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CUTTING TOOLS

Is This Design Flaw Reducing Machine Shop Productivity?

Manufacturers are increasing productivity 15-20% by addressing how toolholder-retention knob design affects precision and increases cycle time.

AM Staff | Aug 21, 2017

What if a small investment of time could yield a 15-20% increase in milling productivity? If this sounds “too good to be true,” note that an increasing number of manufacturers that machine parts are learning to increase cycle times and productivity significantly by addressing one of the most fundamental and longstanding problems in machining: improper seating of the toolholder in the spindle.

This small fact robs machining operations of valuable time, affects tolerances and precision, shortens tool and spindle life, and even increases power consumption. Yet, despite widespread evidence of uneven wear patterns and simple “touch-off” tests that immediately identify it as an issue, this aspect of machining is largely ignored. Manufacturers paying a significant price for this oversight.

Executive level decision — “In my role as an executive, anything that reduced costs or improved efficiency got my attention,” said Joe DaRosa, former president at Toyota Manufacturing of Texas. He added that

improper seating of tapered toolholders in the spindle is frequently overlooked as a factor for CNC milling equipment performance and efficiency.

“Companies purchase top-of-the-line machining centers for a half a million dollars or more, and buy the most expensive cutting tools, and yet they completely ignore the interface between them: the toolholder and the retention knob,” said DaRosa, adding that the purchasing decision for these items often comes down to the lowest priced options.

So, when DaRosa first learned about an inexpensive fix to a machining problem that even by conservative estimates could increase productivity 15% and tool life even more, he was immediately intrigued.

Improper seating of tapered toolholders in the spindle can affect tolerances and precision, shorten tool and spindle life and even increase power consumption. Still, it is often overlooked as a factor in the performance and efficiency of CNC milling equipment.

“If you’re an executive, you’re going to look at this [solution] and see reduced costs and increased productivity. If you are machining operator you will see increased tool life and less frequency of changeover,” DaRosa said.

He described a flaw in the design and use of retention knobs in tapered toolholders secured by drawbars, such as the popular V-flange, that date back to the original designs first introduced decades ago.

The flaw in the system — Although the shank of tapered toolholders is ground to a fine finish to fit in the spindle within very precise, established tolerances, those that use drawbars are also threaded at the narrow end to accept a retention knob. The knob is designed to engage with the drawbar, which exerts a pull force that holds the toolholder firmly in the spindle.

The problem is that poorly designed retention knobs – parts costing less than $20– when tightened create a bulge in the taper that prevents full contact and proper seating in the spindle. Once this expansion occurs, the toolholder will not pull fully into the spindle, and so it cannot make contact with up to 70% of its surface.

Perhaps because the shank and spindle are so carefully machined, or because machinists have used retention knobs on tapered products for decades, this issue has largely been overlooked. However, the results are evident in a wide range of CNC milling issues often attributed to other causes: vibration and chatter, poor tolerances, non-repeatability, poor finishes, shortened tool life, excessive spindle wear and tear, run-out, and shallow depths of cuts.

High-torque retention knobs — There are solutions on the market today that address this design flaw. In 2009, JM Performance Products Inc. introduced its High Torque retention knob. Invented by John Stoneback, it works with all existing toolholders, including BT, DIN, ISO, and CAT toolholders from 30 taper to 60 taper.

The High Torque retention knob is designed to be longer than other options, to reach deeper into the threaded bore of the toolholder. As a result, all thread engagement occurs in a region of the toolholder where there is a thicker cross-section of material to resist deformation.

It also includes a precision pilot to increase rigidity, and is balanced by design. Because over-tightening of even the High Torque retention knobs can create a bulge, JMPP provides specifically calculated torque specs based on drawbar pressure.

By combining the High Torque retention knob with the correct torque, spindle contact with the taper is improved to close to 100% every time. This can be verified by a simple, six-step "touch off" test (www.jmperformanceproducts.com/toolholder-test.aspx). More sophisticated measurement of toolholder expansion (bulge) also can be taken using a taper shank test fixture.

The solution can even provide V-flange toolholders with the rigidity and concentricity necessary for high-speed machining of titanium, aluminum and other metals/alloys, without having to turn to HSK or Capto tooling systems that are 2-3 times more expensive.

Eliminating tooling errors — For Dan Carlstrom of Carlstrom Associates, a manufacturer's rep selling toolholders, milling products and workholding systems, the "light bulb" moment happened when he recommended the High Torque retention knob to a customer struggling with a boring product he had sold to them.

"The customer was having a problem holding size on a component, so they had to take multiple boring passes and then do a final reaming pass to get this hole to size," Carlstrom explained. "When they put the High Torque retention knob on the toolholder, the boring tool was able to cut the hole to size, in tolerance, in one pass.

"They never explained to me the total cost savings, but needless to say it was significant. It also solved a huge headache for them," he added.

Carlstrom, who emphasized that his company does not represent or sell JMPP's High Torque retention knobs, said whenever he runs a test of his product for a customer he does so with the knob installed to eliminate poor seating in the spindle as a variable that could affect performance.

"When I run an end-mill test, a toolholder test, or a boring-bar test, I will not run it without the High Torque retention knob, period," said Carlstrom. "I know it will make my tools — which I get paid to sell — run properly."

ROI via productivity — In addition to increasing productivity, decreased tooling costs and set-up times can increase revenues that more than justify the cost of High Torque retention knobs. Although the product costs nominally more than a traditional retention knob, at a conservative 10% increase in productivity, the ROI can be as little as three weeks. At a 20% increase, the ROI can be achieved in a week or less.

Furthermore, manufacturers running 24/7 or having to add extra shifts to meet production demands could scale back their schedules, if that is a more cost-effective option.

According to DaRosa, with so much to gain, lack of awareness may be the only inhibitor to machine shops' resolving the design flaw that is so common. Although some manufacturers already are benefitting from the High Torque retention knobs, others consider it a competitive advantage, and so they keep the information to themselves. Others remain set in their ways, or even dismiss the notion that improper seating of tapered toolholders in the spindle can adversely affect machining results.

"My entire career, we always looked at cost, not price," said DaRosa. "So when you get my attention with something that can increase productivity, my direction to procurement is to reevaluate the idea, and not based only on the price."