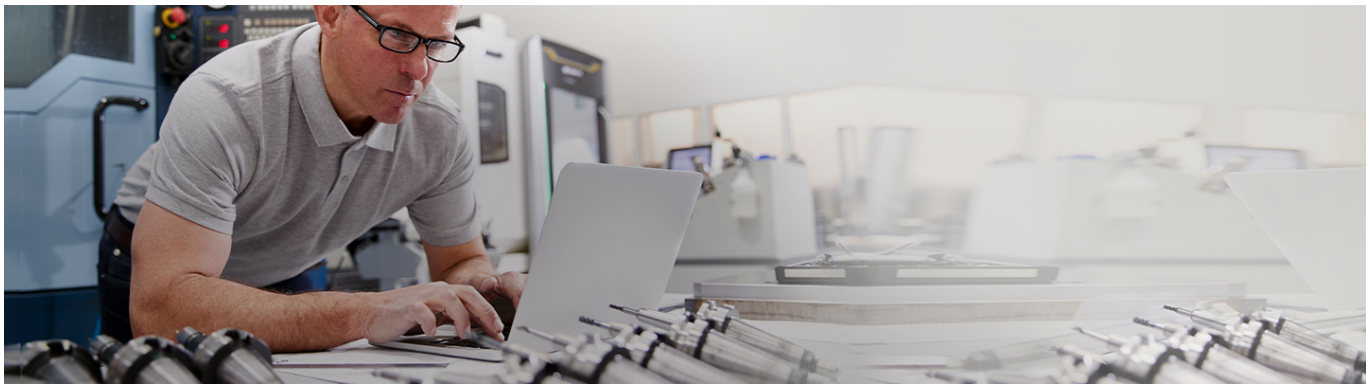

Machining

How Tool Balancing Boosts Tool Life and Productivity

Kip Hanson | Nov 24, 2020

Cutting tool runout and toolholder imbalance make machining challenging. Here's what you need to know about tool balancing techniques and how getting this procedure right can minimize vibrations, improving surface finishes and tool life alike.

Tool balancing is a must for high-speed machining, where spindle speeds reach 20,000 rpm or higher. But many experts will tell you the need for balancing begins at a mere 6,000 rpm and that skipping this critical step reduces both tool life and productivity.

Brendt Holden, president of Haimer Inc., is one of those people. He likes to relate a story from 15 years ago about a machine shop in Wisconsin struggling with a boring operation. After installing one of Haimer's tool balancers, the machine shop was able to significantly increase throughput on that job, along with many others.

"That particular shop didn't have a single machine faster than 6,000 rpm," Holden recalls. "It was a wonderful testimonial to the importance of tool balancing, regardless of spindle speed."

They weren't alone. A major U.S. engine manufacturer saved $250,000 annually on unplanned downtime after implementing a tool balancing solution. K&G Manufacturing in Minneapolis found that offline-preset toolholder assemblies cut to size the first time when balanced. Even the grinding industry knows the value of balancing, as cutting tool manufacturer OSG can attest: after balancing wheel packs, the company found output increased by 20 percent, spindle life went up by 30 percent and power consumption declined 18 percent.

> **"There are many advantages to storing cutting tool and toolholder information within a single database, including improved data accuracy, reduced tool inventories, less downtime, and more efficient process flows."**
> Matt Brothers
> Zoller Inc.

If these anecdotes fail to sway the skeptics out there, here's a more scientific example—one that helps to explain tool balancing's effectiveness.

Don’t Forget the Storage

Tool balancers. Shrink-fit machines. Offline presetters. Tool management solutions.

Whatever your shop’s approach to tool crib management, there’s no escaping one basic fact: All those drills and end mills, inserts, toolholders and spare parts have to be stored somewhere. And when it comes time to release them to the shop floor, it would be great to know who took them, what job they were used on, and if they came back.

Matt Brothers, Industry 4.0 Tech Center manager at Zoller Inc., will tell you that most of this tracking and tracing is the responsibility of the shop’s tool management system. He’s right, but all of this data gathering becomes much easier when it’s coupled with a smart storage solution.

Zoller is one of several manufacturers offering such systems, all of which provide a safe, secure way to keep valuable shop assets under control—just step up, swipe a badge or scan a job traveler and receive the desired tool or assembly.

For example, there’s Zoller’s “toolOrganizer” for perishable tooling, the “keeper” cabinet for tool assemblies and larger tools, the “twister” system for dispensing of shop floor supplies, and several more.

Each communicates with the company’s tool management software, providing real-time visibility to tool usage. No more running short of 1/2" end mills, no more hoarding of 80-degree diamond insert packs. In short, no more surprises.

Haimer engineers mounted end mills in two toolholders, one balanced, the other not. Both were checked on one of the company's tool presetting units and had less than 2 microns of runout. Then they spun each toolholder assembly at 18,000 rpm while analyzing it with an accelerometer. The results? Where the balanced assembly maintained the same near-zero level of runout, the unbalanced one increased to 11 microns (0.0004")—a fivefold increase.

Read more: How to Ring-Test, Mount, Balance and Store Your Grinding Wheels

If tool life-killing runout isn't enough to convince you, try this: Ask any machine tool spindle rebuilder the primary cause of premature failure. Most will suggest it's either a) crashes, or b) toolholder imbalance. For many machining centers—especially those with high-speed spindles—a replacement can easily cost more than a tool balancing unit, and that's without factoring in machine downtime and the resulting production delays.

You might be thinking, “I get it. That’s why we buy balanced toolholders.” And while Holden and others will tell you this is a good start, it’s the equivalent of buying high-quality tires for your car—they still need to be balanced, and as with cutting tools and toolholders, it must be done as a complete assembly.

Truing Up Toolholders

Somewhat ironically, the process isn't all that different. Just as an auto mechanic will add small weights to one side of the wheel to offset imbalance, so too might a tool crib attendant add heavy metal screws or oddly shaped rings to the toolholder, carefully adjusting each until the out-of-balance condition has been canceled out. It's also possible to drill or mill the toolholder itself, removing small amounts of metal until balance has been achieved, although this is obviously a more costly (and permanent) approach.

Tires and toolholders also suffer from the same kinds of imbalance, namely static and dynamic. Remove a lug nut from the wheel on your F-150 and you'll create static imbalance, which can be thought of simply as too much weight on one side. Hit a rock with your fishing boat's propeller and you're likely facing dynamic imbalance, or imbalance in two rotational planes. It's this last condition that's most common on CNC machining centers, especially with longer tools and toolholders.

Read more: 5 Ways Manufacturers Can Use Data Analytics to Improve Efficiency

Ironically, CAT-style toolholders—a favorite of machine tool builders here in the U.S.—are inherently unbalanced due to the flange's nonsymmetrical slots. So are Weldon-style toolholders with their set screw on one side. Even HSK tooling, especially the more common A-form, suffers from some level of imbalance, although it's nowhere near that of steep taper toolholders. Tooling manufacturers attempt to offset these unfortunate conditions, but attach a retention knob to one end of the toolholder, a drill or end mill in the other, and all bets are off. Hence the advice to always balance toolholders as a complete assembly.

Zoller offers several tool balancing solutions, including its “toolBalancer” system.

Tool Balancing’s Proofs in the Pudding

This imbalance is quantifiable. It’s referred to as the G value, and most industry experts suggest that

tools should be balanced to 2.5 G or better (meaning a value lower than 2.5). For the mathematically inclined, the Haimer website offers mind-numbing formulas on the science of tool balancing ***here***, along with additional reasons why it's important to anyone interested in improving their milling, drilling and boring operations.

So what to do about it? The answer should be obvious by now: Invest in a tool balancing machine, just as another of Brendt Holden's customers did several years ago when he bought his first 20,000-rpm machining center. The results were so good that he began balancing everything in the shop, even for his older machines that were limited to 8,000 rpm.

"The improved tool life and surface finish were a side note," Holden says. "What he noticed most were the improved metal removal rates. Where before he might have cut a part at 3,000 rpm, he found he could usually double that by balancing, with a corresponding increase in feed rate. He was thrilled."

Going Beyond Tool Balance

Matt Brothers, Industry 4.0 Tech Center manager at Zoller Inc., can share similar success stories from customers who've implemented one of the company's tool balancing solutions. Yet he's quick to point out that a balancing machine is only one piece of a much larger tool crib strategy. Equally important is the need to preset tools offline, eliminating the chance of operator error when touching off in the machine tool and greatly increasing machine availability to boot.

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

Due to the advanced optical imaging capabilities of most presetters, they also allow tool crib attendants to thoroughly inspect tools before use, and to measure the all-important runout mentioned earlier. And for those shops using shrink-fit tooling, Zoller (and Haimer) offer combo machines able to do both in a single operation.

Brothers suggests that, when implemented with a tool management solution (TMS), offline tool presetters provide cradle to grave visibility of tool usage, while also improving the entire programming and setup process flow.

"Zoller's TMS can communicate directly with the machine tool," he says. "It can interface with the shop's CAM system, its simulation software, or its tool life monitoring system. There are many advantages to storing cutting tool and toolholder information within a single database, including improved data accuracy, reduced tool inventories, less downtime, and more efficient process flows. This is why we feel that TMS should be an integral part of any Industry 4.0-focused shop."

For shops interested in either of these productivity-enhancing technologies, now's the time to investigate. The Section 179 Equipment Deduction ends in December. Contact MSC—or either of the companies listed in this article—to find out more.

What benefits have you seen from tool balancing? What challenges have you faced? Share your thoughts in the comments below.

