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Whether holding parts or tools, the same rules apply.

Secure Measures

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Imagine driving down a gravel road strewn with potholes. It's pouring rain and your tires are bald. Each wheel is secured by three lug nuts with partially stripped threads, and you're traveling at 80 mph. How would you feel?

I would feel unsafe. My car would be riding terribly and in danger of being damaged, handling would be difficult and, most of all, I would be risking my life.

Equally risky practices take place in machine shops every day. Cutting tools placed in old, worn holders are inserted into spindles running at several thousand rpm. The continually dulling tools are applied at high feeds and are pushed into materials that resist the cutting action. Workpieces are bolted to plates with nuts that have been tightened and loosened hundreds, perhaps thousands, of times.

As with the automobile scenario, the risks are high. Minimizing the chance of a mishap—anything from a part that needs rework to an injured operator—requires that strict attention be paid to the devices used to hold workpieces and tools.

Controlling Forces

Work- and tool-holding devices perform the same basic function. And they often function similarly. For example, a

Holding devices for cutting tools and workpieces must be rigid enough to withstand the demands of today's machining environment.

Makino Inc.

setscrew toolholder is like a vise-type workholder. Collets secure both tools and parts, and a chuck can be used to hold a part or tool.

Hydraulic tool and work holders are good examples of devices that have the same positive effect on a machining operation. Both holders reduce vibration, permit machining speeds and feeds to be bumped up, lengthen tool life, exert precise control over the holding forces and bring a high degree of precision to an operation.

In use, tool and work holders are subject to the same forces. These include torque, thrust, a material's resistance to deformation, tool pressures, heat, vibration, material-removal stresses and friction. These forces play a key role in determining final part size, finish quality and tool life. They also influence the wear life of key machine tool components.

To help understand the effect these forces have on the machining of a part, consider a drill entering a 1"-dia. workpiece that extends several inches, unsupported, from a hand-tightened, 3-jaw chuck. First, a force is created because of the workpiece's natural resistance to being penetrated by the cutting tool. This resistance greatly increases torque and thrust pressures, causing heat and friction to increase. As the drill engages the part, vibration

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Holder rigidity problems often arise in deep-hole drilling. Hole tolerances are harder to achieve and tool life suffers.

is exaggerated due to the long overhang of the workpiece. All the aforementioned forces contribute to the creation of irregular tool pressures.

Part quality would likely suffer under such conditions. The source of the problem, though, would not lie with the cutting tool, machine, material or coolant. Rather, it would be due to the forces that arise during machining being allowed to enter the cutting system through the holding devices. Inadequate holding systems greatly magnify the effects of machining forces.

Hold Steady

If a holding device is performing in a substandard manner, it's usually due to lack of rigidity.

Poor rigidity tends to manifest itself in milling as chatter marks on the surface of a sidewall. When drilling deep holes, problems often arise because of excessive tool overhang. The result is hole tolerances are more difficult to achieve because of runout, vibration or chip packing. Wear life decreases, a result of chipping and fracturing caused by the additional forces being placed on long, unsupported flutes. Plus, it's not uncommon for machinists to ruin parts because the drill wanders or breaks.

Adopting common-sense machining and maintenance practices can solve most problems related to tool and work holders. Here are a few rules of thumb to help optimize holder performance:

■ To maximize rigidity, set the tool as close to the spindle as possible. Similarly, affix the workpiece as near the machine bed as you can.

■ If the mechanical components of your holder—screws, clamps, collets, etc.—are worn, dirty and/or damaged, replace or repair them. Components in poor condition may, among other things, cause the part or tool to withdraw from the holder.

■ Maximize the contact area between the holding device and the tool or workpiece. You wouldn't, for example, want to insert a tool with a setscrew flat into a collet-style holder.

■ Insert as much of a fluted tool's shank into the holder as possible without touching the flutes.

Apply sound holding practices uniformly. Toolholders and workholders play equally important roles in the production of good parts. It wouldn't make sense to secure a part with a top-quality fixture while placing the tool in a beat-up, old toolholder. This would negatively affect the holding system, leading to problems such as those caused by inadequate rigidity. That, in turn, would degrade the entire machining process.

Seek Expert Advice

End users who have developed a good overall holding strategy have been able to increase speeds and feeds by 20 percent or more while extending tool life by 30 percent or more. Such productivity-enhancing measures directly impact a company's bottom line.

Toolholder system significantly cuts drilling time

Companies that make seemingly minor changes in the way they hold parts or tools sometimes reap huge productivity benefits. That proved to be the case for a manufacturer of motor frames. Below are the application parameters and results of switching to a new holding system for drilling 1015 steel.

Operation: Drilling 0.3460" holes in 1015 carbon steel with a TiN-coated carbide drill run on a Toyoda FH55 HMC machine.

Problem: Company was applying a major manufacturer's CAT 50 toolholders and collets. Due to lack of rigidity, excessive runout in the holding system limited speed and feed rates. It also shortened tool life and raised the total machining cost.

Solution: Switched to CAT 50 holders and ER32 collet systems from Rego-Fix Tool Corp.

Benefits: Drilling now is done at speeds up to four times faster than with the previous holders. In addition, the company has boosted the feed rate nearly 500 percent and reduced cutting time per hole from 11.08 seconds to 2.10 seconds. Lastly, the number of holes drilled per tool has risen from 450 to 3,000.

—J. Wells

If you're in doubt about how to develop such a strategy, seek the advice of an expert. Individuals who specialize in holding can:

■ Steer you toward the best holding device for your particular application and budget.

■ Teach workers the proper way to operate and maintain holders.

■ Help you develop a consistent approach to securing your tools and workpieces while integrating advanced holding techniques into your current set of practices.

The last item is especially important. As machine tool technology advances, greater demands are placed on holding systems. They must be rigid enough to withstand the forces exerted by these fast, powerful machines.

Remember, once the tool meets the workpiece, the "chain" of a machining process is formed. Tool- and workholding devices serve as the master link in that chain.

About the Author

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