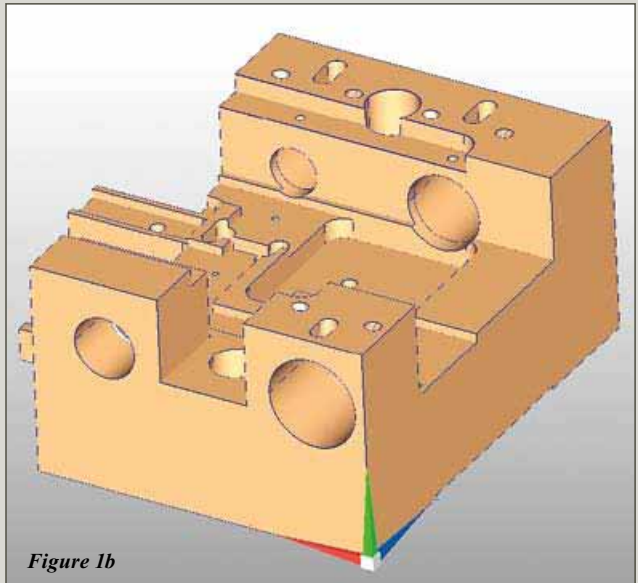


Figure 1b

Multisensor metrology is a dimensional measurement on a measuring machine that utilises two or more different sensor technologies to acquire data points from features and surfaces of a part to perform more measurements than would be possible on a machine using a single sensor. Figures 1a and b show a complex machined part and its corresponding CAD model. Selection of sensors depends on the features to be measured.

The design drawing shows what needs to be measured. The following series of illustrations show areas on a single part

best measured by each sensor technology.

Note that the part has an assortment of holes and slots, surfaces at different depths, and some intricate detail.

Probe.Scan.Laser.Result

Selection of the sensor depends on the characteristics of the feature to be measured. Remember that data points about the part are used for measurements regardless of the sensors used to derive them. Let's consider features of this part to measure with each available sensor.

Figure 2: Certain video tools can automatically follow an edge, collecting points even if it has changes in direction.

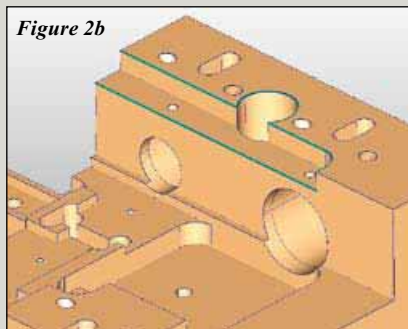
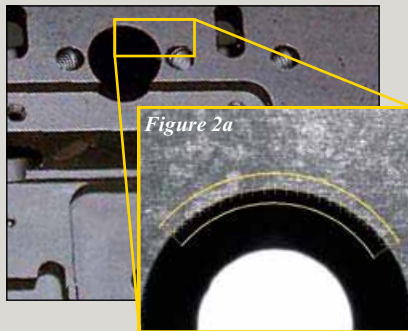


Figure 3: The best sensor for this is a laser as its focus point can be scanned across each plane.

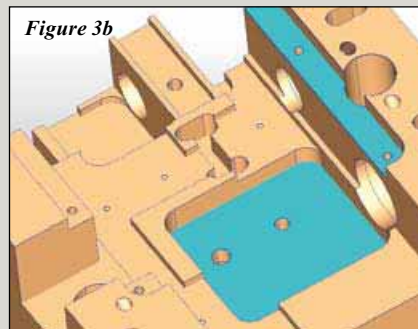
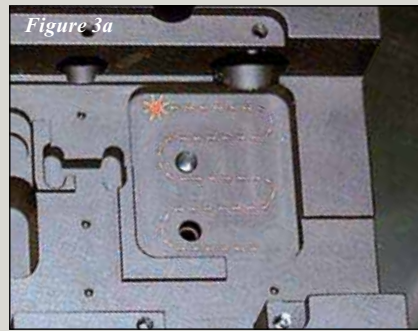
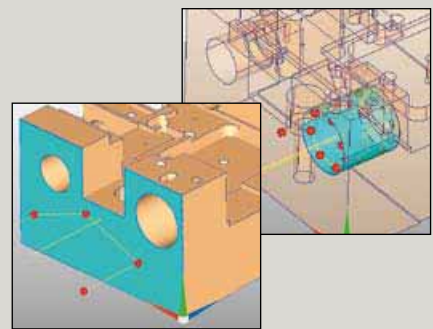
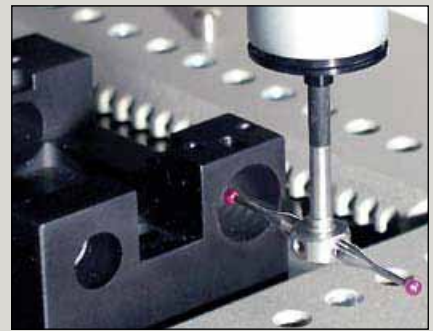


Figure 4: A touch probe is the best tool for the job when measuring the perpendicularity of the cylindrical axis.



Assume the blue-highlighted edges in the CAD model in Figure 2b need to be measured to determine the relationship (distances) between them. Either of those edges can be assumed to be the intersection where perpendicular surfaces meet.

In such a case, a touch probe can collect data points on each of those perpendicular surfaces. The software then fits those sets of points to planes and intersects the planes. Those intersections represent those edges.

That through-hole and the edge radius complicate this otherwise straightforward process. Fortunately, it is possible to measure those edges directly with video. The edges appear to be parallel to the worktable and thus perpendicular to the optical axis of the video sensor.

Capturing Data

Figure 2a shows a video measurement of an arc segment on the actual part. Certain video tools can automatically follow an edge, collecting points even if it has changes in direction. This example also shows that each edge lies in a different plane yet they still can be measured with video.

On the same part, Figure 3b shows two areas in blue that form planes which must be parallel to each other. In addition, it is necessary to know how far each surface deviates from a plane (its flatness). The best sensor for this is a laser. Its focus point can be scanned across each plane acquiring point clouds of data.

Each set of data can be fit to a plane. Deviations from each plane can be measured. In addition, the relationship between

the planes can be compared to determine their degree of parallelism. Not all lasers are created equal and this part has characteristics that make laser selection important.

Note the perpendicular surface between the two planes. Measuring the larger plane requires adequate working distance to avoid collisions with the higher surface. (See the laser spot and its path in the photograph of Figure 3a)

Measuring that plane close to the perpendicular surface may be a problem for some triangulation lasers since that surface may block either the incident or reflected light. Some Through-The-Lens (TTL) lasers can measure up to the base of the perpendicular plane.

This part also has some holes that are perpendicular to the top surface when the part is in this position.

If we want to measure the perpendicularity of the cylindrical axis of one of these holes to the surface the hole is drilled into, a touch probe is the best tool for the job. As shown in Figure 4, points on the plane can be probed. Then a star probe can collect points along the cylinder walls. Those sets of points are fit to a plane and cylinder, respectively and their angular relationship measured.

Choose Wisely

All the measurements described can be performed on one multisensor measurement machine with the part in a single location.

None of the sensors is best for doing all these measurements. Selecting the best sensor for each aspect of the total job depends on understanding what each does best.

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