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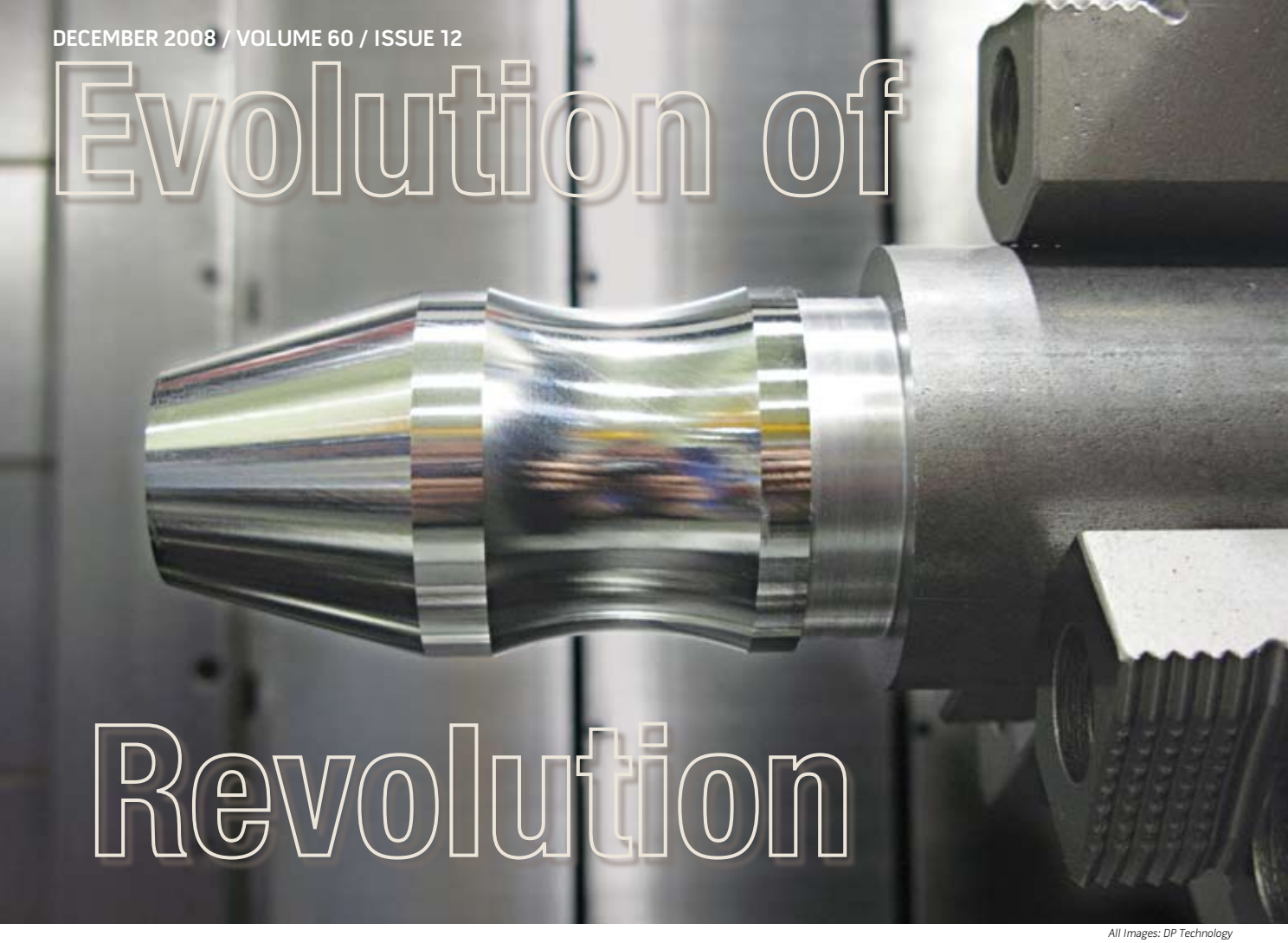
Evolution of Revolution



All Images: DP Technology

The spinning tool was tested with straight rough cuts and back-and-forth finish cuts on angled and curved surfaces.

Putting a spin on turning tools results in up to a 2,000 percent increase in tool life and opens the door to new turning techniques.

By Ann Mazakas,
DP Technology Corp.

Milling tools spin, and turning tools are fixed. Likewise, in past years, milling machines milled and lathes turned. However, multitask machines were created to combine milling and turning in a single machine.

But putting those metalcutting operations in one machine tool raised questions. Why not combine milling and turning in one cutting tool? Why not take the best characteristics of milling tools and turning tools and combine them into a tool that takes best advantage of what multitask machines offer?

These thoughts led Mori Seiki U.S.A. Inc., Rolling Meadows, Ill., a leading builder of mill/turn centers, and Kennametal Inc., a leading toolmaker, to jointly develop a turning tool that spins.

Mori Seiki's spinning tool technology takes a unique approach to live tooling on a multitask machine for turning operations. This new type of cutting technology uses a turning insert similar to a round (full-radius) insert except that instead of being mounted in a turning tool's tool body, this specialized insert is mounted at the bottom of a cylindrical tool shank held in a rotary spindle capable of spinning at high speeds.

A New Take on Turning Tools

CAM software developer DP Technology Corp., Camarillo, Calif., creator of Esprit, put the new spinning turning tool to the test recently with a successful demonstration cut, which was the first to use the Esprit Spinning Tool Add-In to generate toolpaths for the tool.

The spinning tool can reportedly increase productivity by up to 500 percent and tool life by up to 2,000 percent.

"This technology is promising because of all the advantages it provides," said Olivier Thenoz, DP Technology's mill/turn product manager. "In the end, it means better productivity."

The spinning tool's rotation distributes the heat and wear around the tool's entire diameter and distributes them more effectively than a single-point lathe tool. Also, the faster dissipation of heat permits dry machining, eliminating the costs of coolant and its disposal. Mounted on a B-axis spindle, the tool can also be inclined as it cuts for even more effective cooling of the tool.

"The advantage of the spinning tool is that there is no one single point on the tool that is in contact with the workpiece all the time," Thenoz said, "and this is very good for heat dissipation and tool wear. Cutting conditions are no longer limited by the heat generated in the process, but by power available in the machine."

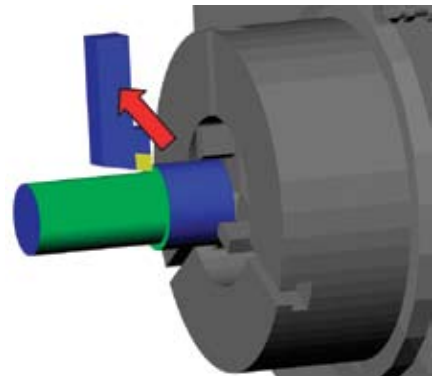
Matching Technology to Tooling

For the test cut, Thenoz teamed up with Nitin Chaphalkar, engineering team leader for Mori Seiki's Machining Technology Laboratory (MTL) at the company's Chicagoland Technical Center. Launched in 2006, the MTL uses its machining expertise to develop innovative technologies in a collaborative environment.

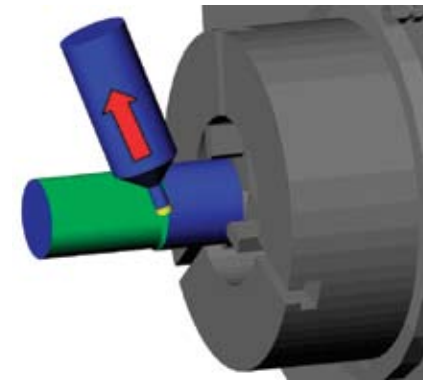
"It's a great partnership with Mori Seiki," Thenoz said of the development of the spinning tool technology. "It's important for us to be involved in this project and to have the opportunity to perform test cuts like this one."

The test included roughing and finishing a steel workpiece's OD with a Mori Seiki NT4200 mill/turn center. The tool's capabilities were put to the test with OD passes on straights, tapers and arcs without coolant. Because of the machine kinematics, the tool cuts on the Y-Z plane instead of the X-Z plane. The tool can also be tilted (B-axis or angular holder) or moved above or below the centerline.

For the rough cut, the spinning tool was inclined 20°, which, according to research conducted by MTL, is the angle that most effectively evacuates heat for this application. The spinning tool can also cut in a back-and-forth motion, and this capability was also demonstrated on taper and arc moves—with impressive results. The cut was much quieter than expected, with virtually no machine vibration, and the tool remained close to the material throughout the repositioning moves during the back-and-forth cutting passes. The long repositioning moves necessary with the use of single-point tools cutting in a single direction were not required.



With a single-point tool, forces try to bend the tool, generating vibration and chatter. Also, one point takes all the wear and absorbs all the heat. Consequently, cutting conditions are limited by the amount of heat generated, which depends on the workpiece material.



In a spinning turning tool, cutting forces are directed axially into the tool spindle to reduce vibration and chatter. Tool rotation distributes tool wear with a constantly changing contact point. Also, tool rotation and tilt reduces heat with air cooling for dry machining, so cutting conditions are limited by the machine's available power instead of heat generated.

> *For the spinning tool's turning operations, it is typical to set the tool spindle and turning spindles to the same rpm.*

Immediately apparent at the start of the rough cut was the dramatic reduction in vibration and chatter. The spinning tool cut smoothly and quietly through the material compared with a single-point tool. "Cutting forces generated while machining with single-point tools impart a bending movement on the tool and give rise to vibration," Chaphalkar said. "In the case of axially loaded tools, such as a spinning tool, most of the cutting forces are directed axially into the spindle and hence significantly reduce vibration. The point of this tool is to reduce vibration and chatter, and to increase tool life and productivity."

The finishes on the rough and the finish cuts appeared to be excellent. Prior to the test cut, the post-processor was upgraded to support the spinning tool. This allowed the NC program to run on the

machine without the need to change a single line of code on the control.

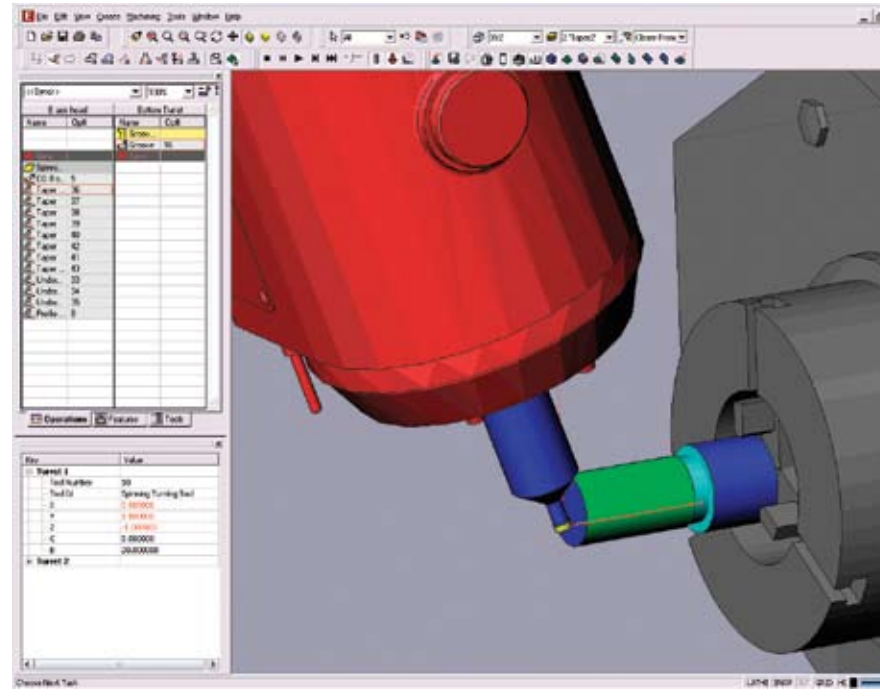
Strength of Three

According to Chaphalkar, Kennametal laid the foundations of the spinning tool and Mori Seiki continued its development by taking its version of the tool to several CAM companies to solicit a software solution for the new technology.

After being contacted by Mori Seiki in October 2007, DP Technology created Esprit's Turning Spinning Tool Add-In by the end of November.

The add-in makes it easy to use the spinning tool. The program provides an interface to define a tool's size and shape and adds new machining parameters to all standard turning operations in Esprit. The new parameters let the user define the rotation speed of the tool spindle and the angle of inclination for the cutting plane.

For the spinning tool's turning operations, it is typical to set the tool spindle and turning spindles to the same rpm. The user has the option of creating the toolpath in +Y or –Y in the Y-Z plane and also has the ability to rotate the cutting plane about the Z-axis to allow machining above or below the centerline. The tilt of the tool is handled using a standard parameter available for any Esprit turning operation. Esprit provides simulation of the cutting path and collision detection. The add-in also includes updated post-processors for Mori Seiki machines.



The Esprit Spinning Turning Tool Add-In makes it easy to use the new spinning tool.

Chaphalkar said while he was able to manually program basic functions, the add-in makes the most of the tool, simplifying programming complexities. "With Esprit, customers will be able to use the technology efficiently," he said.

Thenoz said developing the add-in so it's easy to use while making the most of new technology means better results for end users with diverse needs.

"We are looking for new programming challenges and are trying to stay ahead of all the new cutting technology," Thenoz said. "We have shown that before with the new B-axis turning, and this is a continuation of that philosophy. We want advanced functionalities and, at the same time, functionalities for everyone." CTE

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