➤ BY SUSAN WOODS, FEATURES EDITOR

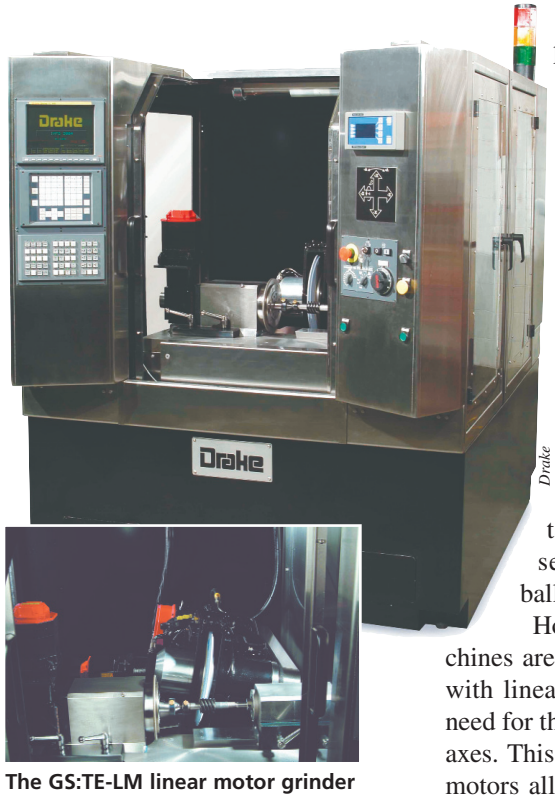
Threads

Machine builders develop technologies that improve thread grinding.

Thread grinding is one of the most challenging grinding tasks, because the operator has to be concerned with precise lead, pitch, and flank and helix angles. It is not just grinding to a diameter, but producing a specific form to a specific diameter. The form may be a 60° V thread, a 29° angle Acme thread or a gothic thread for a ballscrew. This is difficult considering the grinding wheel that is required to hold a fine radius in the root of the thread also has to remove the rest of the material in a cost-effective manner.

Because of material hardness and high-precision and fine surface-finish requirements, some parts must be thread-ground. Precision ballscrews, lead screws, worm gears, thread gages and automotive steering components are good examples. Precision parts with internal threads that are typically thread-ground include ball nuts and thread ring gages.

To meet the needs of companies that produce such parts, grinding machine builders continually develop new technologies. This article looks at some recent developments.



Drake

The GS:TE-LM linear motor grinder thread grinds a high-precision part.

Look at Linear

Basically, a thread grinder consists of a rotary axis that spins the workpiece around its own axis while the linear axis moves the workpiece past the grinding wheel to create the lead. The wheel axis feeds the grinding wheel into the workpiece to control the thread depth.

Today's CNC technology and the capability of processors and digital drives make the task of combining all basic motions relatively easy. This task can be performed by a servomotor connected to a ballscrew and table slide.

However, thread grinding machines are available that are equipped with linear motors that eliminate the need for the ballscrews on the X and Z axes. This is beneficial because linear motors allow for greater acceleration, velocity and contouring capability.

Thread grinder builders have resisted the move to linear motors in the past due to the "cogging" nature of their movement at slow speeds, which

are typical in thread grinding. (Typically, the workpiece is moving between 1 and 12 sfm.) Cogging refers to "jerky," or nonuniform, motion. It is caused by magnetic forces that cause speed changes. Recent advances in linear motor technology—the way the magnets are aligned—have eliminated this problem.

"Another reason linear motors were feared in grinding applications is grinding swarf," said Jim Vosmik, president of Drake Manufacturing, Warren, Ohio, which offers the GS:TE-LM, a thread grinding machine equipped with a linear motor. "However, grinding swarf will contaminate and destroy a ballscrew assembly faster than a linear motor, so there is really no greater risk to a linear motor grinder than one that utilizes ballscrews."

Normac

The MX17 universal thread grinder's wheel and dresser operate in the same plane, which helps ensure accuracy of the final thread form and reduce dressing time.

Linear motors can provide fast speeds regardless of the maximum length the machine is capable of grinding. The maximum speed of a ballscrew depends on its diameter and length, which can be a problem when thread grinding longer workpieces. As the mass of the ballscrew increases with its length, acceleration is limited and stiffness decreases.

With the linear motor, "you eliminate some of the problems with getting a master ballscrew in the machine that can hold the workpiece in its programmed position at all times over its entire length," said Vosmik. "This means you can produce 1m or longer screws that are JIS C1 or better, without fighting the machine."

He added that linear motor machines eliminate backlash, windup and other problems associated with long-ballscrew drivetrains—particularly on the Z-axis. Backlash is lost motion in the interface between the ballscrew and the nut. When changing direction, there is a small amount of rotation of the ballscrew by the servomotor that does not result in movement of the nut. Windup means the ballscrew, the coupler between the ballscrew and the servomotor, the nut mount, and the screw mounts all give slightly while trying to overcome the inertia of the table and workpiece. It results in positional error.

ITMF

International Tool Machines of Florida's Series 2005-THG thread grinder.

While acknowledging the advantages of linear motors, "there is the fact of machine price, performance and feasibilities," said Karl Giebmanns, president of International Tool Machines of (Palm Coast) Florida Inc. "Because customers prefer to pay as little as possible for a grinding machine that can achieve quality results, the servo/ballscrew concept is still dominating and will not be replaced any time soon on machines requiring only short table strokes. With [most] thread grinders, you have very short strokes, so improved acceleration and deceleration doesn't even come into play."

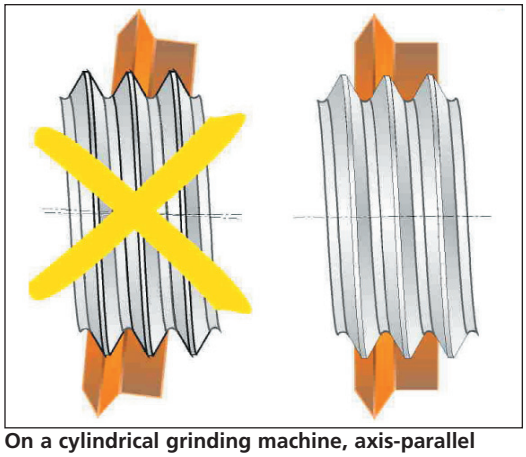
He added that the high temperatures generated by some linear motors are costly to contain and have an impact on the final machine price. "The two major priorities for the customer should always be based on the outcome and quality of the part produced on the grinding machine and the price," Giebmanns said. "Using a new technology just for the sake of using it does not necessarily make the grinding machine better."

Mike Head, inside sales manager at United Grinding Technologies Inc., Miamisburg, Ohio, said the linear motor on its universal grinding machine would not be a benefit for thread grinding and he would recommend the ballscrew version if the user is mostly doing thread grinding. "The tolerances of most threads are not so tight that they would require the extreme positioning accuracy that the linear motor solution offers. A linear motor would be more suited to extremely tight-tolerance cylindrical grinding."

Where There's a Wheel …

Another option for those who produce threads is axis-parallel thread grinding, which can be performed on United Grinding's Studer cylindrical grinding machines. This capability makes it possible to perform thread grinding, along with regular cylindrical grinding, in one setup.

On a cylindrical grinding machine, the wheel is at a 90° angle to the workpiece. Most threads have a helix angle, requiring the grinder to tip its wheel sideways slightly to match that angle.



United Grinding

On a cylindrical grinding machine, axis-parallel thread grinding, right, allows thread and cylindrical grinding in one setup. An inclined grinding wheel, left, does not.

Axis-parallel thread grinding is characterized by a wheel not inclined to the helix angle of the actual thread. The grinding wheel is perpendicular to the Z-axis so that the rotation axis of the wheel remains axis-parallel to the Z-axis.

During wheel dressing, the resulting thread-profile distortion is taken into account by StuderThread software. The software calculates the distortion and generates the dressing routine.

"What is happening is we are deforming the thread flank angle in the form that we dress into the wheel," said Head. "Because the wheelhead is parallel to the part rather than inclined, this deformation that we purposefully induce results in a correct thread form on the part."

The benefits of this feature are the user can grind the thread as well as grind part ODs and IDs in one setup. This results in better part quality because one clamping equals better concentricity between the ground features; quicker turnaround because there is only one machine to setup and program instead of two; and less part handling, which results in less part damage.

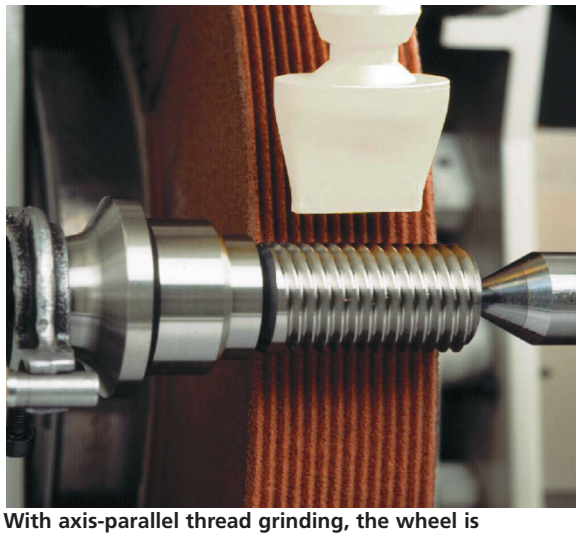
"What would need to be done on two machines, a dedicated thread grinding machine and a cylindrical grinding machine, can be accomplished on a single machine in a single clamping, resulting in less initial capital expenditure," said Head.

As an example, he cited a transmission shop making bearing journals with a thread on the end. With a standard thread grinder or cylindrical grinder, the user could do one or the other. "You could grind all the diameters, but then you would have to break the setup, send it through a special thread grinder and grind the thread," Head said. "The Studer machine can grind the diameters and then switch to another wheel with a turret wheel system and then grind the thread on the part in the same clamping."

No special equipment is required to dress the threads. The StuderThread software helps generate the thread dressing forms by allowing users to call up pre-existing examples that can be easily modified to meet their specific thread. This greatly reduces the programming time required, as the software generates the machine code based on simple data that is either directly input or imported using a DXF file.

Drake Manufacturing also offers this wheel correction feature via its SmartForm software. It allows high-helix and axis-parallel internal thread grinding. "Instead of the wheel cutting at the centerline, at lead angles above 10°, the wheel starts to wash out the thread form," said Vosmik. "We have software onboard that corrects for that washout and puts the 'wrong' form on the wheel to get the right form on the part."

Another feature that not all thread grinding machines have is a dresser that allows for traverse dressing of the wheel.



United Grinding

With axis-parallel thread grinding, the wheel is perpendicular to the Z-axis.

According to Jerry Martin, sales engineer at Normac Inc., Arden, N.C., "many times the dresser is mounted in one place and the grinding wheel in another, so there are limitations as to how the wheel is formed."

On Normac's 7-axis MX17 universal thread grinder, the 2-axis CNC dresser is mounted on the same housing as the grinding wheel. When the wheel is set to a particular lead angle, the dresser maintains position relative to the wheel, so they are both operating in the same plane. This helps ensure accuracy of the final thread form—especially forms with higher lead angles—and reduce dressing time.

An additional benefit to this dresser configuration is the ability to dress the grinding wheel during roughing, which boosts productivity. Positioning resolution of the dressing unit is within 0.0001mm.

Grinding machine builders continually develop technologies like the ones mentioned, which improve the thread grinding process. Users just need to be made aware of them. △

The following companies contributed to this report:

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