➤BY BILL KENNEDY, CONTRIBUTING EDITOR

A multitasking machine keeps the chips flying.

Mori Seiki

Combined Efforts

Machine tool builders continue to improve mill/turn machines.

Combining turning and milling capabilities in one "multitasking" machine began in the early 1980s, when CNC enhancements permitted shops to perform basic drilling and milling on lathes. As control and computing technology improved, Y- and B-axis movements and the implementation of secondary spindles became possible.

The evolution of multitasking machines continues today. In the following pages, machine tool builders discuss advancements in multitasking technology—and share a few caveats regarding mill/turn machining applications.

'More than Meets the Eye'

Dion Coleman, applications engineer and multitasking turning center specialist for the Daewoo Machine Tool Div. of Doosan Infracore, West Caldwell, N.J., said the company's Puma MX machines are representative of today's multitasking technology. Machines in the series feature nine operating axes, a separate milling head and a toolchanger. The milling head combines Y-axis movement with a tilting B-axis to permit drilling and tapping, as well as the milling of flats, keyways and angular features. The head's flexibility of movement enables a range of part geometries to be machined without utilizing custom rotary toolholders or complex fixtures.

Multitasking technology permits completion of parts in a single setup and, thereby, reduces part handling, boosts accuracy by reducing the number of refixturings and increases throughput in many applications. Use of the machines can benefit "anybody from the short-run R&D shop to aerospace and biomedical [manufacturers]," Coleman said.

However, he added, "there is a lot more than meets the eye in the decision to run a part on a multitasking machine." Producing a long run of parts, for example, might be best done on separate turning and milling machines.

"A multitasking machine's spindle can either be milling or turning; it's not going to do both at once," Coleman said. When high-volume parts are run on separate machines, the

operations can be performed more efficiently, boosting long-run output.

In addition, a multitasking machine's setup and programming may require a significant amount of time-consuming thought and planning. Coleman said shop owners considering using mill/turn machines should ask themselves, "Is it worth going through everything I have to do, programming- and setup-wise, for what I am going to save by running the part in the multitasking machine? Will there be enough benefits to justify going through the complexities?"

Similarly, it's often more efficient to produce simple parts or short runs of parts on multiple machines rather than one multitasking unit. There is a "sweet spot," he said, in terms of production volume and part complexity where a multitasking machine performs optimally. "You have to look at the big picture," Coleman said, "but when multitasking is the right choice, it's well worth the cost."

Seth Machlus, marketing manager at Okuma America Corp., Charlotte, N.C., agreed that multitasking machines offer an opportunity to significantly reduce noncutting time, but noted that "it's a matter of being able to use those capabilities." He said that care must be taken when fully exploiting a multitasking machine's flexibility.

"You're talking about many things moving at one time, and dealing with more than three axes—all in motion," he said.

Simulated Action

One way to help maximize productivity and avoid collisions is to first simulate the entire multitasking process. Simulation software lets an operator run a virtual machine tool that identifies collisions that could occur between the workpiece, tooling and machine, then rectify the situation with a reset button.

For example, Okuma's ADMAC Parts software, run offline or on the company's single-processor, Windows-based Thinc-OSP control, offers program verification and the ability to generate Okuma NC code. The system's 3-D Virtual Monitor enables a user to qualify tool lengths and holder types, check and confirm synchronization codes during simultaneous operations, and view the movements of the tooling and machine before the part is run.

While the collision-avoidance system is offered on a number of Okuma product lines, Machlus said the company's new Multus series of multitasking machines is the first to include the software as a standard feature.

Machlus said the Multus machines include a number of features that are intended to improve accuracy, reliability and throughput. Each machine has a rectangular carriage that enhances thermal stability and a tool magazine that is fixed to the machine bed to boost reliability. Compared to prior models, the Okuma Prex motor in the B300, Machlus said, reduces acceleration/deceleration time from 2.3 seconds to 0.8 seconds.

The Power Factor

Even when the complex movements of multitasking machine components and tooling are programmed to be collision-free, executing them effectively and productively requires significant computer power and processing speed. George Yamane, marketing manager for Mazak Corp., Florence, Ky., said, "Computing speed and power are essential, particularly when executing simultaneous 5-axis machining," which includes controlling the motions of live spindles and tools and transferring parts between spindles.

Yamane described the new Mazatrol Matrix control system, which features a 64-bit, twin-engine central processing unit and 16 million-pulse/rotation encoders. Ample computing power combined with the encoders' small step

Okuma

Okuma's ADMAC Parts software offers program verification. The 3-D Virtual Monitor enables a user to view the movements of the tooling and machine before a part is run.

increments provide improved geometrical control for better contouring and surface finish. High-power computation also speeds programming of the huge amounts of data required for simultaneous 5-axis motion in submicron increments, and it reduces cycle times.

While basic multitasking concepts are similar from machine to machine, the benefits of upgrades, like increased computing power, are not necessarily apparent "until you cut the part," Yamane said. Then it becomes clear that "accuracy and cycle time are different."

Regarding multitasking machines themselves, Yamane said that incremental changes in power, torque, size and other features allow a machine's capabilities to meet the needs of a particular shop or industry.

An example is Mazak's Cybertech Turn line of multitasking machines. They're designed for heavy-duty

machining of long, large-diameter workpieces, such as those found in the energy and oil-field industries. The units feature a 50-hp turning spindle, a 15-hp rotary spindle and a maximum swing diameter over the bed of 33.8". Another example is the 100 series of the company's Integrex Mark IV line. These machines are designed to produce small to medium-size parts and feature 15-hp turning spindles, 7.5-hp rotary-tool spindles and maximum swings of 21.46".

Yamane pointed out that many multitasking machines on the market are lathe-based. However, some shops' multitasking applications involve little turning. "In an 80-tool magazine," he said of these shops' toolchangers, "maybe four or five tools are for turning, the rest are for rotating." In such cases, a machining center-based multitasking unit like Mazak's Integrex e-Series machines would be appropriate.

Yamane said, "We have different classes of multitasking machines, from small to large, that are biased to turning or to milling."

Restructuring

Another approach to maximizing multitasking productivity requires builders to take a comprehensive look at machine structure, with the purpose of maximizing rigidity and accuracy.

According to Gerald Owen, product manager of integrated technologies at Mori Seiki USA Inc., Rolling Meadows, Ill., the company's recently introduced NT line of multitasking machines combines key elements of its top lathe and milling technology.

"It's a true machining center platform that's merged with a true lathe platform," he said.

The machines employ the company's "box in box" construction concept for milling machines, which features twin ballscrew drives in both the X-axis and Z-axis for the machine's B-axis head. Mori Seiki calls it Driven at the Center of Gravity technology and says it reduces vibration, aids acceleration/deceleration and improves part roundness.

An octagonal ram supports the head. It reduces deflection—compared to a round ram, for example—because its eight flat sides are better able to resist side forces. The ram's relatively compact configuration also reduces the chance of it colliding with large workpieces.

On the lathe side of the equation, the machine's headstock spindles for turning are supported by a flat bed, which boosts rigidity. The turret for rotating tools is located on the centerline, directly beneath the headstock spindles. This setup keeps the cutting forces in balance throughout the machine. An available option is a built-in milling motor that couples directly to the rotating tool being used. Mori Seiki says the arrangement offers milling capacity virtually indistinguishable from that of a 40-taper machining center.

Owen said that, increasingly, shops are recognizing the value of high accuracy and wide flexibility combined with a large tool magazine and the capacity to store part programs. He said shop owners who know they will need five or 10 pieces of a certain part each month can leave the appropriate tools and programs resident in the machine, employ a quick-change chuck system and run the parts at any time. Some of Mori's customers, within 30 minutes of receiving an order, have the first part in inspection.

"That's same-day shipping," Owen said.

The Human Factor

Yamane said the effort to improve the multitasking process "is a never-ending story. Given the same part, 10 guys can probably come up with 10 different ways to make it on the same multitasking machine," based on decisions about tooling, workholding and other factors.

He added that "even though you may have been using the machine for 2 or 3 years, there are opportunities for new ways of thinking about sequencing, fixturing or part handling, based on the increased versatility multitasking brings."

It follows that full utilization of a multitasking machine's capabilities depends a great deal on human input. "Without a doubt, the [experience] level of the guy you stick in front of this machine has got to be high," said Daewoo's Coleman. "He has to be quick, because when you program these machines at peak efficiency, the movements of one axis or tool are sometimes dependent on the movements of others."

Even with the help of advanced simulation and collision-avoidance software, Coleman said, "ultimately, you're going to have to have a guy who is capable of watching a bunch of things going on at one time, with the ability to catch something that doesn't look right." △

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