Metrology Gets Connected

Metrology devices are able to collect data faster and with finer resolution than ever before, but how should manufacturers best use all this data?

Bruce Morey
Contributing Editor

“Metrology and its relationship to manufacturing is rapidly evolving,” Ken Woodbine, president, Wilcox Associates, a brand of Hexagon Metrology (North Kingstown, RI), recently observed. “We are seeing larger quantities and faster speeds of measurement data collection. The next challenge is what to do with all that data.”

Hexagon is expanding its focus, building off its base in metrology, toward an increased emphasis on optimizing manufacturing processes. Woodbine describes this expansion in a paradigm of the brand’s Sensing, Thinking, and Acting mantra. The point of metrology, after all, is to create information on which to act. There is nothing new in this—why else take measurements in an industrial setting? What’s new today, however, is the challenge to speed up the evaluation of data to guide action, as fast and accurately as possible.

Data used from on-machine probes, like this one on an Okuma vertical machining center, can be used for long-term diagnostics as well as short-term machining operations.
To help create more nimble operations from a sound metrology base, Hexagon is offering its Metrology Management System (MMS). Woodbine has described this in the past as a PLM for metrology. There are three levels of MMS: Pulse, Cadence, and Enterprise. “Pulse, the first level, is a monitoring system for individual devices,” he explained. Pulse, newly available in August 2015, uses a network of sensors to record variations in temperature, vibration and humidity in the vicinity of a coordinate measuring machine (CMM), providing a complete picture of what might be affecting measurements.

Cadence is the next level up in MMS, providing dashboards and reports to supervise a group of CMMs or other metrology devices. It is further enabled by Hexagon’s recent acquisition of Q-DAS, a supplier of SPC. The Q-DAS technology will be integral to Hexagon’s development of its Thinking element in its three-part strategy. The third package of MMS, Enterprise, is aimed at coordinating multiple plants and supply chains that are complete—well—enterprises, exchanging information with Manufacturing Execution Systems (MES). If MMS Pulse provides a connection to the Industrial Internet of Things (IIoT) through sensing, the next levels of MMS—Cadence and Enterprise—close the loop towards action, using statistics and predictive analytics, according to Woodbine.

“The old way of thinking of quality was of sorting the good parts from the bad. Today, the focus is on ensuring only good parts are made by controlling the process.”

To help enable manufacturers to supply the action part of the paradigm, Hexagon recently acquired Vero Software, a provider of CAM software. Their products help design components with modules for metal fabrication, sheetmetal stamping, metalcutting, and even woodworking. “This completes the loop,” Woodbine said.

**Heterogeneous Ecosystems**

Some manufacturing systems are also likely to evolve in separate ecosystems with multiple players. Such an ecosystem that Hexagon is also involved in is the Okuma Partners in THINC program, a collaboration network of more than 46 companies that service the metalcutting and manufacturing industry, under the stewardship of Okuma (Charlotte, NC). “The partnership includes companies who offer workholding, tooling, tool management systems, and others as well.
as metrology,” explained Jeff Estes, director of Partners in THINC. He also notes that metrology devices are expanding their role in manufacturing systems as automated systems become even more of a priority.

One way that metrology has grown is on machining centers themselves. Estes pointed out that about 80% of machining centers today have on-machine probes. “Those probes can do a lot more than just check your part—you can use those to measure artifacts over time to establish trends about the machine itself,” he said, such as machine wear and accuracy. Another trend Okuma leveraged is powerful, general-purpose computing by building its OSP machine controller on a Windows platform. According to Estes, this allows users to write a simple app to take such on-machine probe measurements and plot the data in Microsoft Excel. “Excel has tools like linear regression to make predictions,” he said. He likens these simpler predictive analytics to Little Data in contrast to the Big Data of attempting predictive analytics with terabytes of data. “Technology works best when you can simplify it,” said Estes. By converting complex processes into simpler, easy to understand steps “technology will be utilized and applied.”

Looking into the future, he is excited about rapidly evolving vision systems that are offered by the metrology industry today. “Manufacturers are now using vision systems that measure down to the micron level,” he said. “Most vision is used postprocess, the next step is to use it in-process.”

Another important feature of moving data around is to have a recognized standard format. One such standard is MTConnect, an XML format for machine-to-machine data exchange. “Okuma embraces and supports MTConnect,” he said. The advantage of MTConnect is that it allows machines from different manufacturers to communicate and let manufacturers build heterogeneous systems.
Enabling Automation and Smarts

Others believe automation is a key driver behind developments in making metrology data easier to share and use, especially for larger metrology devices like CMMs.

“Traditionally, CMMs produced paper reports or reports in PDF format,” said Larry Maggiano, senior analyst for Mitutoyo America Corp. (Aurora, IL). “Now, by producing them in an open, digital format, that information can be available to anyone, everywhere.” Eliminating paper is what enables the IIoT, enabling ‘smart,’ even ‘brilliant’ factories. “Moving from paper means smart machines can talk and share information with other smart machines,” he said.

This information is really of two flavors, process results and product results. “The primary purpose of dimensional measurement equipment is to provide information about the part, but there is process information that is important as well,” he said. “That is where the new MTConnect standard is exciting.” He reports that Mitutoyo’s CMMs delivered as of 2015 now support output in the MTConnect format. It provides status and monitoring information about and for the CMM itself, instead of the product. “It determines and broadcasts information if the CMM is idle or busy, or if the CMM is waiting, or if the CMM is off-line for setup,” he said.

Where it really might get exciting is when machine tools can broadcast information in MTConnect to a CMM. At that point, information about how to modify what the CMM is checking becomes possible. Maggiano posed a hypothetical example of a CNC machining center noting that it was taking more power and torque than normal to machine a particular feature, broadcasting that information to a CMM (via MTConnect) and having the CMM determine the need to perform extra checks for that feature.

He was also quick to point out that another, complementary protocol, also based on XML like MTConnect, is the Quality Information Framework, or QIF.

The primary purpose of dimensional measurement equipment is to provide information about the part, but there is process information that is important. CMMs like this one that uses the MTConnect standard for output is one to get that information more widely disseminated.

Aerospace to Automotive . . .
We will design and build a drilling and tapping solution to meet your needs.

Proven solutions from the brands you trust.

Six station dial index machine custom designed to drill and chamfer through holes on a family of automotive suspension components. Challenge us with your application!!

See this machine and others in action in our new video

www.rockford-ettco.com

Aerospace to Automotive . . .
We will design and build a drilling and tapping solution to meet your needs.

Proven solutions from the brands you trust.
“MTConnect is about process, QIF is about results of the part itself,” he said. “MTConnect is about trusting the process.”

Optical Gaging Products (Rochester, NY) is another metrology company that offers MTConnect formatted output from its multisensor metrology systems. Their motivation for adding this feature, according to Ken Sheehan, new product development manager for the company, lies in how industry itself is changing. “We see ourselves as part of the manufacturing process rather than simply as helping the inspection department,” he explained.

While advanced metrology equipment was once relegated to the sterile rooms of inspection departments, he thinks today’s manufacturers see metrology differently. Metrology is migrating to the shop floor, interacting with manufacturing machines. “The old way of thinking of quality was of sorting the good parts from the bad ones. Today, the focus is on ensuring only good parts are made by controlling the process,” he said.

“The value of predictive analytics lies in better understanding of the manufacturing process.”

He believes that MTConnect is at its beginning, both in adoption and its development, but the possibilities are exciting. “Our hope is that metrology tools continue to acquire accurate data, and push that data upstream, delaying the moment of data reduction as long as possible, so that the maximum amount of part information is available to CAM software to better optimize the production process,” he said, in effect automating using measurement results.

An even more important development in his view is designing dimensional measurements based on the process used to create the part. “An additive manufacturing process like casting or 3D printing can and should be measured differently than a subtractive process like machining,” he explained. OGP recently introduced a new software package, ZONE3, to help multisensor measurement systems embed themselves in a manufacturing process. One of its features is 3D animations that display relationships.
between parts, sensors, datum alignments, and machine tooling, as well as MTConnect output.

Who seems to want MTConnect today? Larger customers and those with more flexible production lines, according to Sheehan. “If they have a high-volume transfer line, for example, there is less use for the possibilities that MTConnect provides,” he said. Medical and aerospace companies in particular are likely to be first movers in using tools like MT Connect to integrate measurement data into their manufacturing process control scheme.

Developing a Standard – What it Defines

Why is it so hard to develop a particular communication standard? It is all about the semantics—in the computer science sense—according to Will Sobel, chief strategy officer for System Insights (Berkeley, CA). “MTConnect was really the first standard to open up the shop floor, giving the data a common vocabulary so that now we are able to get the data off the machines and interpret what it means,” he explained.

Before the standard, every manufacturer would develop their data models and formats in isolation. Sharing information and data is an exercise in translation, unless a shop uses only one particular brand of equipment; even with the same brand, the age of the machine can often lead to incompatibilities. This is difficult since few single companies can provide all equipment needed. “That is why you need standards. Once you have them, then you can start doing some really intelligent things,” said Sobel. His company’s main product, VIMANA, for example is expressly made for taking data in formats like MTConnect and performing predictive analytics with large data sets. Sobel has also been a key player on the committee that is defining the MTConnect standard.

However, information models inherent in a standard are aimed at different uses. Therein lies the differences and their power. “QIF is what I call a semantic model for inspection,” he said. As...
he explains it, many standards provide elements like syntax and communication. They are a way to make a request and get data back with definitions of the message format. The next step beyond syntax is semantics, explaining what the data means. It defines that a particular number in a particular location in the pattern refers to, say, the position of an axis of a machine tool, and it is expressed in millimeters rather than inches. “Semantics means you can understand the meaning of the data without additional interpretation,” he said.

The latest version of MTConnect, 1.3.1, is more about machine tool compatibility than metrology data and devices, according to Tim Shinbara, vice president for manufacturing technology for AMT – The Association For Manufacturing Technology (McLean, Virginia). “The rules for the transport of first article inspection is already included in this standard,” he explained. “Those are critical items that need to have a go/no go for first article inspection for any manufacturer to go into production. So we knew we needed that as a primary piece and that is included in the standard.” However, to advance the standard for general use of metrology and related inspection tasks, the prerequisite of parts definition needed to be developed first. “By parts, I mean a workpiece, as defined in the context of GD&T features,” he said.

Data like an SPC report is only useful when it is quick to read, and easy to understand. Datapage+ from Hexagon allows several types of statistical plots to be arranged on a single page. The ability to show the part’s CAD file embedded in the report with customized flags for specific features could be especially useful in connect metrology data with various end-users.
An important point in the development of standards is to not reinvent in a different way existing standards. This serves to confuse instead of clarify. So, as part of the development of the next version of the standard, what he terms as version 1.5, their working groups will carefully look at existing standards (like QIF) and include them via an interface as needed.

Why should someone involved in the development or deployment of manufacturing technology be keenly interested in data standards? “Avoiding non-value-added work,” explained Shinbara. Expertise and time should not be spent understanding, reformatting and renaming data in a certain way to get individual machines or whole systems to work together. “It eliminates a necessary evil that can be expensive.”

Measurement data is often scattered throughout a manufacturing plant and gathered using a variety of devices such as CMMs, laser trackers, articulating arms, or vision systems. Results are created in differing formats, and often remain in isolation, stuck with the device, according to Hexagon. Using their DataPage+, the user can collect all the measurement data from any EMS suite program such as PC-DMIS Vision, and PC-DMIS Portable, plus import data in a variety of other formats, and automatically build a Microsoft SQL Express database with the results.

An important point in the development of standards is to not reinvent in a different way existing standards. This serves to confuse instead of clarify. So, as part of the development of the next version of the standard, what he terms as version 1.5, their working groups will carefully look at existing standards (like QIF) and include them via an interface as needed.

Why should someone involved in the development or deployment of manufacturing technology be keenly interested in data standards? “Avoiding non-value-added work,” explained Shinbara. Expertise and time should not be spent understanding, reformatting and renaming data in a certain way to get individual machines or whole systems to work together. “It eliminates a necessary evil that can be expensive.”