➤ BY JOSEPH L. HAZELTON, SENIOR EDITOR

Multienhancing

Multitasking machine tools, like this mill/turn center, can reduce setups, shorten handling time and increase workpiece accuracy by allowing for complete machining within one enclosure.

Doosan Infracore

Machine tool builders continue to improve the capabilities of mill/turn centers.

Mill/turn centers, the most common type of multitasking machine tool, appear to be the ultimate in process consolidation. Inside its enclosure, a mill/turn center can perform many of the functions of a 5-axis horizontal machining center—boring, drilling, milling, tapping—as well as turning, once limited to lathes.

That consolidation offers several advantages: fewer setups, reduced handling time and greater part accuracy.

Everything has limitations, though, and there are trade-offs with multitasking machine tools. A mill/turn center provides the benefit of process optimization, but its various operations may not be as fast as they would be on separate machine tools. So the cycle time

for a part produced in a mill/turn center can be longer than the sum of the cycle times if the part were produced on separate milling and turning centers.

That longer time, however, is usually recouped through a shorter setup time than the sum of the setup times on the separate machines. As a limitation, the possibility of slower machining may someday be entirely eliminated through improvements to mill/turn centers and other multitasking machines.

However, mill/turn centers have been improved in several ways in recent years.

Fully Functional Milling and Turning

Compared with milling machines and lathes, one limitation of mill/turn centers was the loss of some milling or turning capabilities.

In the past, mill/turn centers were only somewhat capable in their milling or their turning. Previous lathe-based multitasking machine tools could be described as 70 percent turning machines and 30 percent milling machines, according to Gerald Owen, national applications manager for machine tool builder Mori Seiki USA Inc., Rolling Meadows, Ill.

Today, though, there are mill/turn centers designed to mill on par with conventional machining centers and turn on par with conventional lathes. Among those mill/turn centers are the Integrex Mark IV series from Mazak Corp., Florence, Ky., and the NT series from Mori Seiki. To accomplish this, Mori Seiki transferred several subassemblies from its NL lathes and NH machining centers to its NT mill/turn centers, its latest series of multitasking machine tools.

"We did not allow any lessening of performance," Owen said.

The lathe subassemblies included the headstocks and lower turret with integral, driven tools. The machining center's subassemblies consisted of its spindles and structure. The structure includes twin ballscrew drives for both the X and Z axes and thereby permits driving at the center of gravity. Mori Seiki refers to the design as DCG (Driven at the Center of Gravity).

Another recent, significant improvement was a longer Y-axis travel for the NT series. Previously, regardless of the machine tool builder, mill/turn centers often had long X-axis travels, but limited Y-axis travels for the tool spindles. For example, the MT series had models with X-axis travels of 635mm and 1,008mm, but their Y-axis travels were 220mm and 300mm, respectively. Today, the newer NT4000 series of machine tools have X- and Y-axis travels of 750mm and 420mm, respectively.

"We have X- and Y-axis travels more like what would be expected in a machining center," said Greg Hyatt, a Mori Seiki vice president. Hyatt is the chief technical officer for the company's Machining Technology Laboratory, also in Rolling Meadows.

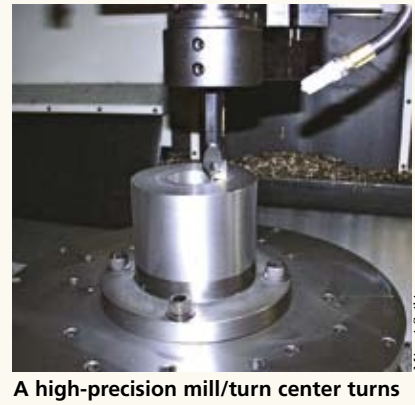
A multitasking machine for a narrow application

Mill/turn centers can perform a range of machining operations. After all, the machine tools can be built to mill, turn, bore, drill and grind to name just some of the possible operations. But, depending on its design, a center's actual use can be narrow, as in the case of the VU65A-SP.

Mitsui Seiki built that mill/turn center for the production of gear carriers, mainly planetary gear carriers. The machine tool builder created the VU65A-SP to reduce the number of machine tools needed to turn, mill, bore and otherwise machine the carriers.

Tom Dolan, Mitsui Seiki's marketing manager, described a conventional way of machining a planetary gear carrier.

The machining starts with a lathe, which rough- and finish-turns the carrier's diameters, including the carrier diameter that will align with the mounting diameter of the carrier's central gear, the sun gear. The workpiece is then transferred to a machining center for rough and finish milling, drilling, tapping and rough and semifinish boring. The bores include those that will align the location diameters of the carrier's planetary gears, which surround the sun gear.



Mitsui Seiki

A high-precision mill/turn center turns the face of a mild-steel workpiece, which became part of an inspection gage inside another machine tool. The mill/turn center's design is based on jig machine tools, so it can perform precision work often done on jig borers and jig grinders. The machine also performed off-center precision boring and milling on the workpiece.

Afterward, the carrier is moved to a jig grinder to finish to final tolerances the bores' sizes and locations. The final tolerance level can be very tight.

"Most often, it's 10 microns or better," Dolan said.

However, Mitsui Seiki reduced the number of machine tools and operations involved in the previously mentioned processing by applying its jig-boring and jig-grinding knowledge to a mill/turn center. The result was a vertically oriented center with a spin table. The table gives the center its turning capability.

Given its jig work, the VU65A-SP is built for high precision. The center has a positioning accuracy of 2 microns or better, and its typical turning accuracy is 2-microns roundness or better.

Thus, three machine tools were replaced by one for producing the planetary gear carrier. "We've been able to achieve all the required tolerances on one machine tool," Dolan said.

—J. Hazelton

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Mazak

A multitasking machine tool processes a cylindrical bar, machining it into a turbine blade. Recent improvements to multitasking machine tools have included direct-driven assemblies and upgraded controls and memory.

Mori Seiki

Consolidating turning and milling in one machine tool once involved noticeable compromising of one or both processes. But many mill/turn centers are designed today to be fully functional in their milling and turning.

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Hyatt added that the longer Y-axis travel was possible because of the ram design. Octagonally shaped, the ram has an opposing side length of 400mm, so the center of gravity doesn't extend over the supported section. The design allows the ram to remain rigid and permits the longer travel.

Mazak improved a number of its Integrex multitasking centers by incorporating a lower turret so workpieces can be machined simultaneously by both the upper and lower turrets. The lower turret accommodates milling and turning tools. In Integrex IV models, the lower turret can hold up to nine tools or serve as a steady rest or center to enhance machining.

The newly introduced Integrex e-420H-ST II has a lower turret for rotary tools with X-, Y- and Z-axis travel capacity. Its spindle has a maximum speed of 6,000 rpm. Also, the lower turrets can be equipped with special adapters to serve as steady rests or centers for supporting shafts.

The following companies contributed to this report:

Doosan Infracore America Corp.
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The 'Brains' of Mill/Turn Centers

Several improvements have centered on the controls and software of mill/turn centers.

A multitasking machine tool requires a lot of computing power to control the simultaneous movement of its many axes. For example, a Mori Seiki NT mill/turn center has the option of being equipped with two headstocks, allowing it to function as a 5-axis VMC at one end of its enclosure and as a 3-axis lathe at the other end.

Given all those axes, there's a greater chance of interference—of tools crashing into workpieces. Consequently, each NT mill/turn center can check for interference via a front-end control that includes a 1.6GB dual processor. As a front-end control, it doesn't take any computing power from the machine tool's CNC system.

Similarly, Mazak's Integrex series includes a 64-bit, twin-engine processor for faster calculations. The processor is part of the company's latest CNC, a sixth generation system called the Mazatrol Matrix. The new CNC results in a more productive multitasking machine tool.

"When you cut the parts, you can really tell the difference in accuracy and cycle time," said George Yamane, Mazak's marketing manager.

Computer memory has been upgraded, too. The Matrix system has memory for a 2MB program, and optional memory for an 8MB program. Also, the previous generation system could store 500 sets of tool offsets and accommodate tool data registration for up to 1,000 tools. The Matrix can store 4,000 sets of offsets and accommodate registration for a maximum of 4,000 tools.

Software was a main concern in 2006 for machine tool builder Doosan Infracore America Corp., West Caldwell, N.J. The company spent time improving programs to speed throughput of its mill/turn centers, the Lynx and Puma series.

Doosan Infracore's efforts are paying off. Bob Appleton, multitasking applications engineer, said time was saved in machining aspects like chip-to-chip time, which was reduced from 16.5 seconds to 9 seconds for the machine tools in the company's Puma MX series. Each of those machine tools has a 40-tool capacity, with the option for an 80-tool capacity.

Also, Doosan Infracore achieved those time savings without changing the designs of its multitasking machine tools.

"Mechanically, not a change at all," Appleton said. "It's all machine logic."

Doosan Infracore's improved programs are available for new installations and as upgrades for current installations.