Routinely checking turret and spindle alignment is an important part of any machine tool maintenance routine. (Provided by Okuma America Corp.)

IF IT AIN'T BROKE ... IT MAY NEED *FIXING!*

Machine shops neglect routine maintenance at their peril

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Some shops think routine machine tool maintenance is overrated. Bad idea.

The big order's running late. The lead programmer called in sick. Your best customer just texted, asking about the quote due last Tuesday. Who has time to worry about the slow drip of way lube from the back of the CNC lathe, or wonder if that slight buzz you hear from the horizontal machining center spells spindle problems?

It's understandable. Everyone gets busy, but neglecting the maintenance on a machine tool isn't like driving to work when your left rear tire's pressure is a bit low. Failure to regularly and adequately maintain CNC equipment can cost far more than the inevitable but unexpected repair bill. It can mean loss of part accuracy, poor tool life, and potentially weeks of unplanned downtime while you wait for a part from overseas.

Keep it Clean

Avoiding all this begins with one of the simplest chores imaginable: wipe equipment down at each shift's end. That's according to Kanon Shiu, product and service engineer at Chevalier Machinery Inc., Santa Fe Springs, Calif., who lamented that far too many machine tool owners could do

a better job on this most basic of housekeeping items. "If you don't keep machinery clean, it almost certainly leads to problems down the line," he said.

Like many builders, Chevalier installs wash-down hoses on its lathes and machining centers. These should be used in favor of compressed air to spray down machine surfaces, as the latter can blast small chips and fines into way areas. If so equipped, chip augurs and conveyors should be left on during machining operations to avoid swarf build-up. If not, accumulated chips might cause the motor to stall and break when turned back on. And filters should be cleaned or changed regularly, as should the sump and cutting fluid.

"All of this makes a big difference on how quickly we can get the machine up and running again when it eventually needs service," Shiu said. "When we come onsite and the equipment is dirty, it's going to take us longer to repair it. That's because the technician might spend the first half of the visit cleaning the affected areas before he or she can even begin diagnosing the problem. The result is unnecessary downtime and, quite possibly, a bigger repair bill."

Control Freaks

Shiu also recommends using a skimmer to remove tramp oil from the machine sump. So does Brent Morgan. An application engineer at Castrol Lubricants, Wayne, N.J.., he agreed that skimming, routine sump maintenance, and regular monitoring of cutting fluid pH and concentration levels all serve to extend coolant life, as well as that of the cutting tools and even the machinery.

However, Morgan also offers an automated approach to cutting fluid maintenance called Castrol SmartControl, and for any shop that has contemplated investment in a centralized coolant system, it might tip the scales.

The SmartControl has been out for "about a year now," he explained. It was developed in partnership with industrial control builder Tiefenbach, and is designed primarily for shops with central systems. Two versions exist. Both continuously monitor cutting fluids, checking values such as concentration, pH, conductivity, temperature, and flow rate, and notifying the user if one of these needs attention. The more advanced version can adjust some of these values automatically—if it reads low on concentration, the SmartControl will add concentrate, just as it will adjust the pH on its own by adding buffer as needed.

Given their additional axes and greater complexity, five-axis machining centers and multitasking lathes require a higher level of care from the maintenance department. (Provided by Chevalier Machinery)

"Customers like these systems because there's none of the hassle associated with cutting fluid maintenance," Morgan said. "You just check the indicator lights and, if anything's out of whack, take the appropriate action. And provided there's an Internet connection, the user can monitor it remotely. There's also an onboard hard drive that keeps a 30-day history of cutting fluid maintenance activities."

Maintenance from Afar

Given the trend towards Industry 4.0 and Industrial Internet of Things (IIoT) technology, remote monitoring systems like these are becoming increasingly common. For example, Chevalier's Kanon Shiu mentioned the company's iMCS (Intelligent Machine Communications System). Like all such systems, it collects information on various manufacturing-related activities. But what's equally important is its ability to detect temperature, vibration, and even crashes, giving those responsible for machine maintenance valuable information.

Chevalier customers can use the company's Intelligent Machine Communications System (iMCS) software together with the iBOX data collection system to anticipate potential equipment problems. (Provided by Chevalier Machinery Inc.)

Guy Parenteau is also big on remote monitoring. The engineering manager at Methods Machine Tools Inc., Sudbury, Mass., he noted that remote machine monitoring allows builders and customers alike to establish operational baselines, which can then be used by AI-based algorithms to identify electro-mechanical trends. Enter predictive

maintenance, a technology that can improve OEE (overall equipment effectiveness).

"A growing number of shops are using productivity monitoring software to understand and optimize machining efficiency," Parenteau said. "The next step is to analyze machine tool data for component wear patterns, changes in servo load, temperature increases, etc. When you compare these values to the ones from when the machine was new, you can predict a motor failure or let someone know that the spindle bearings are about to go."

Visitors to one of Methods Machine Tools' application centers review CNC utilization figures from the MachineMetrics industrial IoT platform. (Provided by Methods Machine Tools)

Such analysis is a two-way street, he noted. Given network access, a distributor or builder can monitor customers' CNCs, much as FANUC has done with its ZDT (Zero Down Time) system to perform remote health checks on robots. This capability alerts manufacturers to potential problems and helps them identify and eliminate product shortcomings.

Customers unwilling to open a port in their firewall (or pay a service fee) can opt to monitor the data themselves. There's nothing wrong with this, Parenteau said, but added that the builder is often in a better position to identify maintenance and operational issues in advance. "They're the ones who know what the machine or robot is capable of, and if anything goes beyond a predetermined value, they can easily trigger an alarm that there's a problem looming, or that the customer might be pushing the machine too hard."

Even without remote access, machine tool maintenance is becoming both easier and more technical than it once was. Ira Busman, vice president of customer service at Okuma America Corp., Charlotte, N.C., uses late-model cars and trucks as an example. "The vehicle's computer tells you everything, and in some models, will even schedule an appointment for you with the dealership," he said. "The machine tool industry lags in this respect, but rest assured, it's moving in the same direction."

That's good news, because most everyone interviewed for this article agreed on one thing: shops generally do a less-than-stellar job at maintaining their equipment. For owners of Okuma machine tools looking for a little help with this nagging task, Busman pointed to the company's App Store. It offers widgets for scheduled maintenance reminders, monitoring and control functions, alarm notifiers, and more.

Castrol's SmartControl continuously monitors cutting fluids and, on some models, will adjust concentration and PH level automatically. (Provided by Castrol/BP Lubricants USA)

As with the majority of machine tool builders and distributors, Okuma is trying to make shop floor life as simple as possible, he said. What's more, Okuma wants to make it "as smart as possible." The automotive functionality described earlier is approaching reality in the manufacturing world as IIoT-based sensors gather information on bearings, motors, and other electro-mechanical components. The machine's computer continuously evaluates this data, using AI to determine when things will go awry.

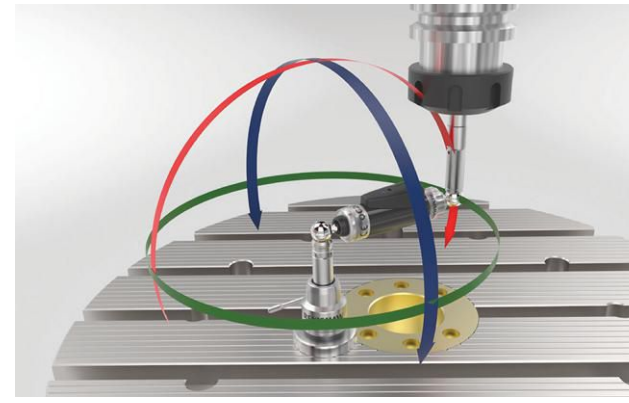
As others have noted, however, it's essential to have a baseline for comparison. Said Busman, "When Okuma builds a spindle for one of its lathes or machining centers, we gather signatures off that spindle for vibration, temperature, and runout. Algorithms within the control can then monitor those values, and when one reaches a predetermined point, the control will notify the machine

operator or send an alert to an external system, telling them that it might be time to bring in a technician."

Mike Hampton, Okuma's business development specialist for aftermarket parts, suggested that this last possibility—alerts to external systems—remain problematic. "I estimate that a very small percentage of the CNC machines out there are connected to the Internet," he said. "As the industry grows more dependent on data, this will become a serious challenge.

"The rollout of 5G and other cellular technologies will likely improve the situation, but there's still a tremendous reluctance—mostly by our customers' IT people—to allow remote access to their machines," Hampton continued. "So while Okuma and others would like to offer more proactive machine maintenance services and increase communication with their customers, connectivity is still the biggest obstacle."

Until that day comes, shops can increase uptime and part quality by scheduling routine health checks of their equipment using a ball-bar or laser calibration system. That's according to Dan Skulan, general manager for industrial metrology at Renishaw Inc., West Dundee, Illinois. He agreed with the others interviewed for this article that establishing a baseline early on in the machine tool's life is a critical piece of any preventive



Renishaw's QC-20 ballbar system is an important tool for manufacturers wishing to determine and improve volumetric accuracy of CNC equipment. (Provided by Renishaw)

maintenance program. Any deviations from this baseline can then be used to identify worn or damaged components and out-of-level conditions. “The number one reason why machine tools lose positioning accuracy is the fact that they’re not securely installed, properly leveled, and then checked regularly,” Skulan said. “That one thing can make a high-quality machine perform poorly, and, conversely, make a mediocre machine perform like one that’s far more expensive. Without a doubt, leveling provides the biggest bang for the buck and is easy to do.”

One notable example comes from a machine tool distributor in Indiana. While setting up a vertical machining center, the applications engineer there noticed that it was positioning incorrectly. He called Skulan, who brought in one of the company’s QC20-W ballbar systems.

This is result of a shop not cleaning the oil reservoir tank and filter on a CNC machine tool. In this instance, the customer received a flow alarm, which had it not been caught in time, would have lead to a gear or bearing failure. (Provided by Absolute Machine Tools)

“The X and Y axes were out of square by 0.004" or so (0.102 mm), and a quick check with a spirit level confirmed my suspicions that the machine was out of level,” said Skulan. By putting the ballbar in repeat mode, the two were able to gradually tighten each of the jackscrews in succession until the machine was perfectly level, bringing the positioning accuracy within 0.0002" (0.005 mm).

Ballbars are great for detecting squareness and similar issues, but for error compensation related to volumetric machine accuracy, the best detection method is a laser interferometer or multi-axis calibrator. Renishaw offers several such systems, which Skulan suggested should be used immediately after the machine is installed and then at periodic intervals afterward, as determined by the type of machining being performed.

“Let’s say you’re making diamond-turned parts for the James Webb Space Telescope and you need to maintain tolerances within a few nanometers,” he said. “In this instance, you’re probably going to run a calibration check before every cut. A shop that machines skateboard parts to plus or minus five, on the other hand, can get by with the bare minimum; from my side, that’s at least once a year, assuming that the machine has settled in and remains level.”

A ballbar is simple to use and with some training most shops are also capable of laser calibrating their machines. This is especially true on new equipment, which often takes care of setting the CNC’s internal compensation values. For shops with large numbers of machine tools and/or multiple facilities, software can track maintenance. In Skulan’s case, this is Renishaw Central, which gathers and organizes data from the company’s CARTO laser measurement software.

For shops lacking the time, resources, or inclination to maintain their machines, Hayden Wellman, senior vice president at Absolute Machine Tools Inc., Lorain, Ohio, has a team of people able to do so. Like many distributors, Absolute offers a range of preventive maintenance programs, from Bronze to Silver to Gold. Absolute also provides ala carte services such as pitch error compensation, servo tuning, and laser-based calibration and alignment.

"For shops that have no preventative maintenance program, we perform routine tasks like changing the hydraulic oil, checking for air leaks, adjusting backlash, and making sure the machine is level," said Wellman. "And for the shops who take care of this on their own, we have all the lasers and other tools needed to keep their investments operating as designed. Some do this once a year, others less frequently, but what's important is that they do it regularly."

Wellman shared dire scenarios such as clogged way oil restrictors that lead to damaged way surfaces, and spindle failures caused by dirty fluids or worn seals. It doesn't take much imagination to predict the eventual outcome of these maintenance failures. Yet he pointed out one scenario that often catches shop owners by surprise: a machine operator able to compensate for an ill-maintained machine, programming their way around alignment and accuracy problems. "Eventually, it gets so bad that the machine stops working, or worse, the operator quits and no one can figure out how to make good parts," Wellman said. "Either way, it ends up costing the shop much more than if they'd had a good maintenance program in place all along."

FYI

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