Machining

Toolholders Provide the Vital Link to Machining Productivity

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Precise machine tools and advanced cutting tools together provide outstanding metal-cutting productivity. However, the link between the cutting tool and machine spindle – the tool holder – is crucial in fully achieving that productivity. Tooling manufacturers offer a wide variety of toolholder styles, with each engineered for optimum performance in certain machining applications. A machining shop, therefore, should base its choice of toolholders on its specific operations as well as on the parts it produces. Nevertheless, while shops seek to acquire the most advanced machine technology and cutting tool materials, they often place minimal importance on selecting, applying and maintaining toolholders that best fit their specific production needs.

All Holders are Not Created Equal

No one toolholding method is appropriate for all possible applications. A toolholder engineered to carry out high-speed finishing operations typically will lack the rigidity and strength needed to be effective in, for instance, deep roughing of raw castings. Conversely, a holder meant for rough machining usually will lack balance qualities that would allow it to run smoothly at high speeds in finishing operations. In addition, the robust design and bulk of a roughing holder can limit its access to fine or deep part features. Tough workpiece materials require toolholders with enhanced strength and rigidity. A toolholder's abilities to damp vibration as well as deliver coolant are also important selection criteria.

Use of an inappropriate toolholder can result in dimensional errors and scrapped parts along with excessive wear on machine tool spindles, shorter tool life and an increase in tool breakage. In noncritical jobs, a value-priced toolholder may produce satisfactory results. But in operations where repeatable precision is mandatory – and especially when scrapping an expensive workpiece will lessen part profit margins – the investment in application-focused, top-quality toolholders provides low-cost insurance against such unanticipated losses.

A Holder for Every Need

Seco Tools continually seeks ways to expand the range of toolholders it offers to meet specific customer needs. In 2000, Seco Tools bought French toolholding systems company EPB, which has extensive experience in the design and manufacture of toolholders, boring heads and damped toolholders. The resources of EPB enable Seco Tools to offer a wide variety of holders engineered to handle particular machining applications.

For example, Seco Tools provides different shrink fit tooling options that feature a variety of gauge lengths and nose profiles. HD shrink fit chucks are engineered for heavy roughing applications, while DIN shrink fit chucks are a first choice for semi-finishing and finishing in high speed cutting operations where quality is a priority. M&D (mold and die) shrink fit chucks are designed for finishing and semi-finishing in deep cavities such as those common in mold and die or aerospace manufacturing.

Similarly, Seco Tools supplies both ER and HP collet chucks. The popular and versatile ER chucks enable users to clamp a range of tool diameters by fitting one chuck with collets of different sizes. HP collet chucks are designed to produce good workpiece surfaces in high-speed finishing and light roughing applications. The holders have a damping effect to minimize machining vibration and are tool-breakage “friendly” because simply replacing the collet and tool permits machining to resume immediately.

For heavy-duty operations, pre-balanced power milling chucks from Seco Tools are capable of high metal removal rates and are alternatives to shrink fit or Weldon holders. They are easy to implement and can hold different tool diameters with the use of reduction sleeves. Also providing toolholding versatility through expansion sleeves, hydro-expansion chucks have runout of less than 5 µm at 3xD and are fine balanced for high speed cutting applications. The integral oil reservoir acts as a damping agent that helps optimize surface quality.

Seco technical sales staff are fully trained regarding toolholder features, capabilities and application, and additional support is available from regional experts. Knowledgeable and experienced technical support helps customers select holders best suited to their specific parts, equipment and machining strategies. Seco catalogs also provide a detailed technical guide to help users to make the most productive and cost-effective choices.

For some shop managers, long versions of toolholders used across a range of applications is a valid cost-saving strategy. However, always applying the shortest holder possible will maximize rigidity, minimize surface-degrading vibration and preserve tool life.

Toolholders represent less than two percent of total production costs. Even cutting that cost in half produces negligible savings, while a scrapped workpiece or broken tool has a measurable financial effect. Premium tools and holders can boost metal-cutting production rates for immediate return on the tooling investment. Particularly in industries such as aerospace component manufacturing where stability of the machining process is paramount, many manufacturers focus above all on acquiring

premium tooling to avoid producing defective parts and wasting time in troubleshooting activities and production stoppages. Aerospace manufacturers typically take extended time to validate new holder concepts before certifying them for production.

Workpiece Factors Influence Holder Selection

Factors influencing toolholder selection include the machinability of the workpiece material in each job as well as the configuration of the final part, which may determine the toolholder dimensions needed to reach certain contours and/or features. Yet, toolholders should be as simple and easy to use as possible to minimize the possibility of operator error.

Regardless which toolholding technology is applied, a machine tool's rigidity, spindle power and ability to generate tight tolerances will dictate what operations are feasible. For example, attempting to produce micron-scale tolerances on a worn machine is a waste of time.

A machine tool's basic elements play a key role – a fast machine with linear guideways will take best advantage of toolholders designed for high-speed application, while machines with box ways provide support for heavy machining. A multitasking machine will fully exploit the capabilities of toolholders that can accomplish both turning and milling/drilling operations.

The machining strategy in use will also guide toolholder selection. For example, shops can choose tools to maximize productivity in high speed cutting (HSC) operations involving lighter depths of cut, or in high performance cutting (HPC) situations that focus on generating high metal removal rates on machines with adequate power but limited speed capability.

Low, repeatable runout can help ensure constant tool engagement and thereby reduce vibration and maximize tool life. Balance is crucial, and a high-quality toolholder should be fine balanced at G2,5-25000 RPM quality (1 g.mm). Machining shops can perform their own research and consult with their tooling suppliers to determine the toolholding system or systems that will cost-effectively fill their production needs.

Each Holder Has Its Niche

Whether simple Weldon, collet, heat shrink, mechanical or hydraulic type, toolholders should also be matched to specific operational requirements. Simple end mill holders for Weldon shank tools, for instance, are rigid, easy to use, can transmit high torque and provide safe and strong clamping with a strong anti-pullout action. They are well suited for heavy roughing but lack precise concentricity. In general, they are inherently imbalanced and do not productively apply for applications using high rotational speeds.

Collet chucks and interchangeable collets are the most common form of round-tool holding technology. Cost-effective ER styles are available in a wide range of sizes and offer sufficient grip for reliable light milling and drilling operations. High-precision ER collet holders feature low runout (< 5µm at the tool tip) and a symmetrical design that can be balanced for high-speed operations, and reinforced versions are available for heavy-duty machining. ER holders facilitate quick changeover and can accommodate a range of tool diameters.

Heat shrink fit holders offer strong clamping force, concentricity of 3 µm at 3xD and excellent balance qualities. Their small, simple nose configurations provide good access to tight part features.

Shrink fit holder

Reinforced versions can perform moderate to heavy milling, but gripping force depends on the ID tolerances of the tool shank and holder. Shrink fit tools require purchase of a special heating unit, and the heating/cooling process consumes more setup time than simply switching collets.

Mechanical milling chucks provide strong gripping force and high radial rigidity via multiple rows of needle bearings. The design enables heavy milling and quick tool changes, but runout can be greater than that of collet systems. Mechanical chucks generally are larger in size than other toolholder styles, which may restrict tool access to some part features.

Power milling chuck

Hydraulic chucks that use oil pressure to generate clamping force have fewer internal elements than do mechanical chucks, and as a result have a comparatively slimmer profile. Hydraulic chucks feature low runout and are effective for reaming, drilling and light milling at high spindle speeds, but are sensitive to heavy radial loads.

Just as important as how a holder secures a cutting tool so too is how it mounts to a machine tool spindle. The spindle or taper end of a toolholder determines torque transfer capability and establishes tool centering accuracy. Traditional BT, DIN and CAT tool tapers are effective on smaller machines but may be limited in high-speed capability. Versions that provide contact on both the holder taper and face provide increased rigidity and accuracy, especially in long-overhang situations. Larger taper sizes are required to reliably transmit greater torque. An HSK-E32 holder, for instance, cannot replace an HSK-A125A in a heavy machining situation.

Choice of the holder taper style often is determined by regional preferences. HSK emerged in Germany in the mid 1990s when 5-axis machines grew in popularity. CAT tapers are predominantly in the United States, while in Asia BT shanks are popular, frequently in taper/face contact versions.

HSK is very common for 5-axis machining. PSC (polygonal clamping system: Capto) and KM

connections are used mainly on multi-tasking machines and are now ISO standards. Both KM and Capto are also modular systems, permitting assembly of specific tools in different lengths by stacking extensions or reducers. Toolholder styles that make it possible to turn, mill or drill parts in one fixturing are growing in popularity as multi-tasking machines increase in use.

Hydraulic chuck

While there are proprietary toolholding systems that use unique holders and collets in innovative ways to achieve impressive results, a shop must calculate their benefits. These systems typically involve greater cost and limited tool choice being from a single supplier.

Cost and Other Considerations

While the basic cost of a hydraulic or mechanical type holder is higher compared to that of a collet or shrink fit holder, other factors are involved, such as the expense of the shrink fit heating system, and the time required to change tools. It also is necessary to have a shrink fit holder to fit each tool diameter, compared to accommodating different diameters by simply switching collets in a collet chuck holder system.

Machine operators and tool maintenance personnel also play an important part in successful toolholder application. As with machine tools and other manufacturing equipment, toolholders require correct usage and maintenance to maximize their benefits and use them to their full potential. For example, the operator must insert the tool shank into the holder to its full length, because improper seating will lead to accuracy destroying vibration or even ejection of the tool. Following tool assembly specifications is critical. Operators should not use an extension handle to apply excessive torque when tightening a chuck, which twists the collet and results in a misaligned tool.

Tool maintenance also is important but often is ignored. Operators should always clean holders before use and inspect the machine tool spindle as well. Holders should be stored clean and dry, with caps to protect the tool taper. The fluid pressure of hydraulic chucks should be checked regularly.

Conclusion

Machine shops need to recognize the importance of toolholders in the machining system and learn how properly matching the right toolholder to their specific machine tools, machining strategies and workpieces can boost productivity and reduce costs. At the same time, toolholder manufacturers are offering more comprehensive selections of holders *(see sidebar)* engineered to meet individual operational needs.

Future improvements go beyond holder hardware itself. Tool management using software and RFID

tags is an element of data-based manufacturing and is becoming more common. Advances in toolholder technology include sensor-equipped holders that permit monitoring of the forces on the holder in real time. The collected data enables in-process adjustment of machining parameters either by the operator or even automatically via artificial intelligence (AI) in link with the machine control unit. These and other new technologies will further reinforce the productive contributions that toolholders provide in machining operations.