

# The **BENEFITS** of Vertical Thread Grinding

Holding a workpiece in an upright position improves numerous aspects of thread grinding. From top to bottom, this approach represents a major change in the way precision leadscrew-type parts are produced.

BY MARK ALBERT

It's not merely a figure of speech to say that a vertical thread grinding machine represents a "top to bottom" change in the way ballscrews and other components with precision threads can be produced. Literally, this statement is true because the grinding wheel on this type of machine moves from top to bottom or bottom to top while the workpiece is held vertically. This is a radical departure from the horizontal orientation of the workpiece on the typical thread grinding machine, where the grinding wheel moves from side to side across the length of the workpiece held between centers.

Figuratively, this statement is also true because the basic change in workpiece orientation involves a rather thorough rethinking and revamping of almost every aspect of the thread grinding process. Putting the workpiece upright enables the grinding wheel to be more maneuverable. New possibilities for changing the wheel automatically and dressing it with CNC enhance accuracy and flexibility. A stream of coolant flowing down the length of the part can provide adequate cooling and lubrication. In addition to thread grinding, a vertical machine can be equipped to grind splines, gear teeth, OD surfaces and other features in a single setup. Because a vertical machine doesn't

**(FACING PAGE)** Producers of shafts with precise threads can look up to vertical grinding for process improvements.



Introduced at JIMTOF 2012 in Tokyo, Mitsui Seiki's VGE60A vertical thread grinder is now available in the North American market.

have to take these grinding operations lying down, but can stand up to the demands of high-precision production, it occupies significantly less floor space.

What is not a change in direction here is that this unusual type of grinding machine was developed by Mitsui Seiki, a company best known in the United States for its high-end multi-axis machining centers. In fact, this builder has been manufacturing and marketing thread grinding

machines since 1965, when it started collaborating with Excello Corporation. By 1977, Mitsui Seiki was designing and engineering its own innovations in thread grinding technology. Its first vertical thread grinder, the new VGE60A, appears to be one more move to advance precision and productivity in thread grinding.

### MORE THREADS TO GRIND

There is a surge in interest in producing leadscrew-type parts, says Tom Dolan, vice president of Mitsui Seiki USA Inc. (Franklin Lakes, New Jersey). He cites several factors propelling this surge. One, OEMs in the automotive, aerospace and robotics industries have been moving from hydraulic to electrical power actuation in many applications. Electrically powered systems are often considered simpler, easier to control, more energy efficient and safer for the environment. As a result, lead-and-feed-screw actuators for power steering, flight control systems and motion control in automated assembly and production lines are in increased demand. Two, lead screws for machine axes and similar applications need to be more accurate and less costly to produce, and Mr. Dolan says this has heightened interest in new technology for producing these components. "Typically, thread grinders have been made in the same way for the last 50 years. For many applications, vertical grinding changes everything," he says.

Strong support for that last statement is apparent in a more detailed analysis of vertical thread grinding as embodied in the company's new machine.

### LESS WORKPIECE SAG

Simply holding workpieces vertically is an advantage toward achieving accuracy. When held horizontally by their ends, shafts and other long, slender workpieces tend to sag from their own weight. Typically, steady rests are required to provide additional support if needed. With gravity in its favor, vertical orientation reduces this tendency to sag. Of course, radial forces exerted by the grinding wheel also must be considered when programming wheel infeed and other machin-

ing parameters.

However, Mr. Dolan points out that other aspects of machine design and construction also influence the accuracy of the grinding results. For example, the mass of the workholding column enables the part to be held rigidly. This column can be more easily isolated from vibrations originating in other machine structures.

The accuracy of thread grinding is usually described in terms of two measurements. One is lead accuracy per revolution of the screw towards the direction of the lead. This measure indicates how uniformly the lead angle is maintained across a given length of the screw. The lower the variation in this measurement, the more predictable and accurate is the travel of a ballnut or other mating component riding on this screw. In tests of the VGE60A at the Mitsui Seiki factory, the grinder held this variation (total accumulated lead error) to values below 2 microns on a 10-mm lead angle over 273 mm of screw length.

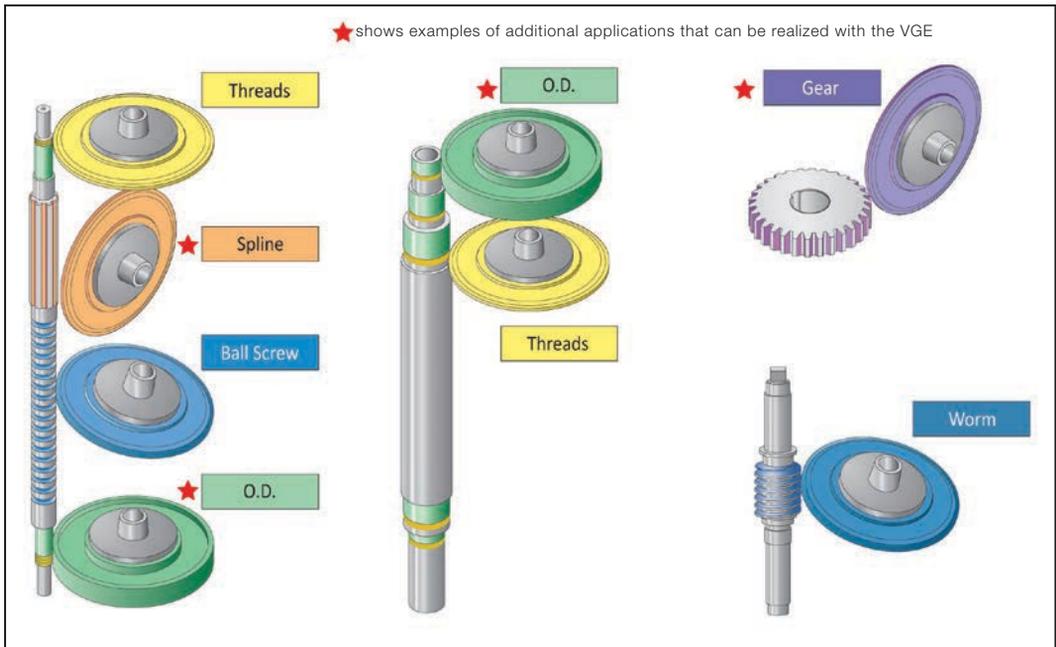
The second key measure is lead error per single revolution of the screw. This variation is often referred to as drunkenness because it represents unsteadiness in the motion of a component riding on it. The lower the variation in this measure, the more evenly the screw can produce linear motion. This measure is especially critical in ball and worm screw applications. Factory tests showed the VGE60A grinder holding a maximum error under 2 microns for any of 12 revolutions of the test piece with a 10-mm lead angle.

### FLOOR SPACE SAVINGS

The new thread grinder occupies a footprint 33 percent smaller than that of a comparable conventional grinder from Mitsui Seiki. The new grinder is narrower and less deep than the older model. Mr. Dolan explains that two of the new machines could be installed in the same space required for one conventional machine.

He also notes that a conventional thread grinder is typically sized for the longest workpiece expected to be produced on it. This means that, although the extra capacity is not always needed, the floor space taken up by the full length of the machine is always in use. Likewise, on a conventional machine, a dedicated bed is required to accommodate the length of the expected workpieces.

Mitsui Seiki USA, call 201-337-1300 or visit [mitsuiseiki.com](http://mitsuiseiki.com).



Combining various grinding operations increases the potential for single-setup part completion.

The new grinder has a standardized bed that accepts modular columns of various heights.

Finally, the vertical configuration enabled designers to position the machine components at a 45-degree angle in relation to the front and side of the machine. This ergonomical arrangement provides easier access to and better visibility of the grinding zone without compromising the operator's convenience, safety or the best use of floor space.

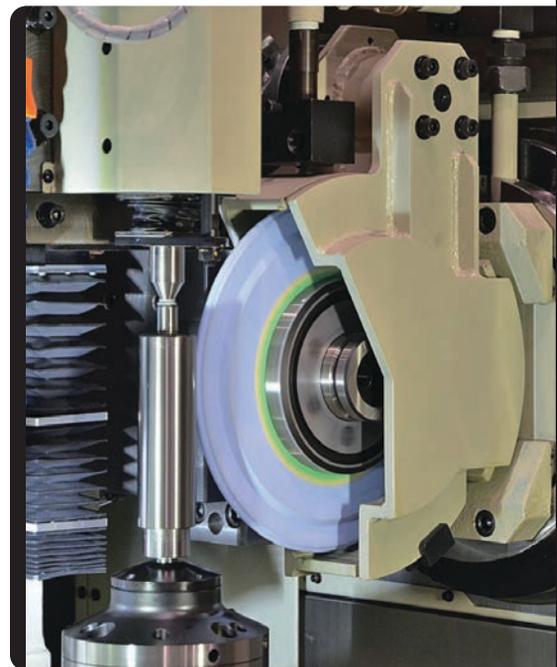
#### A MULTI-PURPOSE, MULTITASKING GRINDER

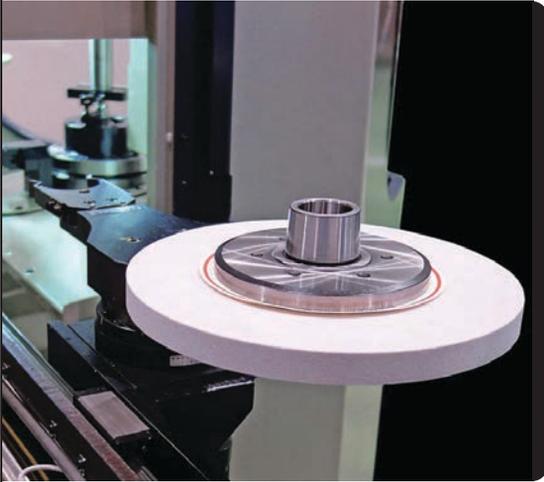
Mr. Dolan believes that the most valuable aspect of vertical thread grinding may be the increased potential for "combination grinding," that is, combining several grinding operations on one machine. On one hand, the machine can be used to grind threads, involute gear teeth or shafts. On the other hand, a workpiece requiring several different grinding applications, such as one with ballscrew threads, splines, gear teeth and cylindrical bear-

ing surfaces, can be completed in a single setup. Eliminating changeovers decreases overall production time significantly while avoiding the potential for errors occurring in multiple setups.

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Three features make this multi-purpose, multitasking capability possible. One is an optional





expansion of the grinding wheel tilt angle. To grind a thread, the grinding wheel must be tilted to an angle that matches the lead angle of the thread. On a conventional thread grinder, a +45/-45-degree range of tilt is sufficient to cover most thread grinding applications. An option for the

An automatic wheel changer exchanges grinding wheels as needed. A variety of wheel storage magazines is available to suit customer requirements.

new vertical grinder enables the wheel to tilt as much as -90 degrees. At the limit of this expanded range, the grinding wheel can approach the workpiece vertically to grind splines or gear teeth.

The second machine feature essential to its multifunctional capabilities is an automatic grinding wheel changer, which is standard equipment on this model. Wheels of different types and/or grinding profiles can be exchanged to perform sequential operations. To reduce the distance between the nose of the grinding wheel spindle and the grinding wheel, the V-grooved interface for the gripper of the wheel changer is not located on the same side as the taper. Keeping the wheel close to the spindle increases rigidity and reduces runout. The taper is a standard HSK-63-style taper, which adds to the rigidity of the grinding wheel.



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The third key feature is a single-point diamond wheel dresser with three tips—one to dress the left side of a wheel profile, one to dress the right side and one in the center to dress a cylindrical (OD) wheel shape. This dresser is mounted at the base of the workpiece spindle so that a desired wheel form can be generated by the synchronized movement of the Z axis (vertical motion into grinding wheel stock) and X axis (in and out motion of the grinding wheel column). Therefore, one dresser can be used to sharpen V-thread wheel shapes, rounded ballscrew thread shapes and straight OD wheel shapes.

Alternatively, a rotary diamond disk dresser for free-form wheel dressing of ballscrew or other complex shapes is available. Dressers can be exchanged by the user in the field.

#### STREAMLINING

Another benefit of a machine like the VGE60A is the efficient use of coolant that comes with vertical grinding. Because a stream of coolant naturally

flows downward along the length of a workpiece, a few strategically placed coolant nozzles can deliver a sufficient quantity of fluid to effectively stabilize the temperature of the workpiece. Additional coolant nozzles can be mounted on the grinding wheel spindle head to flush away grinding swarf and keep the wheel cool and clean as well. Both oil- and water-based coolant can be used.

It should also be noted that the exterior design of the VGE60A follows the current trend toward a streamlined appearance for machine tools. A stylish combination of lines and curves contribute to the sleek look of the sheet metal guarding. A large window and an optimally positioned lighting strip also make the machine's well-illuminated interior highly visible to the operator.

This model accommodates a maximum grinding length of 600 mm and an overall shaft size of 80 mm in diameter (with the largest diameter wheel) and 700 mm in length. ■



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