ACCURACY IS SPELLED S-W-I-P-E

GEORGE SCHUETZ, MAHR FEDERAL INC.

When a gauging system is not performing as expected, we often hear the same dialogue. The operator, who has only his gauge to go by, says, “Don’t tell me the parts are no good- they measure okay on my gauge.” The inspector replies, “Well, the parts don’t fit, so if your gauge says they are okay, your gauge is wrong.”

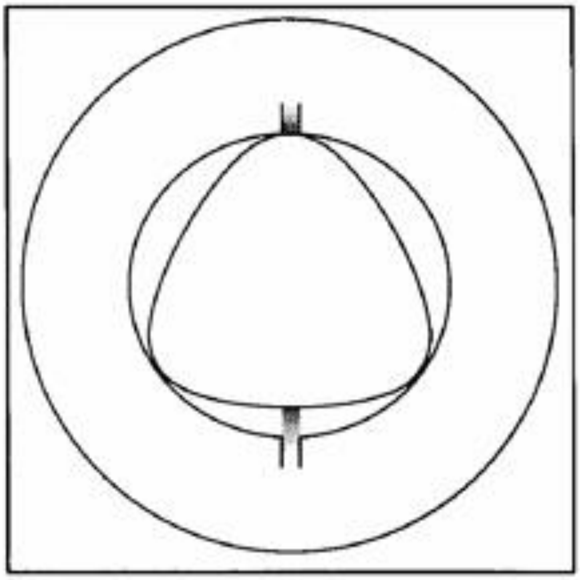

Fig. 1—Variations in geometry and surface finish of the workpiece can directly affect a size measurement. For example, when measuring a centerless-ground part with a two-jet air ring, a three-point out-of-round condition will not show up because you are only seeing average size.

This is the natural reaction. People are quick to blame the instrument because it is easy to quantify. We can grab it, take it to the lab and test it. However, this approach will often fail to find the problem or find only part of it, because the instrument is only one-fifth of the total measuring system.

The five elements of a measuring system listed in an acronym: SWIPE. Rather than immediately blame the instrument when there is a problem, a better approach is to examine all five elements.

S represents the standard used when the system is set up or checked for error, such as the master in comparative gauges of the lead-screw in a micrometer. Remember, master disks and rings handles as carefully as gauge blocks, because nicks and scratches can be a significant contributor to error.

W is the work-piece measured? Variations in geometry and surface finish of the measured part directly affect a system’s repeat-ability. These variations are difficult to detect, yet can sometimes manifest themselves as an apparent error in the measuring system. For example, when measuring a centre-less ground part with a two-jet air ring, a three-point out-of-round condition will not show up because you are only seeing average size. Remember that as part tolerances get tighter and tighter, form and surface finish errors will eat up a larger part of the tolerance span.

I stands for the instrument itself. Select a gauge based on the tolerance of the parts to measure, the type of environment and the skill level of the operators. Remember with what your customers will be measuring the parts. Say for example, you are checking bores with an air gauge but your customer inspects them with a mechanical gauge. Since the surface is not a mirror finish your air gauge is giving you the average of the peaks and valleys, while the customer's mechanical gauge is saying the bores are too small because it only sees the peaks. Neither measurement is "wrong," but you could end up blaming each other's instruments.

P is for people. Failure adequately to train operating personnel will ensure poor performance. Even the operation of the simplest of gauges, such as air gauging, requires some operator training for adequate results. Most important, the machine operator must assume responsibility for maintaining the instruments. Checking for looseness, parallelism, nicks and scratches, dirt, rust, etc., is necessary to ensure system performance.

E represents the environment. Unbelievably, with very tight tolerances, environmental errors are probably the biggest sources of gauging errors. Thermal factors such as radiant energy, conductive heating, drafts and room temperature differentials can significantly influence gauge system performance. Again, dirt is the number one enemy of gauging. The issue could be as simple as your shop being a little warmer or a little dustier than your customer's is.

Before blaming your gauge, take a SWIPE at it, and consider all the factors influencing its accuracy.

NINE ENEMIES OF PRECISION GAUGING

In some manufacturing plants, metal parts made accurate to 0.01 inch. In other plants, there are products that cannot tolerate size differences of even a few millionths of an inch. Making parts to either tolerance range is impossible without accurate gauging. However, accurate gauging is impossible if liberties takes it with the design, handling and maintenance of precision measuring instruments.

Understanding the following nine major enemies of precision gauging will help defend your measurements against inaccuracy.

Wear. The enemy that often ignored. For example, linear measurements usually made by contact between gauging and work-piece surfaces. The gauge wears a little each time it is used and inaccuracy grows by attrition. Wear also deforms gauge contacts and flattens spherical contacts producing discrepancies. The best therapy for gauge wear is systematic checking and calibration against accurate masters.

Dirt. Many measurement errors traces to someone's grubby hands. Those who measure in millionths of an inch should exceed even surgical standards of cleanliness. This applies especially to people who cannot seem to wring gauge blocks together without using what known as wrist oil. A mixture of pore effluent, skin particles, grit, oil and coolant, which coats gauging surfaces with a cement-like sludge ranging from 0.00005 to 0.0005 inch, is height.

Looseness. The average user of gauges tends to make sure the relevant screws, nuts and clamps are secure. However, internal looseness caused by wear may fool the user. For example, sometimes gauge platens and bracket arms creep or a work-piece does not settle firmly into place. The key to diagnosing looseness is measurement repetition. If the same reading does not come up twice then looseness is the likely culprit.

Deflection. Present and active, deflection never seen or felt except by special means. Isaac Newton described deflection in his third law of motion, which states that for every action there is an equal and opposite reaction. Visualize pushing a cylinder into a gauge. Although the contacts separate to accept it, the internal clamping force of the spindle acts equally against the frame, thus causing it to deflect slightly. What is being measured—the work-piece, the frame deflection or both?

Gauging Pressure. This force must be heavy enough to have unwavering authority but not so heavy as to deform the work-piece. Pressure errors usually stem from too much rather than too little force.

Temperature. Everyone agrees that a work-piece is bigger when it is hot. Any action taken to alleviate this usually involves cooling the part too much. There should be a big flashing sign in every precision gauging area that reads, “Keep the temperatures of the workpiece, gauge and master the same.”

Vibration. There are people who put a “millionth” comparator near an aisle used by fork trucks. Others sit them next to air compressors or thumping punch presses. The moral is, does precision works where your comparator will not get the jitters.

Geometry. Measurement must be square to the axis. This is elementary, almost to absurdity. Nevertheless, it points out a major source of error. Whether the instrument is a hand “mike” or an interferometer, many operators persist in cocking the work-piece or cramping the gauge just enough to get a wrong answer.

Approximation. A look at any mechanical micrometer reading shows where this enemy lurks. Perhaps it reads 0.494 inch—and a little more. What is your guess on the “little more”-0.4942, 0.4943 or 0.4944 inch? Do you use this as the true reading? The usual cure is to get an instrument with higher magnification or one with an accurate scale subdivided more closely. Another solution is to switch to a digital readout.

There are other known causes of gauging error, and there are still more to discover. However, the firm that tackles this list will have taken a big step toward greater precision and accuracy.