

# CMM for Gear Inspection

## Why a CMM for Gear Inspection is a Viable Option

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**Gear inspection has long been a highly specialized costly investment and an overall challenging part of the gear manufacturing process.** Given that complicated gages, testers, and CNC equipment all go into creating high quality gears, companies may want to invest in a CMM to streamline inspection.

### The inspection benefits of CMMs

A CMM can be used for gear measurement, production and setup, including measurement of purchased gears.

One of the reasons CMM equipment has become popular for gear measurement is that it's a more economical and a lower priced option than conventional dedicated gear inspection equipment. Today, the cost of fully-programmable, fully-automated, sophisticated gear checking equipment can range from \$300,000 to \$350,000 or more. And this doesn't include the cost of master gears and artifacts needed for setting dedicated gear measurement equipment. The cost of all required components can be at least 2.5 times as much as the cost of CMM machine equipped with a rotary table, high-speed scanning probe head and gear measurement software.

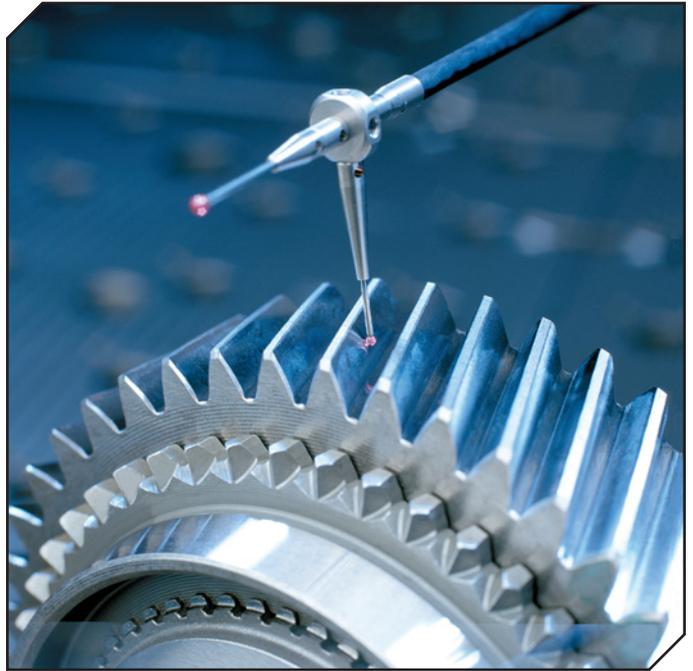


**CMM's are highly versatile, providing the ability to precisely measure different types of workpieces including small parts like gears and larger parts such as engine blocks. This versatility can be a big money and time saver. All photos courtesy of Mitutoyo America.**

### Types of CMMs to consider

Of course, it's important to keep in mind that the type of CMM used to measure gears will depend primarily on the gear size and weight. For large gears with diameters of more than a meter, or for those that are overly heavy, a high-precision, horizontal arm CMM with a rotary table solution is best. This kind of CMM is typically used for inspecting large-scale gears like those used in ships and heavy equipment powertrains, as well as turbine gearing and those used in nuclear and thermal power plants. Due to the open-access structure of this style of CMM, inspection of such large gears is easier.

Conversely, bridge CMMs are usually better for measuring small or medium size gears, and come in two available styles. The first style has a fixed table with moving bridge, while the



**A CMM multi-probe checks a precision gear's tooth, taking and recording measurements faster and more accurately than either a micrometer or tooth caliper.**

other has a moving table with a fixed bridge. This latter affords greater accuracy because the servo drives are located at the center of gravity, with a moving bridge the X-axis drives along one side, so the accuracy will change as the z-spindle moves in X.

### Other inspection uses for CMMs

In addition to replacing dedicated inspection equipment, CMMs can also replace many of the smaller, hand-held and functional gages used in gear inspection. It should be noted that there can be issues around lack of repeatability between operators using manual inspection methods, as well as issues



**A small pinion gear is checked by a CMM. Using a CMM to inspect gears allows for faster, more accurate results without having to rely on specialized instruments.**

GEARPAK				
Gear type	Touch-trigger measurement	Scanning measurement	Required software package/Remarks	
Cylindrical spur gear		●	●	GEARPAK Cylindrical
Cylindrical helical gear		●	●*1	GEARPAK Cylindrical *1: Does not support a cross-stylus
Worm gear (cylindrical)		●	●*2	GEARPAK Worm *2: MBT and MPP310 (Q) are required.
Worm wheel (cylindrical)		●	●	GEARPAK Cylindrical Cylindrical gears only
Bevel gear		●	—	GEARPAK Bevel Supports Gleason gears. Note: Some gears are not supported.
Hypoid gear		●	—	GEARPAK Hypoid Supports Gleason gears. Note: Some gears are not supported.

**Specialized gear measurement software is key when inspecting many different types of gears with precision. Optimal software modules can analyze measurement results to document, present results and archive the data in practical structures.**

concerning slower speed of measurement in general.

It's also good to remember that with manual gages results are written down, making them subject to human error and incorrect values being recorded. An automated CMM can also measure parts while an inspector continues to perform other duties, leading to more accurate, consistent and repeatable results and reporting.

CMMs can even be placed on the shop floor alongside production machines, as long as rapid and dramatic temperature changes, as well as vibrations, are taken into account. If the temperature is somewhat stable, there usually will be no major noticeable errors, even given the tolerances required for gears. And many modern CMMs today come with temperature sensors to help ensure proper compensation is made for any temperature fluctuations that do occur.

## Software is important for all forms of gear measurement

Beyond the precision and accuracy of CMMs, one of the keys to accurate gear measurement, whether on a CMM or on dedicated gear checking equipment, is the software. For instance, calculation of whether an involute curve is correct based on data points extracted during measurement requires the use of high-level mathematical formulas and sophisticated algorithms.

That's why it's vital to look for CMMs with software that can handle these calculations, and can even combine intuitive icon-based programming with the ability to import native CAD models. In addition, it's important for users to be able to choose various software modules to analyze measurement results, to document and present results, and to archive the data in practical structures. This means software that integrates with networked systems for inline process control applications, as well as enables true enterprise-wide functionality.

**For more information:**  
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## CMM Integration

Mitutoyo CMMs can easily be integrated into automated cells. Mitutoyo has a Solutions Group that is dedicated to designing custom fixtures, automation control boxes, and integration in automated cells. A standard package that includes an IO card and a custom designed control box based on the work cell requirements can be added to any CMM to begin the process of integrating it into a work cell.

"They have a significant amount of experience setting up automated work cells with all types of robots in a multitude of industries and work with the local application personnel of Mitutoyo to provide a seamless integration process," said Derek Sporleder, application engineer at Mitutoyo, in an interview in 2019.

None of these advances would be possible without a user-friendly software package that can deliver the right inspection tools for machine operators of many different skill levels.

"The developers of the GEARPAK software have spent a lot of time developing a workflow that helps guide users through the setup of a gear inspection routine. There are various tool tips that give explanations for each input. The help files for a particular input can be easily accessed and are very informative as well," Sporleder said.

Mitutoyo uses Renishaw probing systems for touch trigger systems and most scanning probe systems so the customer has many options when it comes to probing. Additionally, rotary tables can be integrated into the CMM to improve cycle time as well.

"This gives Mitutoyo the ability to offer a system much more tailored to the customer's needs such that a customer who wants spur gears and is comfortable with discreet touch points could be offered a CMM configuration with a fixed probe head and touch probe system whereas another customer that makes various types of spur, helical, straight bevel and spiral bevels gears may need an indexable probe head with a scanning probe system and a rotary table," Sporleder said. Learn more about CMM inspection here: [www.geartechnology.com/issues/0719x/measurement-management.pdf](http://www.geartechnology.com/issues/0719x/measurement-management.pdf)

