

# Manual Measurement Equipment

The Marposs M1 Wave electronic bore gage contains a wireless transmitter that uses Bluetooth technology to send real-time measurement data to a display unit or computer.

*Small dimensional metrology tools are becoming more usable and durable*

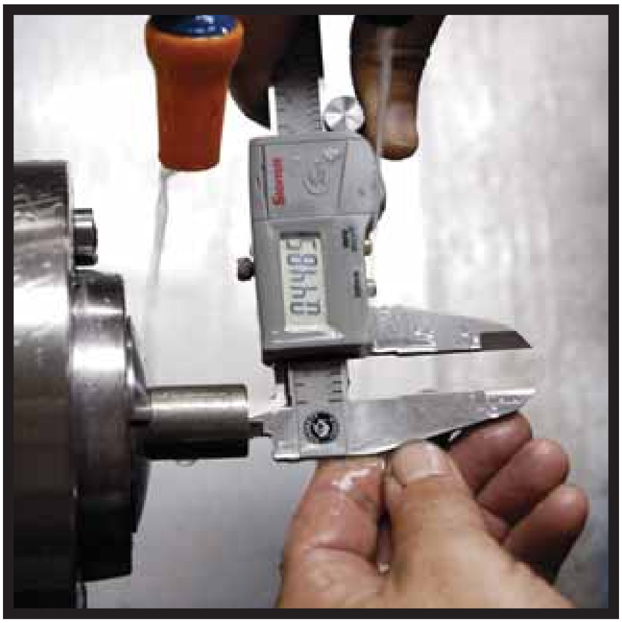
**Michael Tolinski**
Contributing Editor

The precision and accuracy of calipers, micrometers, gages, and other small measuring devices may have not improved much over the last couple decades, but these tools are better in other ways. "The biggest improvement has been in ease of use," says Tom Bress, a researcher and coordinator of laboratories for the Department of Mechanical Engineering at the University of Michigan in Ann Arbor.

The introduction of digital/electronic measuring tools provided immediate advantages for users. Obviously, digital readouts eliminate the difficulty of deciphering a vernier scale for thousandths of an inch precision. Plus, electronic tools can be zeroed at different set points, and can be toggled between English and metric units with the press of a button.

Summing up these improvements, Bress offers the historical analogy of the move from slide rules to electronic calculators. "Slide rules were analog; calculators are digital. They're both accurate enough to be used to design bridges, cars, and spacecraft, but calculators are much easier to use."

**Manual measurement devices** continue to be fortified with features—making them easier to use and more rugged. This points to their continuing importance in manufacturing, despite the availability of cheaper, smaller, and more portable CMMs and other table-top tools.



**Starrett's 797 calipers are said to resist liquids in real shop environments.**

The dimensions of many machined parts still have to be checked frequently, quickly, and by hand, so small measuring tools are certainly not going away. "The use of precision tools or gages is obviously necessary and important. However, machined parts may not have to be checked by hand nearly as frequently today," says Scott Robinson of L.S. Starrett Co. (Athol, MA). "Today, modern high-speed machines are so accurate they can make repetitive parts much more consistently than even five years ago. So you might not have the same interval of inspection periods, but at some point you have take a sample."

"Of course since the widespread adoption of automated metrology systems, hand tools account for a smaller share of 'total measurement activity' than before," explains George Mullen of Mitutoyo America Corp. (Aurora, IL). "That said, most machinists and metrology professionals keep their micrometers and calipers close at hand. Sort of like a doctor who has easy access to an EKG but who, nevertheless, uses a stethoscope as step one in a heart exam." Along with their utility, small measuring devices and manual gages continue to be relatively inexpensive, compared with larger, more expensive metrology equipment like CMMs.

**The most high-tech** improvement to small measurement tools has been the use of wireless technology to transmit measurement values to a display/storage unit. This allows electronic data transfer without cables dangling from each measuring tool, reducing both measurement and maintenance time.

Different companies have established wireless technology for small metrology instruments. Going wireless last year were two manual electronic gages from Marposs Corp. (Auburn Hills, MI): the M1 Wave bore gage and M2 Wave snap gage, for checking inner and outer diameters, respectively.

To transmit measurement data reliably, wireless devicemakers typically equip tools with small radio transmitters that send discrete values to a display or storage unit. The Marposs gages use Bluetooth technology, which can provide a continuous stream of data from the wireless gage, says Bob Harman, the company's Testar Division gaging products manager. He says the M1 and M2 gages are unlike wireless measurement devices that have a LCD that shows the output value and a button that transmits the reading to computer storage.

He offers the analogy of "snapshot versus video." Like a video camera, the Bluetooth connection allows a continuous live feed of data, allowing the probing of a bore or diameter. "So the user can look and see what the actual condition of the bore is in order to measure such characteristics as taper or ovality."

He says the wireless gages are particularly helpful for checking large machined engine or transmission castings, for example. For checking multiple bore diameters in a casting, wireless bore gages make life much easier for the inspector. Traditional electronic gages, each wired to an amplifier, invite downtime from twisting, turning, and knotting cables. "You can imagine a bench 6 or 7' (1.8 or 2.1-m) long holding the component, with a bunch of these gages lying around, and the operator using these in sequential order time after time." Even with pulleys or hangars to separate the cables, "in these kinds of applications, the wireless rids the user of the problem of having to manage the wires."

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**Similar benefits apply** when comparing wireless gages to air gages, he adds. The air gage requires a hose for compressed air, plus a chain of hardware connections for communicating inspection data; it's connected to a converter and then connected to a box that is interfaced with an amplifier. "With the wireless system, we actually take away that chain of components."

## Pitfalls of Digital Measurement

Despite their ease of use, hidden dangers lurk behind electronic measurement devices with digital readouts. "Using a digital device saves you from arithmetic mistakes in reading the measurement from the device, but that's about all," says Tom Bress of the University of Michigan.

A digital display may provide several digits past the decimal point, implying that all of those digits are legitimate. However, "If you have other sources of error in your measurement, you need to know which digits are good and which are not." In other words, just because a device readout provides six digits past the decimal point doesn't mean that the measurement is truly accurate to ±0.000001.

In his role as laboratory coordinator, Bress has observed inexperienced engineers learn other lessons about dimensional metrology for themselves. One is that increased precision comes at a price: more precise measurements are harder to make, take more time, and require more expensive instruments.

"The bottom line is that engineers and technicians need to have a good common-sense feel for the level of precision needed *before* they make a measurement," he says. "It's a waste of time and money to use instruments more precise than needed, if the extra precision is going to be lost to other sources of error in the measurement."

For example, it makes sense for machinists to use micrometers when their equipment, fixtures, and techniques are all designed to be precise at the length scales micrometers can measure. But higher-error-measurement situations don't benefit from the precision of micrometers; here calipers may be appropriate. "So I would say the most common mistake in using these devices is in using the wrong device for the job at hand."

In machining operations, another benefit of electronic/wireless gages over air gages has to do with total costs and safety, says Harman. An air gage requires compressed air (itself an extra cost) to check parts, and it can blow coolant off the component. "You put an air spindle or an air gage in and it tends to spit or mist that coolant." In some situations this could be an environmental hazard, leading to extra costs for protecting operators (although some see the air pressure as helpful for cleaning off parts).

But air gages have their own advantages. Their noncontact operation is particularly useful for checking highly polished, thin-walled, or other sensitive parts, explains Robert Edmunds III of Edmunds Gages (Farmington, CT). They're easy to use by unskilled operators and can measure dimensional relationships that can be difficult to check with contact gaging, like squareness, straightness, flatness, and groove width and parallelism.

And they can be made relatively portable, as shown by a new digital handheld air gage, the Micro-Dimensionair from Mahr Federal Inc. (Providence RI). In describing this gage, the company points to its ability to blow contamination from parts as an advantage.

**For handheld electronic measurement tools,** resistance to contaminants has become perhaps the most important design factor over the last few years, says Ray Funaro of Hexagon Metrology's Brown & Sharpe division (Kingstown, RI). "A lot of machinists have been reluctant to use electronic tools, because if they get any contaminant in the module, it would short-circuit the system."

Liquid-proof tools can be used right at the milling machine, grinder, or "anything where you're getting splash-back from your coolant," says Funaro. At trade shows, Hexagon has demonstrated tools working underwater, but in a real environment they're also exposed to coolant, oil, chips, and particles of debris.

Thus, device-makers offer more calipers, micrometers, and even height gages that meet high ingress protection (IP) ratings of the IEC 529 international standard for the sealing of electronic enclosures against foreign matter. Various measuring tools now meet ratings of IP 65 (dust-tight and resistant to jets of water) or IP 67 (dust-tight and resistant to short-term water immersion). Funaro says that meeting an IP rating initially added to the price of electronic measuring tools, but prices have come down as higher volumes of tools are produced.

Focusing on more rugged tools, companies are expanding their lines of IEC/IP-rated instruments. Mahr Federal has introduced EW Series digital micrometers that meet IP 65, and EW calipers, which meet IP 67 and include "dirt wipers" integrated into their slides.

L.S. Starrett is also adding to its lines of IP-rated tools, says Scott Robinson. The company's 797 electronic calipers have an IP 65 rating, meaning they're tested to resist a water jet from multiple directions for three minutes. The calipers have digital displays and come in size ranges from 6 to 12" (150–300 mm) maximum extensions.

**Another kind of shop contamination** is invisible, but can affect the performance of wireless metrology devices. It's electromagnetic interference (EMI) from motors,


**Handheld gages go beyond measuring just basic dimensions. The next generation Pocket Surf PS1 from Mahr Federal reportedly can measure more than 24 surface finish parameters with its inductive probe.**

rotating spindles, induction hardeners, and other electrical systems in the shop which can interfere with the transmission of data.

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The use of mesh networks is one way to minimize the corruption of wireless measurement data in a shop, says Jeff Wilkinson, general manager, L.S. Starrett Advanced Technology Div. Simply put, mesh networks send data through multiple routers, choosing the clearest router pathway. (See Wilkinson's *Quality Scan* article *Making Wireless Data-Collection Work* in the June 2006 issue of *Manufacturing Engineering*.) Programming verifies that each transmission from a measuring tool eventually makes it to the "gateway" storage point, a computer. Starrett stresses the robustness of mesh networks integrated with its DataSure wireless metrology data collection system.■