

# Good, Better and Best with Handheld Gauging

Getting the most from your inspection process means using the right instrument and an effective measurement process

Gauge blocks, micrometers, and calipers are the basic measuring tools used by inspectors and production personnel to check their work. They are the backbone of the manufacturing world.

Gauges are indirect-reading instruments. The measurement units live not on a scale, but off-site (in a calibration lab somewhere), and a master or other standard object acts as their substitute. The work piece is directly compared against the master, and only indirectly against the measurement units. The gauge thus evaluates not the dimension itself, but the difference between the mastered dimension (i.e., the specification), and the work piece dimension.

Gauges bring a whole new level of measuring capability to the user of the gauge. What might have been a difficult  $\pm 0.001$  in. tolerance for a caliper to measure is now a piece of cake with a comparative gauge. Depending on the configuration, tolerances of  $\pm 0.0001$  in. or better are easy for the dedicated gauge. Also, gauging tends to be faster, both because it is less general-purpose in nature and because the operator need observe only the last digit or two on a display, rather than count all of the units and decimals up to the measured dimension. Because of its generally much shorter range, gauging can also be engineered for higher accuracy (resolution and repeatability) than measuring instruments.

## GOOD MEASURING INSTRUMENTS

The caliper is an extremely versatile and useful tool for making a wide range of distance measurements (both ODs and IDs). The caliper can span from two inches to four feet, depending on the length of the scale. External measurements are made by closing the jaws over the piece to be measured, while internal measurements are made by opening up the inside diameter contacts.

While the caliper is a versatile tool, it is not one of the most precise. Skill is required for positioning the tool and interpreting the measurement result. As the user develops a “feel” for the tool, his measurement results will become more consistent. While the digital caliper may take some of the guesswork out of reading the measured value, it still requires skill on the part of the operator to apply the tool properly to the dimension being measured. The humble caliper is a surprisingly versatile tool for a wide range of general purpose distance measurements.

A small step up in accuracy and performance—but with a shorter measuring range—is the micrometer. The basic micrometer is probably the second most popular and versatile precision handheld measuring tool on the shop floor. While

the most common type is the outside diameter style, the same measuring principle can also be used for inside diameters, depths, and grooves. With so many options for holding the spindle and alternate contact points available, micrometers can satisfy an endless number of measurement applications.

The biggest problem with micrometers (as with calipers) is that measurements are subject to variation from one operator to another due to “feel” or inconsistent gauging force, and other subjective factors.



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The micrometer is a contact instrument and sufficient torque must be applied to the micrometer barrel to make good positive contact between the part and the instrument. The only torque calibration in the human hand is the operator’s “feel.” What feels like solid contact to one operator may not feel correct to another, so the readings will be different. In order to eliminate the “feel” part of the measurement, the designers of micrometers have incorporated a ratchet or friction thimble mechanism. This is an attempt to assure more consistent contact pressure and eliminate human influence.

In addition, the process of aligning the hand tool to the part, getting the range of the instrument close to the part size, and then finally moving the contacts to the part with the correct gauging force all take time and skill, and the resulting measurement may not be accurate enough for the tolerance you are trying to measure.

## BETTER COMPARATIVE GAUGES

Once a job gets into an area where accuracies are within 0.0005 in. tolerance, you begin to enter the region where a comparative gauge such as a bench stand, snap gauge, or ID/OD gauge is required.

Snap gauges can be hand held to measure work piece ODs while still on the machine, or can be mounted on stands for use with small parts. The heart of the tool is a simple C-frame casting, and measurements rely upon a direct in-line 1:1 transfer of motion. These factors make snap gauges simple, reliable, and fairly inexpensive.

With a standard dial indicator installed, the measuring range of an adjustable snap gage is typically .020 in., with a resolution of .0001 in. But there's no rule that says an adjustable indicating gauge has to have a mechanical dial indicator. One can specify digital indicators, air probes, or electronic probes. With a good digital indicator you can achieve resolution of 20 microinches, for tolerance measurements tighter than .0005 in.

Aside from the higher performance of the snap gauge, other key features are the speed of the measurement and the lack of operator influence. There is no need to adjust the gauge to the right size, or to assure the gauge is square to the part, or to apply the right force on the part. It's all built into the gauge. Thus, snap gauges improve performance through speed and accuracy.

### BEST COMPARATIVE GAUGES

But what if you need to measure that shaft tolerance to  $\pm 0.0002$  in., on the machine and in a machine shop environment? To do that, we take the snap gauge and improve it more. Notice the trend when we moved from the micrometer to the mechanical snap gauge: we went from an operator influenced tool having a measuring range of about an inch to a comparative gauge having a total measuring range of 0.020 in. Less range generally means better performance.

To achieve accuracy in measuring tolerances in the  $\pm 0.0002$  in. range while still measuring them quickly, an air snap gage is the way to go. An air snap is a very limited range snap gauge—generally with 0.003 in. total measuring range—but one that can get performance resolution to 10 $\mu$ in. or better, and be just as fast as the mechanical snap gauge.

### SELECTING THE RIGHT INSTRUMENT

Just as there are a number of ways to make an OD check on the machine, there are also a number of things to be considered when selecting the measuring tool or gauge that best meets your needs.

For example, how quickly must inspection be performed? Many gauges that are capable of high levels of accuracy require careful operation to generate reliable results. Others are more foolproof and can generate good results quickly, and with less reliance on operator skill.

Where will inspection take place? Some gauges are relatively forgiving of environmental variables, such as dust, cutting fluid residues, vibration, or changes in temperature, while others are less so. As with many other factors in the gauging situation, the ability to obtain specified accuracy from a gauge in a real inspection situation depends upon the prior satisfaction of many parameters, both explicit and assumed. Key points to consider are:

- **Throughput:** If literally hundreds of thousands of parts need to be measured, inspection has to be fast and foolproof.
- **Output:** Does the manufacturer require the capability of



	Good	Better	Best	More Best
Versatility	👉👉👉👉	👉👉👉	👉👉	👉
No Operator Influence	👉	👉👉	👉👉👉	👉👉👉👉
Ease of use	👉	👉👉	👉👉👉	👉👉👉👉
Accuracy	👉	👉👉	👉👉👉	👉👉👉👉
Cost	👉👉👉👉	👉👉👉	👉👉	👉

- automatically collecting data for SPC?
- **Portability:** Perhaps the parts being gauged are large, so the gauge has to come to the parts, not vice versa.
- **Accuracy:** What to do when most hole tolerances are  $\pm 0.001$  in., but some are as tight as  $\pm 0.0005$  in.?

### SPECIFICATION, CARE AND MAINTENANCE

Once you decide to use measuring tools, gauges, or—as most users do—both, there are steps you can take to get the most from your measuring process. Let's review a couple of the bedrock principles that apply to virtually every precision measurement situation: proper gauge specification, inspection, care and maintenance.

First, remember the “ten to one” rule. The measuring instrument should resolve to approximately 1/10 of the tolerance being measured. In today's world of tightening tolerances, this may not always be achievable, but it is a good goal. For example, if the total tolerance spread is  $\pm 0.0005$  in., the smallest increment displayed on the gage should be 0.000050 in. A hand tool that only reads to 0.0001 in. can't resolve closely enough for accurate judgments in borderline cases, and doesn't allow for the observation of trends within the tolerance band. On the other hand, a gauge that resolves to 0.000005 in. might give the user the impression of excessive part variation, and requires more care to read and record results. It also might not have adequate range, and would certainly cost more than necessary for the application. For some extremely tight tolerance applications (say,  $\pm 50$  microinches or less), 10:1 is not readily achievable, and it may be necessary to accept 5:1. For coarse work, 10:1 or something very close to it should always be used.

All measuring tools should be inspected at least once a year for calibration and repeatability. Tools that are used for critical measurements, or that are subjected to unusually hard or frequent use, should be inspected more frequently, possibly as often as every three months. If a gauge is dropped, don't take a chance; get it checked right away. Even though it appears to work properly, accuracy or repeatability may have been compromised. The cost of having it inspected and calibrated is usually trivial compared to the cost of relying on bad measurements, which can lead to scrap, rework, returns, and possibly even legal liability.

Certification is the process of verifying that a measuring tool meets original-equipment specifications by checking its

performance against a standard that is traceable to a national reference standard. Certification thus represents a higher level of assurance than a normal inspection, which may be performed using gauges and standards that are believed to be accurate, but are not themselves certified and traceable. Annual certification of all precision measuring instruments should be a requirement in any shop that prides itself on accurate and/or close-tolerance work, and must be done in shops working to achieve or maintain ISO/QS 9000 certification.

Poor gauge repeatability has many possible causes. These can generally be summarized as parts or components that are loose, bent, worn, or sticking. Gauge contacts or anvils are probably the most common source of problems, because they're in direct contact with the work pieces and are exposed to damage. They should be visually inspected frequently for chips, scratches, and visible signs of wear, and checked periodically for parallelism and flatness as well. If a chip or dent is detected, it's a good indication that the gauge has been dropped, and a signal that you need to have it checked for calibration.

Most handheld measuring instruments are sold with a fitted box. Use it. Don't put loose gauges in a toolbox, alongside old drill bits, screwdrivers, and assorted chips and grime. Keep your gauges clean, and treat them with care and respect. Any time you see a gauge that looks beat up, it probably has been. Don't trust it, unless you first prove its capabilities through inspection, calibration, and certification.

We occasionally see shops that pay their machinists well, and spend hundreds of thousands of dollars on new production equipment, but use old gauges, micrometers, and vernier calipers with problems so severe that they won't repeat to within several divisions on the indicator dial or barrel scale. That's false economy. Regular gauge inspection and certification is a clear sign to customers that you take pride in your work, that you're making proper efforts to eliminate bad parts, and that you're seriously committed to quality. **QC**

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[www.mahr federal.com](http://www.mahr federal.com)

## Gauging the Right Gauge

### DANATRONICS

Danatronics, in conjunction with Spectrum Instruments Ltd. (Ottawa, ON), offers the EHC-09 Wave, the world's first, smallest and only thickness gauge with live colour A-Scan. Weighing only 8 oz., the gauge includes unique features such as a 50,000 reading data logger. The gauge vibrates and changes the A-Scan colour on alarm, centres echoes in the



middle of the screen independent of thickness range, offers .020-20 in. (.5-508 mm), blanking, gain adjustments of the waveform, echo to echo to ignore coatings, and RF and B-Scan.

[www.spectrum-instruments.com](http://www.spectrum-instruments.com)

### DEFELSKO CORP

The redesigned PosiTector 6000 coating thickness gauge has new tougher, smarter features. Still simple, durable and accurate, the American made gauge retains all of its simplicity and functionality for measuring coatings on all metals. New features include large impact-resistant Lexan display, IP5X ingress protection and protective rubber holster. Tough probes, robust housing and a strong warranty make this gauge the right choice, says DeFelsko. A wide range of probes are available for a variety of applications.

[www.defelsko.com](http://www.defelsko.com)



### FISCHER TECHNOLOGY

The FMP Series is the most recent addition to Fischer's product line. The instruments offer a large and bright graphic display with a durable shock resistant casing. A large selection of probes are interchangeable, yielding



extreme accuracy and a wide measurement range, says the company. The probes are designed for hard to reach areas, curvatures, surface roughness and even underwater measurement.

Fischer says there is an instrument in the new FMP family to fit a company's measuring application. Fischer coating thickness gauges measure over ferrous, non-ferrous, or both ferrous and non-ferrous substrates.

[www.fischer-technology.com](http://www.fischer-technology.com)

### GE SENSING AND INSPECTION TECH.

The CL400 locks quickly onto the reading, displaying a rock-solid value that provides an accurate measurement while minimizing test time. Routine tasks, such as selecting a probe type from a list of standard setups, performing calibration, and setting of alarms, are simplified by following the onscreen step-by-step procedures.

[www.ge.com/inspectiontechnologies](http://www.ge.com/inspectiontechnologies)

### H.E. MORSE CO.

According to H.E. Morse Co., HEMCO gauges last longer and save manufacturers money because they provide longer life than plain steel or other imitation chrome plated gauges, almost 400 per cent longer, claims the company. The gauges don't require calibration as frequently as other gauges, saving calibration costs and the company says that they don't need to be replaced as often as other gauges, saving overhead costs.

[www.hemcogages.com](http://www.hemcogages.com)

### IMADA

Imada Inc. has introduced a line of easy-to-use digital force gauges featuring a large easy-to-read LCD display and push-button operation. The DS2 gauges feature an ergonomic metal housing which protects the accurate loadcell and electronics in tough industrial environments. Other



features include a push-button selectable lbf, kgf, and Newton unit; programmable High/Low setpoints with LCD indicators for Go/NoGo testing; and selectable real time or peak mode operation.

[www.imada.com](http://www.imada.com)

#### ITM INSTRUMENTS

The micro-computer LSI circuit and crystal time base offer a high accuracy of  $\pm 0.5$  per cent  $+ 0.1$  mm. No more guessing or errors when reading your measurements, the digital display always provides exact readings. The broad band receiving sensitivity means the meter can read probes of different frequencies. Offering exceptional measurement ranges: 1.5 to 200 mm (#45 steel) and velocity: 500 to 9000 m/s this ultrasonic thickness gauge measures the thickness of steel, cast iron, aluminum, red copper, zinc, quartz glass, polyethylene, PVC, gray cast iron and nodular cast iron.

[www.itm.com](http://www.itm.com)

#### L.S. STARRETT

The L. S. Starrett Company has introduced the new 797 Electronic Caliper Series. The 797 Calipers offer IP65 level protection, which is ideal for harsh



manufacturing environments. The 797 is part of Starrett's extensive line of electronic, dial and vernier slide calipers.

With IP65 Protection, the calipers are resistant to coolant, water, dust, dirt and metal chips. According to IEC529, IP65 stands for a "6" protection against ingress of dust and particles and a "5" protection

against water jets projected by a nozzle from any direction for a duration of three minutes.

[www.starrett.com](http://www.starrett.com)

#### MITUTOYO

Mitutoyo Canada Inc. has announced availability of the new QuantuMike line of micrometers. Measurement time, repeatability and accuracy as well as ergonomics are all improved over conventional micrometers, says the company. It provides accuracy at an industry-leading  $\pm 1 \mu\text{m}/.00005$  in. throughout its measuring range and is also dust and water resistant – rated IP65. A coarser thread feeds the spindle



at 2mm per thimble-revolution instead of the standard 0.5mm. The increase in thread lead is made possible by new, high-precision thread-cutting and testing techniques.

Trials on typical workpieces show that compared to conventional micrometers, QuantuMike's spindle positioning time is reduced by about 60 per cent while overall measurement time is decreased by as much as 35 per cent.

In tests where a conventional micrometer took 53 sec. to position and measure six diameters on a single, stepped workpiece, the QuantuMike performed the same measurements in 22 sec.

[www.mitutoyo.ca](http://www.mitutoyo.ca)

#### MAHR FEDERAL

Mahr Federal's Series 300P Indicating Snap Gauges are designed for accurate and reliable measurement results on cylindrical parts with narrow tolerance ranges. The gauges are available in a variety of



sizes with measuring capacity increasing in 1 in. (25 mm) increments up to 9 in. (229 mm). Series 300P Snap Gauges can be configured with a number of different indicators and all are fully adjustable with positive position locking at any point within the gaging range.

The measuring range of Mahr Federal Series 300P adjustable snap gages is .020 in. with a resolution of .0001 in. But they can also accommodate digital indicators, air probes,

or electronic probes using the same standard 3/8 in. diameter mounting.

[www.mahr.com](http://www.mahr.com)

#### QUALITEST

The new Pocket III X-ray fluorescence (XRF) analyzer combines an advanced Si-PIN detector with a powerful 40kV X-ray tube. The Si-PIN detectors are electronically refrigerated, eliminating the need for liquid nitrogen and allowing the instrument to be used at normal room temperatures without additional accessories or procedures. EDX Pocket III is the latest development in Handheld X-Ray Fluorescence Spectrophotometers.

[www.WorldofTest.com/edxpocket.htm](http://www.WorldofTest.com/edxpocket.htm)

