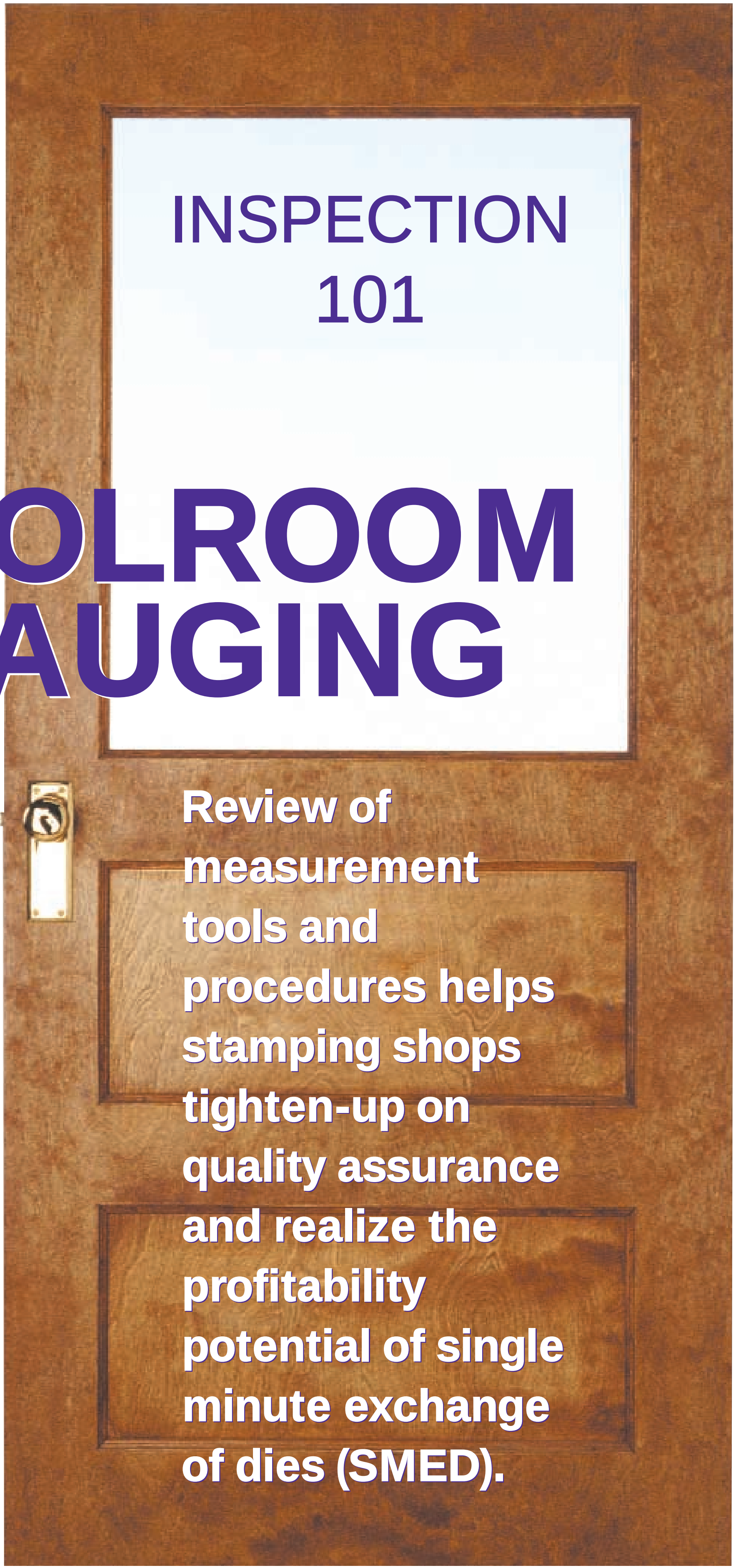
TOOLING technology

INSPECTION 101

TOOLROOM GAUGING



Review of measurement tools and procedures helps stamping shops tighten-up on quality assurance and realize the profitability potential of single minute exchange of dies (SMED).

by George Schuetz

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You made the right choice. You listened to your customers, reduced setup, geared up for just-in-time and focused on single minute exchange of dies (SMED).

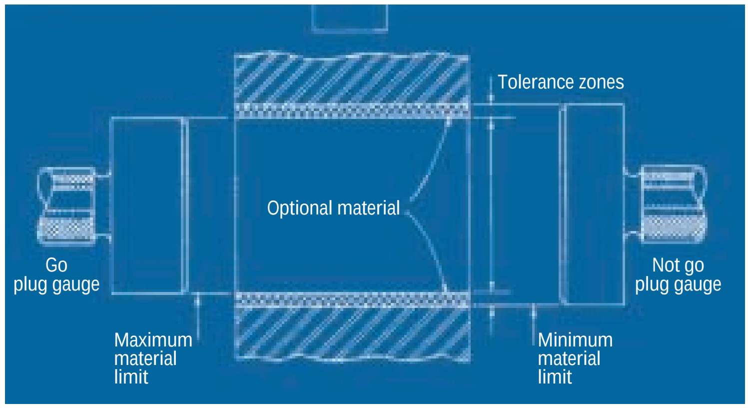
Most short-run stamping operations have implemented this strategy to transform nonproduction setup time into time spent actually making parts. SMED represents a significant investment in terms of tooling and training, an investment that should yield a significant return in terms of improved up-time, faster turns on inventory and greater profitability.

Ensuring that the theoretical return on investment becomes an actual one is the role of quality assurance. This means establishing appropriate inspection processes to monitor production output and ensure timely refurbishing of tooling to specifications, as required. For high-volume production shops it also may involve using statistical process control (SPC) to characterize tooling wear, foreclosing on the potential for high scrap rates.

Low- to medium-volume shops, on the other hand, need only get back to basics.

Production Measurement Process

Fortunately, stamping typically is a very stable manufacturing process. A well-designed punch and die can produce thousands of parts before wearing to the point of making bad parts. So the aim of inspection is most often to monitor for sudden tool breakage and to document part quality.



A good choice for checking hole dimensions is a fixed gauge such as a go/no-go plug gauge. Portable and independent of power, these gauges can be used anywhere in the shop with no need for support equipment. Made to the minimum size to check the smallest hole size allowable, a shop can prevent a part from being pressed and forced into a hole that is too small. Using the "no-go" side, if the plug fits into the hole, then the hole is too large.

Inspections should be as simple as possible. In many cases a basic inspection chart suffices. The chart defines a process for verifying initial quality and proposes a plan for continued process monitoring using simple measurement tools and procedures.

The basic inspection chart, however, will not predict the forming of bad parts. This is where SPC plays a role. Recording measured data on charts and plotting the data over time enables a shop to predict when parts will drift out of tolerance so preemptive action can be taken. Since stamping is such a stable process, SPC is overkill in many cases.

Basic Measurement Tools

Most punches and dies produce parts with tolerances well within the capabilities of hand-measurement tools typically found on the shop floor. But what tools should you use? There is such a bewildering variety. Take a simple blanked hole, for example. It may be visually inspected for presence, checked with a go/no-go plug, inspected for size with handtools or 100-percent inspected on an automatic gauging system that checks not only size but also can inspect for geometry as well.

Here are some guidelines for making the best choice.

Fixed Gauging/Plug Gauges—A good choice for checking holes is a fixed gauge such as a go/no-go plug gauge. Inexpensive and easy-to-use, fixed gauging provides fast, positive dimensional information ("yes" or "no"), which rarely calls for human judgment. Portable and independent of power, the gauges can be used anywhere in the shop without the need for supporting equipment. For a manufacturer producing multiple holes at loose tolerance, this size-verification inspection method can be ideal.

Note that the plug-gauge measurement concept is a little different for holes that will be used in press fitting. In this case the operator needs to prevent the mating part from being pressed into a hole that is too small. The go/no-go plug gauge made to the minimum size will check the smallest allowable hole size. In this case you may want to prevent the part from being forced into the hole. On the no-go side, if the plug fits into the hole then the hole is too large.

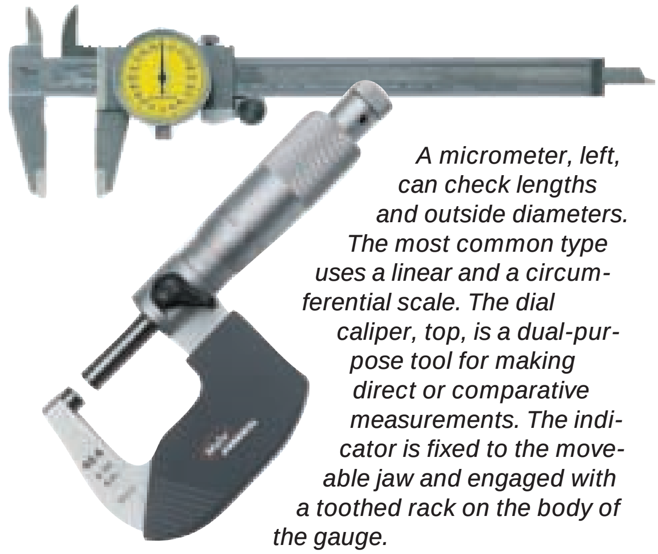
Variable Gauging/Micrometer—Fixed gauging won't tell an operator how a measurement characteristic varies from part to part. For this type of information, a handtool with variable readout suffices. Tools with variable readouts, while providing much more information than a fixed gauge, require a certain level of understanding and skill on the part of the user.

Micrometers are the most commonly used variable-readout handtools for checking lengths and outside diameters on the shop floor. They also can be used for inside diameters, depths and grooves. The most common type incorporates two basic scales: a linear scale to directly measure the axial advancement of the spindle, usually identical to the pitch of the micrometer screw; and a circumferential scale that indicates the amount of partial rotation applied to the micrometer barrel.

The micrometer is a contact instrument that requires sufficient pressure to ensure good positive contact between the part and the instrument. The only torque calibration in the human hand is operator feel. What feels like solid contact to one operator may not feel as solid to another, so readings may vary among operators. In order to eliminate this subjective use of a micrometer, manufacturers offer the devices with a ratchet or friction-thimble torque mechanism. More consistent gauging pressure results.

Indicating Micrometer—An even better solution to the inconsistencies created by relying on the operator to sense solid contact when using a micrometer is to use an indicating micrometer. These instruments combine the flexibility of range with the high resolution and consistent gauging force of a dial indicator.

The lower anvil of an indicating micrometer is actually the sensitive contact of a built-in indicator that



A micrometer, left, can check lengths and outside diameters. The most common type uses a linear and a circumferential scale. The dial caliper, top, is a dual-purpose tool for making direct or comparative measurements. The indicator is fixed to the moveable jaw and engaged with a toothed rack on the body of the gauge.

provides readings clearly and quickly with no vernier to read. As when using a standard micrometer, inspectors can adjust the spindle to the size needed and obtain consistent gauging force when the dial indicator is set to zero using a master. They then lock the spindle into position. A retraction lever makes it easy to position the part for measurement and helps reduce contact wear. Now the measuring tool begins to act like a gauge, making measurements in a comparative mode.

With this one gauge an experienced operator can quickly set up the measurement process. Once locked in place, an indicating micrometer applies identical gauging pressure for every measurement, regardless of the inspector. It is a perfect gauge for medium-run high-tolerance parts.

Calipers—While micrometers are very accurate, they have a limited measurement range—typically several inches. Where more range is called for, inspectors opt for a caliper, which spans from 2 in. to 4 ft.

External measurements using a caliper are made by closing the jaws over the piece to be measured. Internal measurements are made by opening up the inside-diameter contacts.

There are three caliper types that may be found in a machinist's tool chest. The vernier caliper, the original design, is the most rugged. Graduated much like a micrometer, it requires the alignment of an etched scale on the vernier plate with an equally spaced scale that runs the length of the tool handle. Skillful tool alignment and interpretation of the reading is required in order to achieve the stated accuracy of the tool.

The dial caliper, similar in construction to the vernier caliper, replaces the vernier scale with a dial indicator. It can make direct or comparative measurements. The indicator, fixed to the moveable jaw, engages with a toothed rack on the body of the unit. The dial, balanced to move in either plus or minus direction from zero, may be graduated in either inch or metric units. The jaws of the tool slide past each other to allow contact points or depth-rod extensions to fit into narrow openings for small ID measurements.

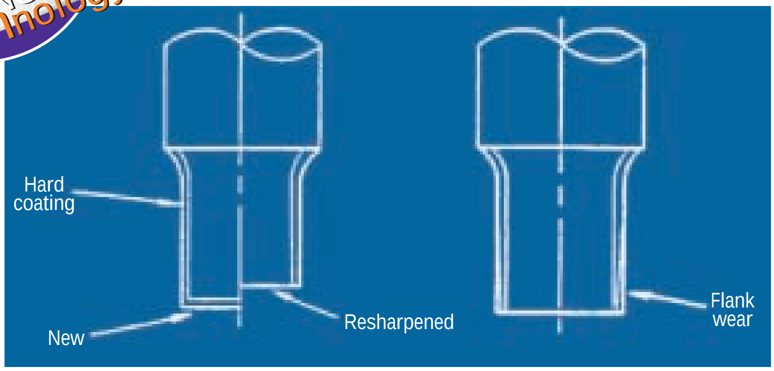
Measuring thin-sheet-formed components such as aluminum cans can be a self-defeating process since they may distort while being measured. In these cases special tooling will help to round-up the part to enable accurate measurement.

The third type of caliper is the digital caliper, which offers a number of electronic features that make the device easy to use with little added cost. These features include simple switching between inch and metric units, tolerance indications, digital output to electronic data-collection systems, zero setting anywhere along the range of the caliper and retention of the zero setting even with the caliper turned off. With no moving parts in the readout, the digital caliper proves exceptionally durable.

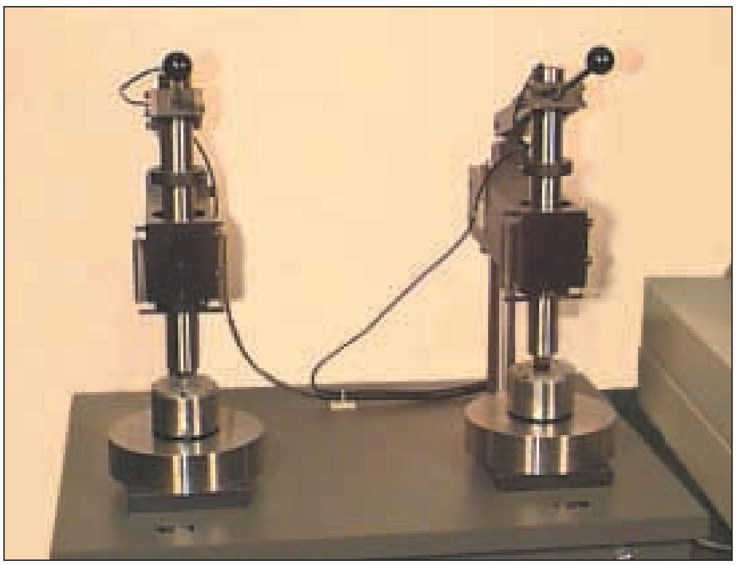
Proper Use and Care

Measurement results are limited by the condition of the gauge and the manner in which it is used. Adhere to the following guidelines and a shop can expect good results.

- Treat all handtools with care and respect. Don't use them to pry things apart or to hammer things together. Wipe them clean after using, and don't throw them on the workbench. For dial calipers, be particularly wary of dirt that can accumulate on the rack, throwing measurements off and ultimately damaging the indicator. Store a tool in its case. If it's going to be there for a while, apply a thin coat of oil to the jaws to inhibit corrosion.
- Check the tools often for wear, as well as for burrs and scratches on the jaws and contacting surfaces. With calipers, simply pass a master disc along the jaws while inspecting for wear or taper.
- Calibrate all measurement tools at least once a year, more often with heavy use or where several people share an instrument. For fixed gauging, this requires the operator to send the gauge to a calibration room where the plug or ring is measured and compared to a specified tolerance. It also may be measured at multiple locations, inspecting for



When dies and punches arrive back at the toolroom, inspect them for cracks, chips or burrs. Then use a handtool such as a blade-style micrometer to inspect dimensions for signs of wear.



To inspect and measure dimensions of punches and dies used in high-speed metalforming operations, tolerances may be tight on a number of critical dimensions, profile and surface finish. Here, custom-designed gauges may be required. For precision dies, mechanical plug gauges can be made to measure close-tolerance diameters.

form errors and checking for scratches and nicks.

Gauge Resolution and the Rule of Ten

The Rule of Ten says that a measurement tool should have 10 times more resolution than the tolerance of the dimension being measured. Calipers typically read in 0.001-in. or 0.0001-in. units. So if the required tolerance is tighter than 0.0005 in., a higher accuracy tool is needed.

Some parts will require special tooling to ensure that the critical dimensions can be measured quickly and reliably. A good example is the metalforming process used to manufacture aluminum cans. Trying to hold the can and measure it is self-defeating because the can distorts. Such cases may require special tooling—perhaps a fixture to “round up” the part for diameter measurement, as shown in the photo.

In the Toolroom

When dies and punches head back to the toolroom, inspect them for cracks, chips or burr. Then use a handtool, such as a blade-style micrometer, to inspect for wear (tapering) at points around the working area of the tool.

Measure at various points near the end of the tool. A significant change in size indicates punch wear —grind the end to the proper diameter to restore the punch. A fine-grit grinding wheel will provide the required finish.

Verify surface finish and cutting-edge quality using a surface-finish gauge. After grinding, inspect the edges of the punch for burrs and remove burrs with a soft stone.

The same process is used to refurbish dies. Inspect the hole ID for taper at the opening and correct any taper by grinding the surface of the die to restore proper ID.

For High-Speed Metalforming Punches and Dies

…like the ones used to manufacture cans, tolerances may be closer and there are often more critical parameters to be checked, including geometry, profile and surface finish. Where handtools prove inadequate, gauges may be custom-designed. For precision dies, mechanical plug gauges can be made for close-tolerance diameters at specific locations.

With simple stamping processes where parts may only cost pennies, scheduled maintenance is sufficient and sampling can spot random problems. However, high-speed metalforming processes can make hundreds, if not thousands, of bad parts in minutes. Here, SPC becomes necessary to monitor the wear of dies and punches, and maintenance is needed to avoid catastrophic scrap generation. These highly specialized applications call for a comprehensive plan and the use of measurement tools well beyond the scope of this article. **MF**

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