► BY ALAN RICHTER, MANAGING EDITOR

AutoGrind

Productivity-enhancing accessories and software for tool and cutter grinders.

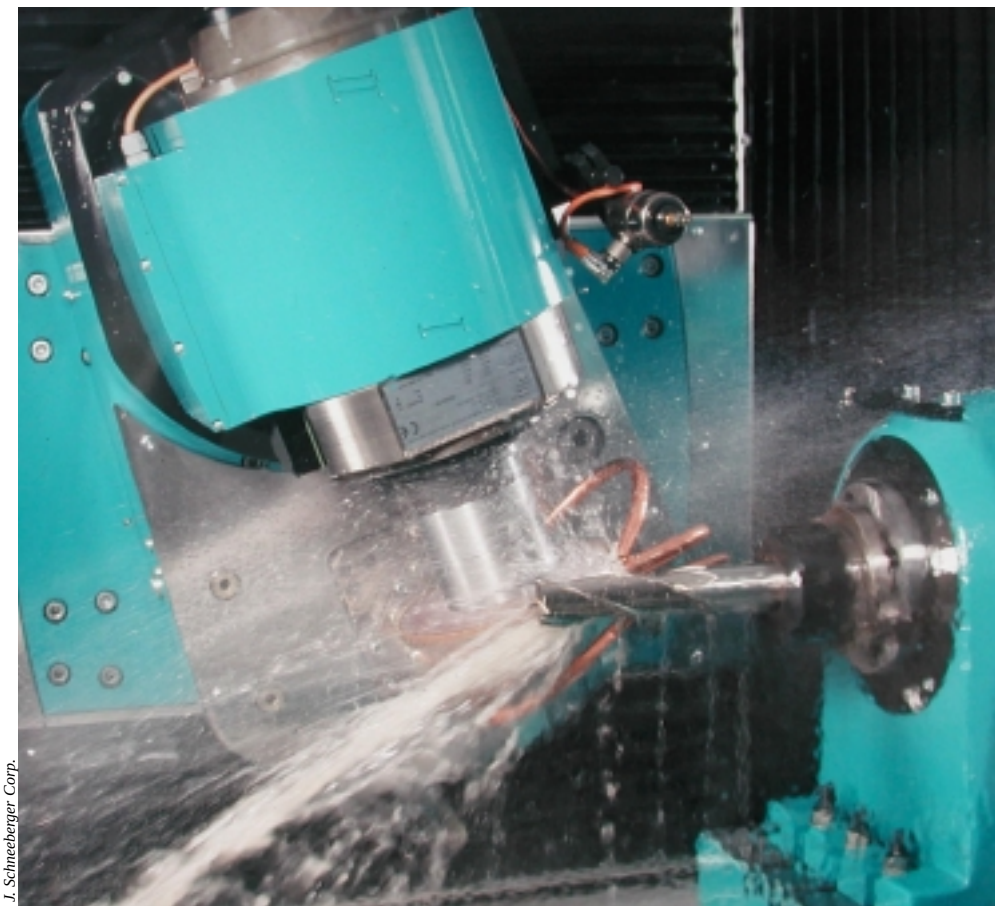
Without a doubt, tool and cutter grinding has evolved from an art requiring a high level of operator skill to a manufacturing science with high repeatability for exacting dimensions and complex geometries. And some recently introduced equipment and updated software packages have made the task even more productive and automated, as well as easier to perform.

For example, before any metal is removed from a tool blank, 3-D grinding-simulation software allows toolmakers to design and virtually grind cutting tools offline without having to produce costly prototypes. In addition, simulation software significantly shortens grinder setup time for complex cutters, provides verification and optimization of geometries, and displays the required grinding sequence and wheel paths, with different colors on the "finished" tool representing the different grinding steps (Figure 1).

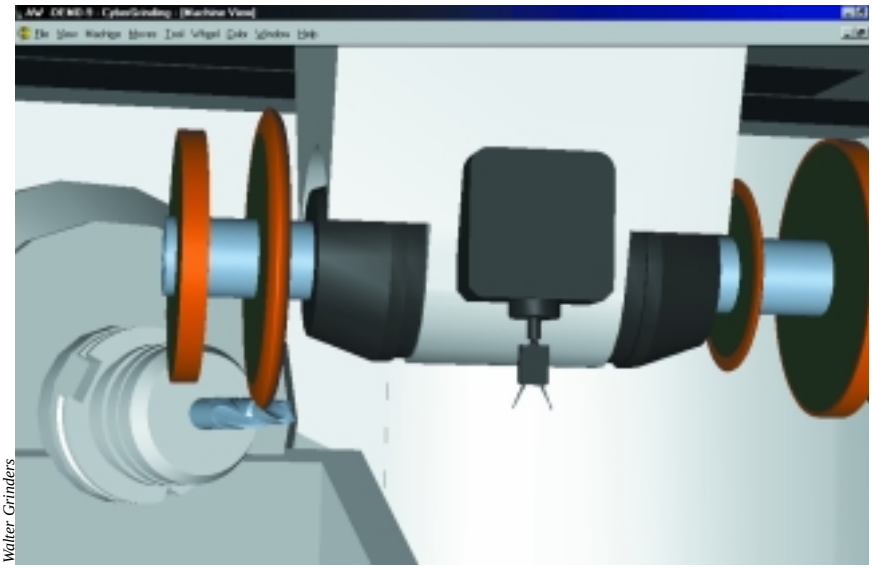
A number of software packages are available from grinder manufacturers, including Cyber Grinding from Walter Grinders Inc., Fredericksburg, Va.; VirtualGrind from Rollomatic Inc., Mundelein, Ill.; and Quinto NT from J. Schneeberger Corp., Elgin, Ill.

Rolf Herrmann, general manager of J. Schneeberger, said Qunito NT for 5-axis tool and cutter grinding is for the Windows NT operating system and, in addition to the user-friendly, graphical interface, features open programming to allow the operator to generate his own G-code routines with custom graphics, if desired. The software works in combination with the grinder's Fanuc 160i control, which features an integrated industrial PC as the user interface and touch-screen programming to ensure fast setups, he said. The software also allows machines to be linked to a network.

Eric Schwarzenbach, president of Rollomatic, indicated that VirtualGrind for Windows NT represents a hub for a group of software programs. The package includes FluteCalc for the fluting of drills, step drills and endmills; TaperCalc for the fluting of tapered endmills; BurCalc for grinding industrial,



J. Schneeberger Corp.



Walter Grinders

Figure 1: Simulation of the grinding process on a PC reduces setup time on the actual grinding machine.

medical and dental burs; and the company's 3-D grinding simulator, 3DCalc for fine tuning tool geometry. He added that 3 days are required for software training.

Although it doesn't have the same intuitive graphical interface as grinding-simulation software, Schwarzenbach said an end user can also program Rollomatic and other CNC grinders using Microsoft Excel spreadsheet software. With Excel, a company's cutting tool database needs to be entered into a spreadsheet, including the parameters, such as rake angles, diameters and land widths.

"It's complicated to set up, but once it's set up you have the entire company template in a spreadsheet," Schwarzenbach said. "You don't rely on the operator to input any more data, since the information is already recorded and the operator is forced to use that input. The template is then uploaded into the VirtualGrind software."

If the data is uploaded into VirtualGrind via Excel, the simulation program will have the same capabilities as if the data was entered directly into VirtualGrind.

Besides simulating tool grinding, locating and correcting design flaws, and optimizing grinding wheel movements, Harry Rein, Walter Grinders' senior engineering manager, said Cyber Grinding allows a user to send the "cyber" tool to a customer for review via the Internet. "The customer, in turn, can view the tool from any angle, rotating it in three dimensions, before giving his approval," he said.

To incorporate Walter's simulation software into a cutter-grinding operation, the user only needs one Windows-based PC and an investment of about $10,000 for one software package.

However, Rein said that to accurately simulate tool grinding, accurate data about the actual grinding wheels needs to be entered. Without precise wheel measurements, an imperfect simulation results, which requires "tweaking" the machine during setup. "On average, tweaking time—including grinding one or more setup blanks—accounts for about 60 percent of the total setup time," he said.

The data generated from the measuring of the wheel pack, or set, offline with a CNC measuring machine can then be imported into the computer loaded with the simulation software. This ensures that the wheel pack is placed into the grinder exactly as expected and reduces or eliminates the need for expensive setup tools, Rein said. The company's measuring machine, loaded with menu-driven software for measuring both tools and wheels, costs about $73,000.

Tru Tech Systems

Figure 2: Ground on Tru Tech Systems' 3-axis blank-prepartion grinder with a diamond wheel in one setup, the carbide workpiece with two diameters and point (left) was done in 3 minutes and 41 seconds and the blank with radius features took 4 minutes and 32 seconds.

Blank Preparation

Once a tool is designed and the grinder is set up and verified, blanks are needed. The blanks placed into the tool and cutter grinder can have complex features already ground into them.

Rather than grind the various diameters for step drills on an expensive, 5-axis CNC cutter grinder, for example, a toolmaker can reduce cycle time by preparing blanks on a less-costly Tru Tech 3-axis grinding system, said Toby Roll, sales and grinding technician at Tru Tech Systems, Mt. Clemens, Mich. He noted that the 3-axis grinder prepares the blank in one setup, allowing a 5-axis tool and cutter grinder to perform the fluting on the prepared blank (Figure 2).

In addition, he said the company's grinding system allows end users to grind with straight A1A wheels instead of more expensive special wheels, which often require dressing away a greater amount of diamond or cubic boron nitride. The A1A wheels have the simplest form—a flat bottom and straight sides—and can be used for more than one job, even if the required preparation differs.

Roll pointed out that its CNC Pick-N-Place software for Windows enhances the ease of operating Tru Tech's

grinding system. Developed in-house, he said the software provides audible instructions that walk an operator through the process. (However, the talking software wasn't developed to receive verbal commands.)

"The software is easy to program, so even an inexperienced grinder can write a program in 1 minute and have it running in 5 minutes," Roll said.

The standard 3-axis grinding system accepts workpiece diameters from 0.010" to 5", and custom grinders can be ordered. Although major toolmakers are Tru Tech's biggest customers, the company also sells machines to companies that specialize in blank preparation and, to a lesser extent, shops performing in-house grinding.

Tru Tech is also developing an automated loader to integrate with its grinder. The company is currently working out the bugs in-house.

"With an automated loader, one operator will be able to run four or five Tru Tech grinders more easily," Roll said.

Tool Palletization

Whether a toolmaker is placing prepared or raw blanks into a tool and cutter grinder, or removing finished products from the grinder, Active Automation Inc., Elk Grove Village, Ill., has developed a product to help them. Its adjustable tool pallets accept shank diameters from 0.025" to 0.500" (Figure 3). Specials can be ordered that accept diameters up to 1¼". In addition, the pallets also accept square shanks and other shapes with an even number of sides.

According to Sam Marinkovich, Active's president, this eliminates the need to have a separate pallet for each tool diameter. "A toolmaker might need 150 or more pallets to accommodate all its tool sizes, and the adjustable tray eliminates that need," he said.

The pallet's top and bottom plates move together in unison as the thumb wheel is adjusted, while the middle plate moves an equidistance in the opposite direction. This plate movement provides a constant tool centerline, so that once a robot is "taught" the centerline, it's able to grip each tool—without recalibration—regardless of the tool's diameter. Of course, even without a robot, Marinkovich said the pallet is an effective tool-handling system.

Each pallet should be adjusted so there's a slight amount of clearance between the tool and the pallet opening. This allows a tool to be easily inserted and removed, said Frank Kowalski, engineering manager for Active Automation. He added that as the robotic gripper experiences wear and loses accuracy, a chamfer on the bottom of the tool or top of the opening helps guide the tool into the tray.

Because tool and cutter grinders from individual machine builders have different footprints, Kowalski said Active either has to design a pallet based on a manufacturer-supplied print or reverse-engineer it when a print can't be obtained. Pallets are available for most of the popular machines on the market, including Rollomatic, Walter and ANCA Inc. tool grinders.

Elements of Automation

As competition among toolmakers heats up and the skilled-labor pool evaporates, robotic tool loading and other equipment for unattended grinding helps toolmakers meet customers' demands for the highest-quality tools with the quickest turnaround—without having to hire additional skilled operators.

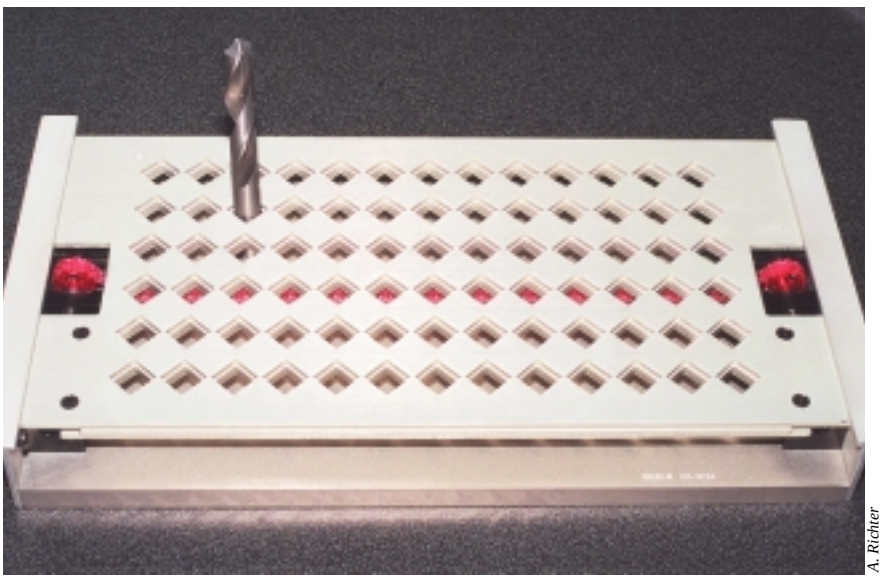
Herrmann noted that J. Schneeberger's machine-integrated loader with V-shaped gripper, in combination with the company's software, provides the flexibility for producing a single tool or thousands. On the external multipallet system, he said a sensor reads the binary-like code on the pallet and the specific tool's program is automatically uploaded into the CNC.

The pallet holding the blanks and finished tools is protected from the coolant by a pneumatically activated door, isolating the pallet from the grinding chamber during the machining process.

For quality control when auto loading, wheel wear can be checked and any wear is automatically compensated for. "It's a nifty automation system," Herrmann boasted.

Schwarzenbach pointed out that Rollomatic's high-speed, robotic loader travels at a rate of over 213 feet per minute and can load or unload a tool in less than 10 seconds (Figure 4). Tools up to 12" long can be loaded automatically, and, combined with the company's cassettes for holding blanks and finished tools, the robotic loader allows unattended production of up to 1,000 tools.

In addition to other grinders, the 3-axis robotic loading station integrates with Rollomatic's GrindSmart 6000XL hydrostatic tool grinder. According to the company, the hydrostatic functions allow friction-free linear and rotary



A. Richter

Figure 3: Active Automation's tool pallet eliminates having a unique pallet for each tool diameter.

movements in all 6 axes, including the grinding spindle, to enhance accuracy, speed, rigidity and repeatability. Plus, the machine comes with a wheel-dressing and cleaning system to augment unmanned tool grinding.

Although automated grinding equipment adds to the total cost of a tool and cutter grinder, the increased output that's possible justifies the investment, said Ed Sinkora, Walter's marketing manager. And the grinding machine builder's sales figures indicate that having an automated toolroom is a growing trend among toolmakers.

"Last year, we saw a huge increase in the percentage of grinders sold with automatic loaders, jumping from 20 percent to 60 percent," Sinkora said.

Walter's automated loader for its Helitronic Power family features stiff pneumatic grippers to transfer tools from the pallet to the chuck via a rigidly mounted CNC axis slide, the company reports. The pallets, which can hold four different diameters, also move on a CNC axis.

While advances in automation allow unattended tool grinding, and running a CNC tool and cutter grinder has made the task easier, operator skill will always be required, especially for resharpening, said David Brigham, vice president of Schütte TGM LLC, Jackson, Mich. CNC tool grinders offered by Schütte provide a variety of automated features, such as automatic changing of the grinding wheel and coolant manifold, probing and integrated tool changing for different shank sizes and tool styles.

"Especially when regrinding, where the necessary stock removal varies according to the wear of the cutting edges, the operator must monitor this wear and make offsets as required," he said. "For manufacturing, lights-out production is achievable, but for tool regrinding, that's another story."

Tying It All Together

Achieving fully automated tool production requires networking the simulation software, measuring machine and tool grinders, said Walter's Rein. "It combines all the elements of the grinding system," he said.

Once this is done, all program file transfers occur on-line. He added that the transfer of tool-inspection data enables automatic compensation during a production run. This is important because even if a wheel is measured accurately at the start of a run, it wears during production and this wear inevitably shows up in the finished tools.

But the rate of wear isn't consistent. "A new wheel wears more when producing, say, the first 10 cutters than it does grinding the next 60," Rein noted.

Temperature fluctuations and other process factors also minutely alter the finished tool geometry. Measuring machines track these differences and automatically make adjustments to the CNC tool grinder.

With a network, Rein said all grinding programs, wheel files and toolholder files are stored in a password-protected central database, allowing the end user to design and set up a tool once and manufacture it on demand exactly the same whenever required.

Sinkora pointed out that storing the programs on a central database gives a toolmaker a sense of security, because if a programmer leaves, his work remains stored on the company's hard drive. "It centralizes the expertise."

Rollomatic

Figure 4: This high-speed robotic loader loads or unloads a blank or finished tool in less than 10 seconds.

Building a network requires an additional PC to function as a file server, network interface cards in the machines, a fiber optic hub, fiber optic cables and the necessary network software. Rein said that depending on the size of the installation, the whole package costs from $10,000 to $20,000.

Networking also helps overcome inconsistent tool grinding as a result of operator differences. “With a network, you just need one really good engineer to program the grinding operations for many machines,” he said.

The elements have been around for a while, but Rein said automated and networked tool production is still in its infancy, with more and more manufacturers moving in that direction, including large, in-house regrinders.

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“The complete system is already cutting about 70 percent of the setup time. In the future, there’ll be more integration and a higher level of perfection,” he predicted. “But in reality, there is only a certain percentage of perfection that’s possible, because there’s always something left that can’t be controlled.”