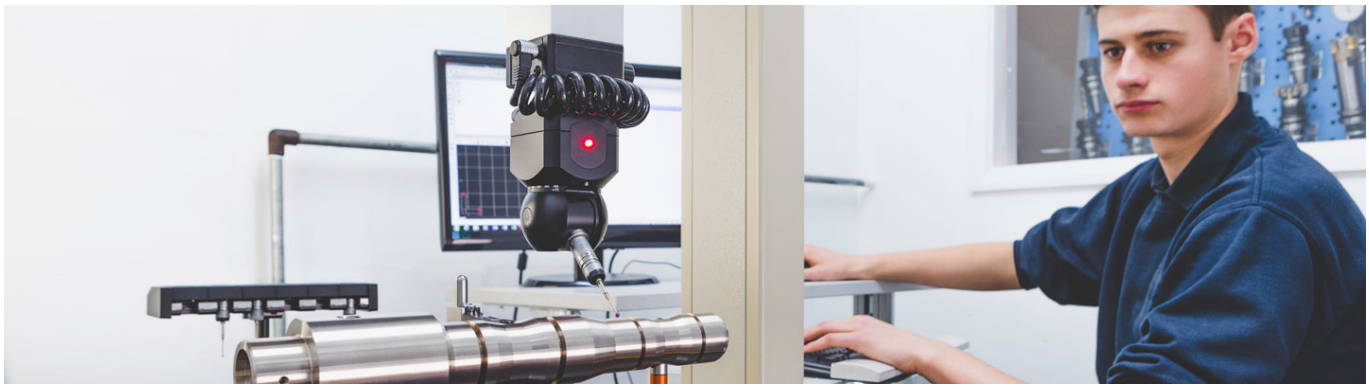

Machining

# Where Metrology Meets Today's Precision Manufacturing

Don Sears | Feb 26, 2019

**In many manufacturing industries, speed to delivery of finished parts is paramount. But a scrapped part is not a finished part. The accuracy and quality of parts made to industry or compliance-based specification is just as important. We talk to experts in metrology to better understand how the technology is used to ensure quality—and when.**

What's going on in today's metrology? As specifications for parts become more and more precise, so too does the measurement of the accuracy and quality of those parts. For example, in the automotive industry, many parts are frequently undergoing model year changes with a broad diversity of parts. Every time the specs of a part change, even a little, that means new CAD data, new dies or molds, the potential for new tools and changes in measurements.

From real-time in-process probing and measurement to intelligent measurement functions that are easy to use being built right into controllers, today's metrology helps companies reduce scrap and become more accurate sooner in the part-making process. More sophisticated inspection machines move closer to the CNC grinder, right to where the tool-making process is happening.

## The Evolution of Metrology in Manufacturing

Like everything in high-production manufacturing, metrology has shifted to adapt with the times. The trend is toward getting more precise gauging on the shop floor that is simple to use and provides very accurate information.

"Tolerances are getting tighter and tighter, and so operators today are being asked to make pretty precise measurements on the shop floor," says George Schuetz, director of precision gages at ***Mahr***, who has been with Mahr for 42 years. "People used to send parts to a central inspection area, but often now the operator of the big CNC machine is asked to be the quality control person too."

Some companies may still be using labs for quality inspection, but workers can expect to wait to find out the quality of their parts in a queue. And when time is money, plant managers are looking for ways to move the quality checks and part-making corrections upstream. This is not to say that labs are not used at all—but that the production pressure is a reality.

From a lean manufacturing perspective, metrology is one of the most embracing areas of ***Industry 4.0***

***and the industrial internet of things***. The technology used in today's metrology has evolved both in "in-process" and "post-process" areas.

Post-process metrology happens either manually or through automated techniques—using a variety of handheld, operator-centric tools after a few parts are made. In-process metrology is happening inside machines using robotic arms with probes, data-capturing sensors and automated correction measures—using networked software and programming. The most advanced in-process metrology has the ability to course correct in real time.

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## Getting Accurate Parts in Real Time

"For best practices in metrology, a manufacturer has to understand their process to be able to know when a part is good or bad," says Erik Novak, director of business development for 4D Technology Corp, in a ***Better MRO article*** from ***IMTS 2018***.

"You need to know the depth, width, and in some cases, the volume of allowable defects–for example, how much of the area can be covered by corrosion pits," he says.

"Assessing whether 10 percent of the area is corroded or 1 percent of the area is corroded might make the difference between throwing a part out, repairing the part or allowing the part to proceed without any intervention," he says.

Understanding your process also includes knowing how much access you need to a product–do you need portability or do you want a microscope-based laboratory system?

Another point to consider when selecting equipment is the need for automation on a production or service line, because some metrology systems can be mounted on robotic arms.

"If you look at data after parts are produced, which is what the majority of companies do now, it's valid information, but it doesn't help you change the process to be more efficient," says Dan Skulan, general manager of industrial metrology at Renishaw. "What you really want is to measure discreet characteristics that are critical to the manufacturing process at each point along the cutting of a component, and take that data using sensors and techniques that ensure it is valid."

The challenge is to determine what are the critical characteristics of a component to measure for process control? In many cases, there might be upward of 30 features cut in a single process, but likely there are only a couple of key dimensions that are critical to ensure quality upstream, so it requires a deep understanding of what can be adjusted and monitored in real time that will affect significant change.

## Getting Beyond Cycle Time to Reduce, Avoid or Eliminate Scrap

No matter the technology being used—or whether it's officially part of the Industry 4.0 moniker—metrology spokespeople interviewed agree on this: Scrap is the enemy. Production rates are always being pushed to the maximum—especially in aerospace, automotive, oil and gas and other industries. But bad parts will add time and delay delivery. Finding out when you have bad parts is key to keeping production humming—even if it adds a little bit more time in process.

"From measured results to process monitoring and field networking, all that information needs to be compiled into one—it's crucial," says Patrick Harkness, vice president of distributed product sales at *Mitutoyo America*. "From small hand tools to machine centers to coordinate measuring machines to vision systems, there's a way of integrating your data management to make a smart factory that reduces costs and labor and ensures you have accurate parts with little to no scrap."

Lilian Barraud, president at Blum-Novotest, a testing manufacturer, *told* Advanced Manufacturing what is happening in the automotive industry:

"[I]n the past they would only talk about cycle time and production … They are now willing to accept a slight increase in cycle time to include in-process inspection because it is the most efficient and intelligent way to ensure that all parts are produced or manufactured within tolerance, avoiding scrap, scrap recycling…"

Harkness, who has been with Mitutoyo for nearly 20 years and began his career as a design engineer, explains how a smart, networked factory with metrology as a major data hub can help a manufacturer become predictive. The right data can tell you how many cycles you can make parts in—and when it's precisely the right time to make an adjustment before scrap is likely to occur.

"When you're getting true measurements coming out of a digital tool, those readings over time can help dictate process control changes," says Harkness. "With the right statistical analysis that metrology provides, you can know when to go in and make a tool change—and avoid scrap altogether."

## Common Types of Precision Gages in Metrology

What's the best gage for production at an operator level? It will depend on conditions. There are thousands of ways to measure a hole, but process engineers and machine operators will have to understand the right questions to ask before choosing the right metrological tool.

What's the tolerance and where is it? What's the volume? Is it on the same machine every time? What are the conditions in the machine and on the floor? What's the temperature?

Beyond understanding whether a part is accurate and of the right quality, one also has to consider the surface finish—especially in automotive parts, explains Schuetz. Will the hole bear weight? Will it have moving parts inside of it? Will there be fluid or oil traveling through it? Maybe it needs to be super smooth.

Here are four common types of precision gages, from the simple to the more complex and data-driven.

### *Go, No-Go*

"Go, No-Go" rings have been in use for a long time, says Schuetz, but they don't assess quality. "They are precision ground holes that if a part passes through it, you know that part is good, but it's just a piece of steel," he says. There's nothing telling the machinist the quality of the part, just that the size is correct.

### *Calipers, Micrometers*

If you want a little more information than that across a wider variety of parts, operators tend to use calipers and micrometers. Here, Schuetz says those types of hand tools give some versatility; they tend to be very operator influenced because you have to hold them right and you have to make sure that you're not squeezing the part too tight.

"So those are good general purpose tools, and they're very valuable. They're great for the machinist, but there are some tolerances out there today that maybe they're not good enough to make the measurement that's being required," says Schuetz.

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## Variable Gages

These are little bench gages that can be adjusted to measure an "ID" (inside diameter) or "OD" (outside diameter). "They have a master that you can set them to and they have an indicator on them, and so you set that gauge up to measure a specific dimension," says Schuetz. "Now that gauges a lot faster than a micrometer because it's already set to that size. It has a pretty good resolution, and it may have a digital indicator. The benefit with variable gages is the ability to start doing statistical process control, or 'SPC,' because you obtain a data reading.

"Once you have it, you know how good or bad the part is. And so that's another step up giving the operator the ability to measure," says Schuetz. "You can use that data on a running average to tell you what the machine is producing so you can see part trends. … If you start recording the measurement information, you can then begin to make some smart decisions."

## Fixed Variable Gages

These are made to measure specific dimensions—and essentially eliminate the opportunity for operator influence.

"Take automotive, for example. You might have a water pump part that has some very precise holes, which are being manufactured by the millions … It can give them a very good reading," says Schuetz. "So that's virtually a foolproof way to make some very precise lab grade measurements right on the shop floor."

One major shift metrologists point out: Wireless tools. Many of the latest gages and handheld tools have cut the cord—which helps save time and effort for operators without sacrificing the functionality.

***How does your shop evaluate part quality and accuracy? What are your favorite or least favorite metrology devices and why? Share in the forum. [registration required]***


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