➤ BY STEVE LOGEE, WILCOX ASSOCIATES INC.

All Images: Wilcox Associates

Historically, machine tool probes, with their restricted functionality and limited macro languages, have been of minimal use for all but the simplest applications. That is now changing as software vendors are adapting their products to satisfy more demanding on-machine metrology requirements.

Three paths *forward*

A user's guide to selecting metrology software for on-machine probing, from basic to advanced.

Metrology software developers are providing new programs for parts manufacturers that want to use spindle probes on CNC machines. Spindle probes eliminate the need for users to write probing macros. They offer many more features and functions than the macros and generate more accurate results with probing sequences and calculations based on proven coordinate measuring machine (CMM) algorithms.

Software developers also offer a range of third-party, on-machine metrology products, allowing users to choose the one that most closely fits their usage requirements while minimizing the impact of on-machine probing on the CNC equipment's productivity. The question is, "How do you determine which type of on-machine probing software is best for your requirements?"

Typically, manufacturers purchase spindle probes for their CNC machine tools for one of three reasons:

- To perform simple checks of part geometry and serve as a setup aid,
- To perform in-process evaluations such as tolerancing of features or relationships between features that do not require direct interaction between the machine tool and the measurement software but do require sophisticated metrology capabilities, and
- To perform checks that require both sophisticated metrology capabilities and direct, bidirectional communications between the measurement software and the machine

tool's controller.

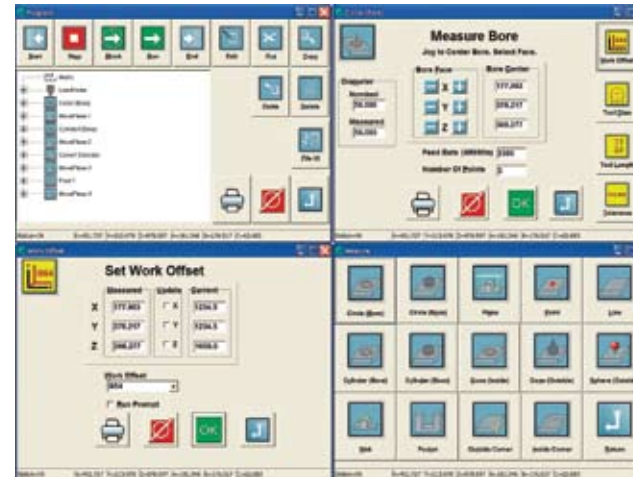
A Basic Solution

Most spindle probe purchasers do not expect to use the probes for sophisticated metrology applications. Rather, they use them as aids for part and machine setup and to make simple checks on basic geometries.

For setup, these users generally measure a few features and use the data to calculate and set tool and work offsets. In checking geometry, they use probes to check a few features in-process to make sure nothing is grossly wrong. For heavy-duty metrology and reporting, these users typically rely on CMMs.

Speed and accuracy are vital for these users. CNC machine operators need to get checks done quickly and be able to rely on this data to make basic manufacturing decisions. This category of on-machine measurement generally requires software that is easier to use and more robust than the probing macros typically supplied by probe manufacturers.

To meet these basic on-machine measurement needs, metrology software developers create user-friendly products for spindle probes. At minimum, these products incorporate icon-based graphic user interfaces and table-driven data entry routines that make it easy for operators to select and set up probing sequences and measurement evaluations. This basic on-machine measurement software isolates operators from the complexities and potential errors associated with manually entering data into cryptic macro calls.



Basic Solution: PC-DMIS Lite from Wilcox Associates provides a core set of certified measurement and alignment algorithms driven by a graphic user interface. This software will be sold directly by CNC machinery builders and will be commercially available in the last quarter of 2008.

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Some of these products may include metrology algorithms certified by groups such as the national metrology institute Physikalisch-Technische Bundesanstalt, Braunschweig, Germany. These algorithms evaluate measurement data and provide operators with control over the placement and density of probe touches (two features lacking in basic probing macros). In addition, some products can format and produce basic reports, save probing sequences for subsequent use and store measurement information for additional analysis by other software.

For most NC probe users, a set of basic measurement and setup tools is all they will ever need.

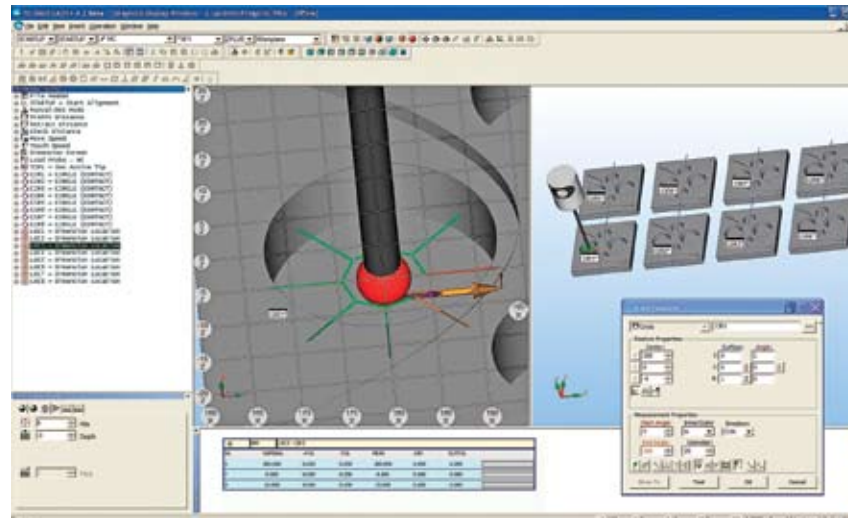
The Middle Way

Other users, however, require richer on-machine measurement and analysis software that offers advanced metrology and statistical process control tools for tasks such as analyzing machine performance, measuring large parts that are either impossible or very difficult to measure on a CMM, calculating complex alignments and monitoring the quality of their parts as they are made. For these users, on-machine metrology features, functions and flexibility typical of advanced CMM software offer the best solution.

This mode of on-machine metrology does not

typically require the user to operate his machine tool as if it were a CMM. In many cases, that would be more of a drawback than an advantage because the time spent taking measurements and analyzing them would reduce chip producing time. For many on-machine metrology applications, though, there is a middle way that allows users to develop part programs, execute them, analyze them and report the results with minimal impact on the manufacturing process.

To create this middle way, CMM software developers have adapted their core software to the on-machine measurement environment by limiting the work done on the CNC to part probing. Everything else happens offline. In much the same way CAM systems work, offline programming packages generate the G and M codes needed to drive a probe. When these routines run on the machine tool, they use either a serial or network port to send the data they generate to a separate computer for processing. Here, the core metrology software accesses and evaluates the point files in batch format as they come from CNC machines. Using this



Middle Way: With PC-DMIS NC Server, measurement data collected by the spindle probe is processed offline in batch mode. This reduces the time spent on the machine tool controller for measurement and simultaneously gives users a set of measurement, analysis and reporting capabilities. A single software license can support multiple CNC machines.

methodology, the only impact on machine time is the time spent taking points.

This type of on-machine measurement product deals with data in batches, so it can concurrently manage and analyze data coming from multiple machine tools. The offline programming software generates probing sequences customized for the specific machine tools on which they will be used. On the back end, the analytical engine pairs the machine with its data files and matches that data with the appropriate part program.

Users who have purchased the core software system can usually connect it to additional CNC machines without incurring substantial additional costs. This type of on-machine measurement system may be able to support a number of machines, depending on the volume of data coming from the machines and the topography of the user's network.

The middle approach offers users the benefit of adding measurement and programming capabilities along with analysis and reporting functions, while minimizing the factors that can retard machining output.

Full CMM-Like Operation

In addition to requiring a full range of metrology functions, some applications also demand a software solution that is directly integrated with the machine tool. This approach provides capabilities similar to those described above, but also allows for direct communication between the measurement software and the machine tool during program execution. This makes it possible to take advantage of such functions as iterative alignments, relative measurements and adjustments to program execution based upon conditional logic.

In these cases, the machine tool runs almost like a CMM. The software that CMM software vendors offer for these applications is typically a direct adaptation of their standard products. The probing software controls the machine tool as if it were a CMM. It is even possible for the software to compensate for the machine's volumetric inac-

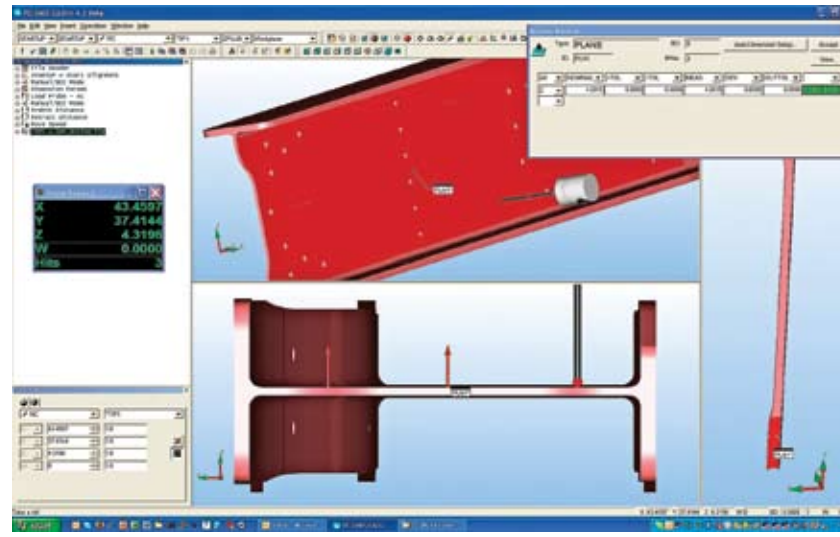
curacies and temperature variations as if the machine were a high-accuracy CMM. With the exception of manually driving the probe to collect data points, which is a cumbersome process on a CNC machine, this measurement software behaves much as it does on a measurement machine.

Because of its interactive nature, the impact of this software solution on cutting is greater than the batch-mode solution. This is true not only when measurements are being taken but also while the software is evaluating data and generating reports because everything is done on the machine. However, for many applications, the trade-off in time lost is more than made up for by the increase in machine functionality.

Metrology software developers have addressed the diverse requirements of on-machine gaging. As a result, users can now select from a range of software products to hone in on feature sets that most closely fit their intended uses.

For most applications, the only thing needed is a basic set of inexpensive and easy-to-use measurement software tools for locating parts, calculating offsets and evaluating basic geometry. The most important things in this case are that the on-machine probing software be easy to use and metrologically accurate.

For more advanced applications requiring sophisticated metrology and reporting functions, the choice is between software systems that capture raw measurement data at the machine but process it offline and interactive products that assume complete control of the machine tool during the measurement and analysis process.



Full CMM-Like Operation: PC-DMIS NCi interactive on-machine gaging software from Wilcox Associates assumes full control of the machine tool during measurement and analysis. This means the CNC machine can do almost anything a CMM can do.

If real-time interactivity between the metrology software and the machine tool is not required, the batch-mode, offline solution is more cost effective. However, in specific situations, interactive systems may be the only way to get the job done. This solution costs more than other approaches because separate software licenses may be required for each CNC machine, and cutting operations are interrupted while measurements and analyses are underway. If on-machine gaging is the only choice, though, the additional cost of the interactive approach is well worth it. △

About the Author

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