Machining

Good Vibrations: How to Optimize Your Machine Setups to Minimize Chatter

Vanessa Jo Roberts | Oct 13, 2020

Is chatter slowing down your shop's productivity? We speak with experts about a new approach to minimizing vibrations in machined parts manufacturing which means you can speed more parts to market at a faster pace and with less waste.

Excessive machining vibration, also called chatter, is the enemy of all efficient metalworking operations.

The unwanted shaking—which corresponds to the relative movement between the workpiece and the cutting tool—places undue wear on your tools and machines, and it increases the chance that a machining process will produce a product that's not to the correct part specifications, says Tony Schmitz, professor of mechanical, aerospace and biomedical engineering at the University of Tennessee, Knoxville.

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> Jamie Goettler
> Director of Metalworking Innovation at MSC

For the past two years, Schmitz and his colleague Dave Barton, a manufacturing industry veteran, have worked with a team of engineers at the Oak Ridge National Laboratory to introduce a tool that helps shops better optimize for machine vibration.

"In milling, you have a rotating cutter—that removes the chips," explains ***Schmitz***, who is also Joint Faculty at ORNL. The cutting force grows and declines with each tooth engagement, he adds. "Think about it like a heartbeat—with the tooth coming in and out of contact. It's that force going up and down that causes vibration."

Reduced Chatter Delivers ROI

Why does the ability to identify and reduce chatter matter?

First and foremost, a machine that can run at the optimal speed and feed for a part creates capacity by reducing cycle time, Goettler says. If you can optimize in near real-time, and then produce your part almost immediately, that means you can speed more parts to market at a faster pace and with less waste.

Goettler sees three game-changing benefits for shops if they can increase capacity using ***MSC MillMax***:

- No. 1: the ability to be more profitable and competitive. In today's economy, the opportunity to take on new share is real, and being cost-competitive, both domestically and globally, is imperative.
- No. 2: the ability to grow the business and potentially tap into new revenue sources.
- No. 3: the ability to "stiff-arm" the skills gap because the efficiencies gained will let current machinists take on more work.

"Each of those is affected by reducing cycle time," Goettler says. "Ultimately, this tool could help shops mill at the best price point possible."

Finding a way to smartly reduce chatter and maintain a rhythmic machining "heartbeat" is not just about speed control, it's also about optimizing a machine by understanding the vibration happening at the tool tip relative to the material being worked, and the specific setup on each machine, Barton explains.

The challenge comes from the fact that every machine-tool setup has its own set of unique vibration frequencies. That makes testing each tool-holder-spindle-machine setup for a product critical, and often that's time-consuming work for shops. However, this information is required to find the optimal machining parameters without costly trial and error.

Learn more about MSC MillMax.

How Shops Typically Minimize Chatter

For most machinists and shops, managing chatter is a process of trial and error—it is, more or less, just guesswork, Barton says.

It's quite common for machinists to rely on the recommended settings provided by tooling manufacturers to reduce chatter, or on dense speeds-and-feeds charts, Schmitz says. Then, machinists adjust the settings as needed, he adds: "The challenge is these speeds and feeds found in a book or online do not account for the dynamics of your machine and setup."

Typically, machine and tool manufacturers publish parameters at high, medium and low speeds for the surface footage and feed, says Jamie Goettler, director of Metalworking Innovation at MSC.

Based on that information, most machinists will "go right in the middle," Goettler says. "If there are issues or chatter, they back down until they find a stable operating rate."

Using this approach, shops generally conduct a test run for each new material or product part, he adds. A machinist will start by running the tool at the manufacturer-recommended speed, feed and depths of cut, then have to intuitively adjust each of these parameters over multiple test passes.

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It's not uncommon for a shop to spend the better part of an entire shift attempting to optimize its setup before beginning parts production, Goettler says. It's easy to see why businesses take this time, he says: They strive to achieve maximum productivity, control waste and extend tool and machine life.

Some shops may keep detailed logs and spreadsheets for different combinations of tooling setups for specific work products, only to find that the next time they use that combination it may chatter because their original findings were not robust or repeatable. Other shops fight chatter every day using manual overrides or trying different tools.

A New Tooling Technology to Reduce Chatter

Barton and Schmitz say ***MSC MillMax***, the milling parameter selection tool that they developed, can make optimization a faster process.

Of greatest concern is how the tool is cutting at its tip, Schmitz explains. Measuring the "specific vibration behavior at the tool tip" provides the vital data that shops need to perfect each setup combination, he adds. "You can think of each tool-holder-spindle-machine combination as having a unique dynamic fingerprint. MillMax enables you to measure the fingerprint and make the best use of that combination."

MillMax is a small kit that uses a sensor to gather the vibration frequency data and then present it in near real-time to a digital dashboard. Armed with that information, a shop can build a setup that will let its machinists produce parts at the fastest possible speed and maximize metal removal, Barton says.

"We attach a small sensor to the tip of the tool, then tap the tool with an instrumented hammer to get the vibration data," he explains. There are "billions of potential milling system combinations of items in the MillMax system."

Once you have the setup for a specific work product on a specific machine, there's no need to retap, Schmitz adds. You only retap if you change the tool length or the machine you plan to use.

"We aren't trying to sell a specific tool, but help them find the right tool," Barton says. Essentially, "we're the truth detector" that can show a shop actual data about what's happening with vibration frequency on their unique setups or to compare multiple setups. "And we can do it in a matter of minutes," he adds.

Are you using the right end mill for the job? Read our article "When to Upgrade Your End Mills" to find out.