The "Wow" of Wireless Gauging

This technology is so smart, it may soon be calling your cell phone.

by Bob Harman

Know & Go

- New gauges embedded with Bluetooth wireless technology promise to lower overall inspection and operating costs, improve quality, and eliminate gauge cables and related maintenance—all while making operators more productive.
- The speed and bandwidth of Bluetooth wireless technology enable capturing streams of measurement data vs. snapshots.
- Portability and ease of use of Bluetooth devices offer new inspection possibilities.
- Operators may obtain measurement information in real time and receive detailed inspection instructions when wireless gauges are paired with an intelligent gauge computer.

What if you could lower your inspection and operating costs, improve quality and eliminate gauge cable maintenance—all while helping your operators be more productive? The same technology that lets you clip a fully functional telephone to your ear can make all of that, and a lot more, possible.

The technology is called Bluetooth, and it already operates in more than a billion devices around the world. Bluetooth is based on a global standard; it's robust, secure and well proven; and it's ideal for wirelessly connecting gauges to computers and data networks in a factory environment.

What's been missing until recently are the shop floor devices you need to take advantage of the capabilities of the Bluetooth wireless technology. That's rapidly changing, but as with any new technology, you should be aware of the capabilities of the various approaches before you commit time and capital to make your equipment wireless.

Why go wireless?

The argument for wireless gauging has been covered by *Quality Digest* and many other trade journals during the past few years but is worth a recap.

Wireless gauging or data acquisition involves the use of wireless transmitters attached to a measurement device. Measurement data are sent directly to a data acquisition device or computer for immediate use or later analysis. A few of the benefits are the elimination of tangle-prone cords and their maintenance, the ability to get measurement probes or devices into hard-to-reach areas, and the ease of expanding or deploying a measurement system within a manufacturing cell. Anyone who's switched from a wired gauge to a wireless one understands the freedom of "cutting the cord."

Articles about wireless gauging often describe how a wireless transmitter is attached to a hand-held gauge such as a micrometer or caliper. Several companies manufacture such equipment, including The L.S. Starrett Co., MicroRidge Systems Inc. and I & R Partners LLC. These systems depend upon the 802.11 standard (typically used on a wireless computer network) or on a proprietary wireless technology.

Embedding Bluetooth technologies into gauges takes wireless gauging one step further toward on-machine inspection or verification. In this application, information from a gauge provided with Bluetooth technology attached to a machine can stream real-time data directly into the machine control to prompt any necessary adjustments required to bring the part into specification. The part can be reprocessed if necessary in the same fixture in which it was originally held, with the same tooling, and under exactly the same clamp force, temperature and coolant conditions.

Compare that to the common practice of unfixturing a part and moving it to a bench gauge or a coordinate measurement machine in the quality control lab. In either case, the interval from machining to inspection is substantial. Production personnel are faced with the dilemma of either continuing to produce parts that may be out of specification or stopping production until the inspection is completed.

With a Bluetooth gauge setup, the data acquisition and analysis device is computer-based, so it can also deliver information to the operator in real time. It can, for example, display detailed inspection instructions for the operator to follow and even be programmed to vary those instructions based on the data generated by the gauge.

What is Bluetooth technology?

The official Bluetooth technology Web site, *www.bluetooth.com*, describes it this way: "Bluetooth wireless technology is a short-range communications system intended to replace the cables connecting portable and/or fixed devices while maintaining high levels of security. The key features of Bluetooth technology are robustness, low power and low cost. The Bluetooth specification defines a uniform structure for a wide range of devices to connect and communicate with each other."

Translating that into a shop floor environment means that Bluetooth-enabled devices can connect with each other (forming what's known as a "piconet") during operation, with no outside intervention required. Once they're connected, they can exchange data at speeds of up to three megabits per second (Mbps).

Find a system that takes full advantage of the speed and bandwidth granted by the Bluetooth technology.

Bluetooth operates at 2.4 GHz, which is one of the unlicensed industrial, scientific and medical (i.e., ISM) radio bands available throughout the world. To defeat the effects of electromagnetic interference (EMI) within the working range, Bluetooth technology uses adaptive frequency-hopping among 79 channels on the ISM 2.4 GHz range at 1 MHz intervals to achieve a high degree of interference immunity, making it secure from other wireless frequencies. In fact, a piconet will intelligently avoid frequencies being used by other devices within its range.

Radio communication capabilities allowed by the Bluetooth technology come in three variations with different ranges. For the industrial environment, particularly for gauging applications, Class-2 radios with a range of 10 meters (30 feet) are the most commonly used.

What to look for in a wireless gauging system

The first feature you should look for in a device enabled with Bluetooth technology is complete, seamless integration. The harsh environment of on-machine verification dictates that chips integrating the Bluetooth technology should be built into the gauge, not added on. Even for bench applications, embedding the chips into the device gets rid of the cable (albeit a short one) that connects the measurement device to the transmitter, further enhancing the reliability of the device (no more stocking gauge-to-transmitter cables).

Second, look for effective integration of the gauge with the data acquisition and analysis system. It should be seamless, and the devices should be mutually supporting. This means that the acquisition and analysis parts of the system should help the operator perform the inspection tasks more efficiently, as well as produce data that are useful to other parts of the process and the quality management system.

The third consideration, and arguably the most important, is to find a system that takes full advantage of the speed and bandwidth granted by the Bluetooth technology to achieve more than just burst communication. An efficient gauging implementation should deliver continuous communication between the gauge and the data acquisition and analysis device.

This last item may be a sticking point for some people because it might require purchasing new gauges. Although add-on transmitters are available that will connect an RS-232-enabled gauge to a Bluetooth transmitter, the question is, can the gauge be enabled to stream data rather than simply take data snapshots?

The ability to stream data is important for on-machine verification and other types of measurements. Imagine having a bore gauge specifically made for a given size. Yes, you might have to purchase a new gauge, but imagine if this one gauge could measure the bore in more than one position and in more than one axis while continuously sending live data. This is difficult to do with some of the current add-on wireless systems.

A bore plug embedded with Bluetooth technology can capture a maximum or minimum reading dynamically or, by pressing the button on the wireless device, communicate to the computer to instruct the operator to move to a different position in a bore and take another

measurement. In this type of "guided sequence," the operator is led through a procedure established by the engineering and quality departments to obtain all the data required for analysis. With a guided sequence, the end result for a single bore can include measurements such as maximum and minimum diameter, diameter top, diameter bottom, taper, barreling or waisting. When you've finished gauging the bore, you can press the same button and automatically move to the next bore plug embedded with Bluetooth technology and begin gauging the next hole, or carry on with the same bore plug to measure a different hole with the same size bore.

In a situation where gauging involves many bore gauges, Bluetooth's dynamic capabilities capture data in a way that can't be done by using the snapshot technique of other wireless technologies. With Bluetooth, changes in the part condition can be seen live and the interactive process can collect the data stream at any time, just like a video.

Further, several devices can send data at the same time to the receiving gauge computer, and each transmission is secure.

Finally, a reliable Bluetooth wireless system should be cost-efficient and flexible. One handle with built-in Bluetooth technology can be mated with a variety of different gauge heads in a simple, self-configuring, "click-and-collect" mode, which is ideal in certain applications.

Choosing the right system is the key to getting the best wireless performance for your application.

In practice, however, particularly in an application where multiple measurements using a variety of devices enabled with Bluetooth technology is in place, each gauge has its own handle with a unique electronic identification. This ID ensures that the collected measurement goes to the correct gauge computer. Transmitting devices can be paired to the receiving device and send only to that device, even though other devices embedded with Bluetooth technology are in use in the same area.

The gauge computer can set alarms to alert the operator when battery levels are low. The alarm is based on the setup conditions offered in the system; the user selects 5 percent, 10 percent or any other percentage to trigger a warning to change batteries or send a message to the gauge crib to be ready to swap batteries.

Such a system requires each gauge to have its own handle, but if a gauge becomes redundant for its application, the handle could be reused anywhere there's a gauge equipped with a receiver using the Bluetooth wireless technology. Choosing the right system is the key to getting the best wireless performance for your application.

How does it work on the shop floor?

Let's look at a typical implementation using a simple manual plug or snap gauge and currently available technology, such as the M1 Wave, which is part of Marposs Corp.'s line of M1 Star manual gauges for measuring internal and external characteristics. The gauge itself consists of a Bluetooth-enabled handle that can be mated with a variety of gauging heads to measure inside and outside diameters and thicknesses. The intelligence built into the M1 Wave gauge allows the gauge computer or column to know which gauge head is active, receive the data, and display the result or observe a live reading.

The gauge can communicate with a variety of Bluetooth-enabled data acquisition and analysis devices, including a small, stand-alone gauge computer, or a more capable system with data acquisition and analysis software, advanced data storage and manipulation capabilities.

In this example, the smaller device is a Marposs Merlin compact gauging computer designed to operate in a shop floor environment. The Merlin unit can handle simultaneous inputs from up to 16 conventional devices, or serve as the master for a complete piconet using the Bluetooth technology, depending on application requirements. The gauge computer can also store inspection data or provide outputs in Excel CSV or Q-DAS formats to a memory stick or via LAN Ethernet to a cell or plant server.

The gauge computer has integral communication capabilities featuring Bluetooth technology, and enough processing power to provide the operator with a step-by-step inspection sequence. This is a useful capability for inspecting complex parts with multiple features, such as an automotive transmission case. A stepped inspection sequence ensures consistent results and minimizes the possibility of operator errors.

Connecting a manual plug gauge to a powerful computer with Bluetooth technology may seem like overkill, but the benefits of such a system are real. Implementations like this make it possible to migrate inspection processes upstream from the quality control lab to the machine tool and bring manufacturing one step closer to producing a good part the first time, and every time. Bluetooth technology also means the possibility of your machine tool calling your cell phone to report a problem is one step closer to a functioning reality.

About the author

Bob Harman is the product manager with the Testar Division of Marposs Corp., located in Auburn Hills, Michigan. Harman's 42-year career in the field of metrology has spanned both sides of the Atlantic. His first 27 years were with the Sigma Instrument Co. in the United Kingdom. During the past 16 years, Harman has worked for several other metrology companies in the United States. His career has involved all aspects of the business, including gauge design, project engineering and sales, covering both the automotive and aerospace industries. For more information, visit the company Web site at www.marposs.com. **QD**

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