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By Keith Jennings

Old school vs. new

In most machine shops, including ours, it's common for older, more experienced metalworking professionals to work alongside younger ones. Ordinarily, the younger workers would be wise to listen to their experienced co-workers and incorporate their techniques that have been many years in the making.

There are times, however, when the unavoidable clash of generations prompts a vigorous debate about old style vs. new style. Respectful debate is healthy and can provide an excellent venue for brainstorming and troubleshooting, from which—hopefully—the best practices of all are combined to create an effective solution. Negative results can occur, however, if some are unwilling to consider the benefits espoused by the other generation. Our company has certainly experienced the old vs. new head butting that inevitably occurs.

Those who rush around from office to shop, machine to meeting, phone to forklift, scrap bin to tool cage and back to the office again, while sweating profusely probably aren't utilizing their time effectively.

After 16 years, I'm certainly not a new guy anymore, but perhaps some of my ideas are. In any case, I'd like to compare the generations and identify differences. First, let's dispel an old-school notion embraced by many experienced machinists, managers and owners: Computers are worthless, and you must be physically busy and hectic throughout the day to be productive. That isn't correct and makes me tired just thinking about it. Unfortunately, a few technology-challenged subordinates succumb to this belief that creating chaos, sweating and getting dirty means you're a hard worker and getting much accomplished.

Those who rush around from office to shop, machine to meeting, phone to forklift, scrap bin to tool cage and back to the office again, while sweating profusely, probably aren't utilizing their time effectively. If an employee gets up from his desk and goes to the shop to clarify something, it usually takes a minimum of 20 minutes, regardless of whether the actual issue required a 2-minute fix. Being busy just to feel worthy doesn't make much sense and could be wasting time and energy.

Meanwhile, younger employees who rely on technology and aren't desirous of frequent walks to another work area often become more productive than their sweaty counterparts. Nonetheless, computer-minded young workers have a few hyped-but-not-terribly-useful practices of their own. For instance, posting volumes of bandwidth-intense material online doesn't seem to garner much attention in the machining trenches. Electronically recording every process in a shop with wireless gadgets isn't productive either, but collecting some real-world data is better than none.

It's OK to take advantage of computer-based manufacturing technology. Younger workers are usually comfortable with that and learn quickly, so take advantage of those strengths. Also, it can be valuable to use your company's database to look for trends, patterns and statistics that can open a giant window of business-generating information right from your desk without going to the shop.

While I don't like worn business phrases, working smarter instead of harder will make it easier to grow your business. Determine how those technology-savvy young workers can multitask without breaking a sweat. Effectively using older employees' experiences with today's technology-driven ideas is critical. How your shop adapts to ever-evolving conditions and these inevitable generational clashes will ultimately determine success. Now, excuse me while I monitor my dad's shop from a laptop in Fiji. CTE

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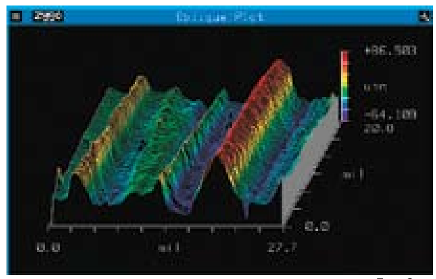
Measuring surface finish

By Dr. LaRoux K. Gillespie

Surface finish impacts part life, corrosion resistance, friction, electrical contact resistance, appearance, fluid flow and a host of other functional characteristics. Measuring a part's surface roughness is generally straightforward, quick and inexpensive. Drawings and standards specify what surfaces need specific finishes and where, but part designers must specify the best roughness parameter to achieve the desired finish.

Experienced machinists have long drawn a fingernail across a surface to determine its roughness. That technique doesn't meet ISO standards, but it works until faced with a finish of 8µin. R_a or finer. A $30 electroplated, hand-held roughness comparator measures finishes produced by several machining processes down to 2µin. R_a, providing a quick, visual means to estimate the finish on turned, milled or ground parts.



Zygo Corp.

A 3-D roughness image from a prosthetic implant.

Actual measurements are normally made using a profilometer, which drags a probe with a tip radius across the surface of interest. The part can be carried to the measuring device or a portable profilometer can be taken to the part. The instrument can provide strip-chart printouts that document the roughness found at any point on the part. Profilometers can also print any of 10 different common parameters that define roughness. Portable devices cost from $900 to $6,000 while standard desktop machines cost from $3,000 to $45,000.

Usually, surface finishes are measured over a small area of the part, a typical area of finish. A profilometer's stroke can be as short as 0.020" or as long as 8" to reach, for example, the bottom of an automotive piston cylinder wall. Typically, the stroke length is about five times the cutoff value. Cutoff values by the U.S. standard are 0.003", 0.010", 0.030", 0.100" and 0.300", so the surface finish analyzer will be able to measure five different sets of data when the cutoff value is set to 0.030" and the stroke is set to 0.150" or longer.

Some low-cost analog profilometers measure only average roughness (R_a) and cannot be upgraded to provide more information. Digital profilometers, although more expensive, provide up to 80 different measurement values and allow users to export the data.

Laser and white-light measuring machines provide a 3-D view of the surface, or topological map, and calculate up to 100 different roughness values. These machines typically cost $50,000 to $100,000. The topological mapping provides instant visual clues of what has changed and that often leads to an understanding of how to correct an issue. These machines may take as many as 300,000 surface measurements in a few seconds and can determine the finish in an area as small as 0.001" in diameter, which would be unusual, or as large as a part's entire surface.

A deep surface scratch may appear to affect surface finish values, but it actually has little impact on the average value because the deep scratch is only one valley among the many measured. The ANSI B46.1 standard specifies that surface finish is measured in the direction that provides the highest roughness value. That is normally across the feed marks.

Profilometers can have three different tip radii (2, 5 and 10 microns) that reach into surface valleys. A 2-micron radius tip allows a user to measure smoother finishes more accurately. A 10-micron radius tip tends to make the surface appear smoother than it is. The smaller tips, however, wear quicker and can be damaged more easily than broader tips. A profilometer manufacturer might offer up to 25 different tips or more to allow measurement in deep-hole surfaces and unusual part features.

The R_a scale is the arithmetic roughness average. R_y, or R_{max}, is the peak-to-peak roughness and is typically four times the indicated average roughness. A mirror finish has a roughness of about 4μin. R_a, and lapped and polished surfaces typically are from 8μin. R_a to 16μin. R_a.

The R_q scale is the average of the measured height deviations calculated as the root mean square (rms). R_a is the average of the peak-to-valley heights, but R_q is the rms of that value. Some companies use R_z to define roughness. This value is the 10-point height: the average absolute value of the five highest peaks and five lowest valleys for the measured length. CTE

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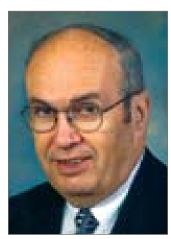

The Next Generation of Waterjet Pumps

KMT Booth #B-6235
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Progress through partnership

By George Weimer

Consider this premise. Machine tool control technology needs to be upgraded. The industry needs to reinvent itself technologically and that can only be done through cooperative programs with suppliers, universities and customers.

That's what some machine tool builders believe now and that's why machine tool builder Okuma America, for example, built a new facility recently in Charlotte, N.C. It houses Partners in THINC, a cooperative technology development program. THINC stands for "THe Intelligent Numerical Control."

Here's how Okuma officially describes this cooperative effort with its suppliers. "Partners in THINC brings together multiple supportive companies from throughout the industry to create the best manufacturing solution for our customers. The Partners in THINC facility is a meeting ground where intuitive thinkers from these companies can come together to test ideas and sharpen solutions in a real-world setting."

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In other words, it's a manufacturing lab that Okuma uses to enhance its products by offering membership in the program to its suppliers and customers. The Charlotte building's entrance does not say "Okuma." It reads: "Partners in THINC" to emphasize the program's cooperative nature.

View THINC as a control that offers "all you need to run machine tools as well as everything you expect in a PC. It is also flexible and can offer manufacturing solutions for the entire manufacturing enterprise," said Robert Tain, senior director-controls for Okuma. Partners in THINC asks for supplier input on just how it can achieve that flexibility and offer those solutions. Here's an example.

Toolmaker Kennametal Inc., Latrobe, Pa., is a partner with Okuma and in one project was able to integrate THINC with its Tool Boss tool storage and management system. "THINC allows the operator to know things about a job such as the state of tool wear," said Curtis Rellick, global product manager for Kennametal. "Tool Boss allows the operator to know things about insert needs for a given job." Integrating those into a time- and money-saving system is one of the results of Kennametal's participation in the Okuma program.

"We have another special control feature coming out of this program, which we will demonstrate at IMTS '08," added Okuma's Tain, though he declined to offer further details.

Other machine tool builders have also entered into partnerships with suppliers and customers in recent years. For example, Mori Seiki USA Inc., Rolling Meadows, Ill., has partnered with CAM software developers DP Technology Corp., Camarillo, Calif., and CNC Software Inc., Tolland, Conn., as well as motion-control products manufacturer Lord Corp., Cary, N.C., on various projects.

Doug Nemeth, corporate sales manager for CNC Software, which develops Mastercam, said his company partnered with Mori Seiki to develop a post-processor for the Mori Seiki NT series of machine tools.

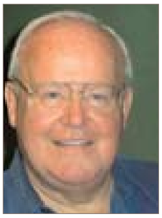
"The key point in our collaboration with Mori Seiki was the fact that we worked with them on this project well before the machines were on the market," Nemeth said. "Typically, a customer of CNC Software posts—or those of any other CAM vendor—would call after he bought the machine and we would start to gather information about the machine from the customer to develop a post-processor that outputs the appropriate G code. This has always been a problem with posts." Partnering with Mori Seiki allows CNC Software to deliver posts in a timely fashion. Nemeth also said his company has another development project with Mori Seiki that he could not disclose.

Cooperative efforts on the part of the builders are really exercises in "relationship building," added Kennametal's Rellick. They need top management support. "Dr. Mori [Dr. Masahiko Mori, president of Mori Seiki Co. Ltd., Nagoya, Japan] himself was in the initial meetings with CNC Software," noted Nemeth. "They were very cooperative and any time we asked for information on the project, they gave it."

Mori Seiki also partnered with Lord Corp. to develop an adaptive balancer that is now used on many of Mori Seiki's machine tools. Typically, weights are manually added to a workpiece to minimize vibration at high speeds. Lord's technique, which uses a rotating weight collar that fits onto the spindle before the chuck, is automatic and extends tool life.

Will this partnership approach produce benefits for machine tool users? Should you investigate this approach with your machine tool suppliers? Judging from these examples, it's certainly something to look into. Some technologies may be experimental, but they may produce important benefits for machine tool users. Being in on the ground floor of some of these developments may just provide your operation with a competitive edge. **CTE**

About the Author:



George Weimer, a freelance writer based in Lakewood, Ohio, has an extensive background in the metalworking industry's business press. Contact him at gweimer@jwr.com.

Part progress

By Bill Kennedy, Contributing Editor

George Trulock has been making interchangeable chokes for shotgun barrels for more than 25 years. The simple-looking parts are indispensible tools for many shooters. An interchangeable choke is a tapered constriction of the gun barrel's bore at the muzzle end that compacts and shapes the charge of pellets to maximize their effectiveness at a certain range.

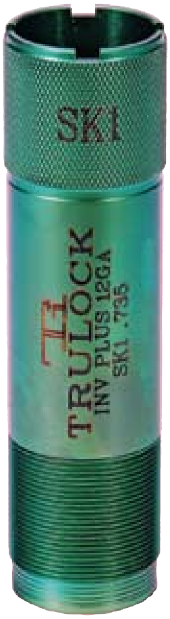
As opposed to fixed chokes that are integral with the shotgun barrel, interchangeable chokes screw on or into the barrel and, by providing different amounts of constriction, enable a shooter to "pattern" his gun for certain game or conditions. Most interchangeable chokes have a conical, parallel internal design, in which a tapering cone blends into a bore with parallel sides. This stabilizes the shot as it leaves the barrel.

Trulock Chokes, Whigham, Ga., makes chokes in a withering selection of styles and sizes. Chokes range from 1½" to 4½" in length, 0.530" to 0.775" in ID and 0.625" to 1" in OD at the choke head. A particular choke tube design in a certain gage may be made in as many as 15 different bore sizes. Trulock makes the chokes for retail sale as well as for gun makers. Lot sizes range from 10 to perhaps 2,000 pieces of a given exit diameter.

Over the years, Trulock's products and processes have changed significantly in response to government regulation, advances in manufacturing technology and market demands. When he started his business, Trulock used a No. 2 Warner & Swasey turret lathe to make versions of the Winchester Winchoke, the only interchangeable choke then on the market. "There was basically one style of thread for factory choke tubes," he said. "Winchokes came in 13⁄16", ¾" and 11⁄16" by 32-pitch series threads."

A policeman and part-time gunsmith before he began his company, Trulock quickly realized that adapting Winchokes to other fixed-choke guns was unsatisfactory. The Winchokes were relatively large in diameter, and adapting them to a fixed-choke gun required either expanding the gun barrel at the muzzle end or mounting an adapter. Trulock designed the Truchoke with a smaller OD and thread so it would fit into smaller barrels. He also designed tooling to ream and tap the barrel's end to accept the Truchoke system. Production began in 1982.

Growing demand led Trulock to replace the turret lathe with a cam-controlled 2G Brown & Sharpe single-spindle



Trulock Chokes

The interchangeable shotgun barrel chokes made by Trulock Chokes have evolved from a few choices machined from stress-proof steel to a withering selection of styles and sizes, including this titanium version.

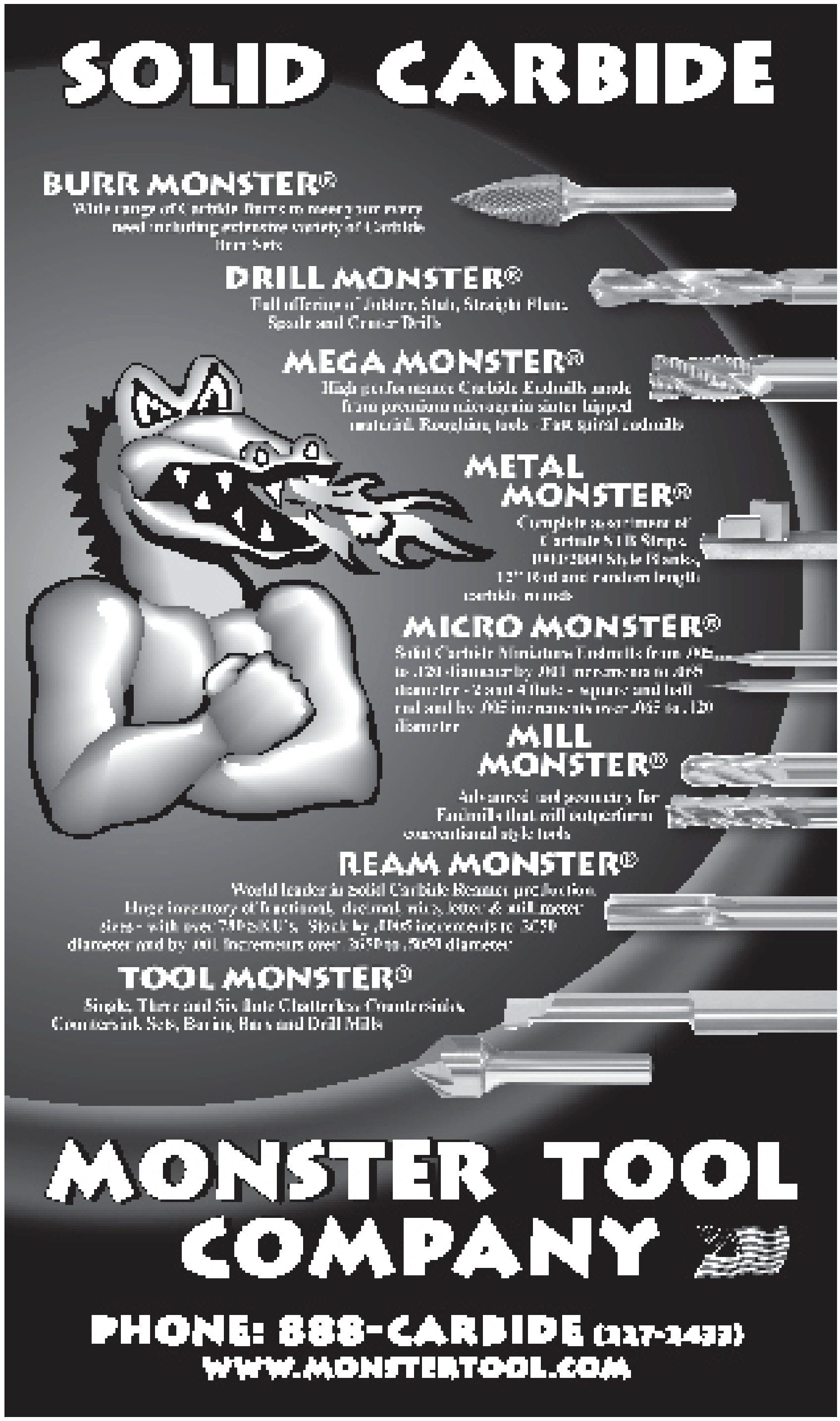
automatic screw machine. Then, when gun makers began to order chokes for their products, the variety of threads specified prompted Trulock to begin a switch to CNC machine tools. Today, the majority of the shop's machines are CNC. "The threads didn't force us to go to CNC, but that is certainly one of CNC's big benefits," Trulock said.

Shortly thereafter, environmental regulation rocked his industry. Ducks were dying after ingesting lead shotgun pellets, and the U.S. Fish and Wildlife Service, following the lead of a number of states, mandated that waterfowl shotgun shells must use environmentally friendly shot (most often steel) by the 1991-'92 hunting season.

"The changeover from lead to steel shot caused big problems," Trulock said. "It was not a fun time." Choke makers and others in the gun industry "started having cracking problems with steel shot. Resulfurized steels, including the stress-proof and 416 stainless used in chokes, had a tendency to crack with steel shot." Apparently, Trulock noted, needle-shaped sulfide inclusions created stress risers in the chokes. "They'd split the length of the choke tube with just as nice and pretty a crack as if you took a slotting saw and ran it down that sucker," he said.

As a result, choke makers generally switched to 4140 carbon steel and 17-4 stainless steels. The materials do not enhance or degrade shooting performance, Trulock said, but choke designs had to be modified to optimize performance with steel shot.

In terms of machining, however, different materials and designs combine to preclude establishing any simple machining formulas for the chokes. "You've got to run a fairly small nose radius, or you're going to get chatter," Trulock said, "and the chokes generally require a 30µin. R_a finish on the ID." But running at a slow feed rate to achieve that finish can ruin chip control. "Now the chips wad up, and what are you going to do? I have caused many a tooling sales rep to lose his religion after coming in here," he said. Probable solutions like wiper inserts don't work, Trulock said, although running at a shallow DOC when finishing and applying special boring bars can help at times.



As a result, there are different tooling and process setups for nearly every different choke. Effective parameters vary even within a common style. "If we take [one] style of tube in 12 gage, we may machine some sizes of those totally different than we do others. The basic processes, obviously, are the same; they all get turned, drilled, bored and threaded. But the order of operations and the feeds and speeds for one may be different from another."

Trulock said his shop performs secondary operations to produce features such as choke wrench notches, ports and front chamfers. Time to machine a choke varies widely, from about 90 seconds to 6 or 7 minutes.

Trulock believes his selection of machines is a good match for the work he does. The selection includes Hardinge, Wasino and Mori Seiki lathes, some of which are bar fed, and a Fadal and Bridgeport vertical machining center. "Most everything is 2-axis," he said. "We've looked at multispindle, multiaxis machines, but based on our studies, throughput is better without utilizing them."

Trulock said the equipment setup enables him to perform primary and secondary operations at the same time. He said he could see more value in machining chokes in one chucking if tolerances were a major concern. The tightest tolerance is 0.0005", and most are more open than that.

Like any successful manufacturer, Trulock responds to customer demand. About 2 years ago, he began to make chokes from titanium (Ti6Al4V) that sell for $100 each—about twice as much as a regular choke tube. Titanium provides no better shooting performance than steel alloys, but is lighter in weight. He did note, though, that titanium "is nasty stuff to machine. Every problem you have with conventional steels, either carbon or stainless, is magnified with titanium, by a large factor." It's been another learning process involving changing cutting tool grades, order of operations and cutting parameters.

The only operation Trulock does not perform in-house is color-oxiding of the different sizes of titanium chokes.

Trulock said his chokes "look simple, and some of them are. But some of them, well, I don't know how long I'm going to be on this earth, but I guarantee you if I had never gone into the choke business, I'd have lived longer." CTE

For more information about Trulock Chokes, call (229) 762-4678 or visit www.trulockchokes.com.

contact us

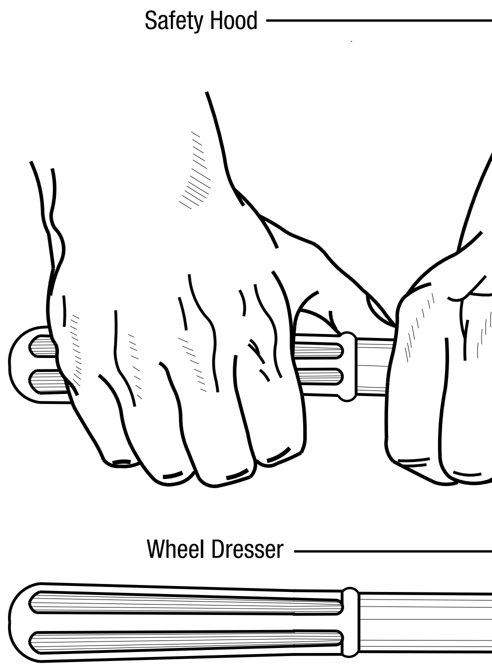
If you have manufactured a part that would make a good candidate for a Part Time article, contact Contributing Editor Bill Kennedy at (724) 537-6182 or billk@jwr.com.

Grinding operations

By Frank Marlow, P.E.

When work is brought in contact with a rotating grinding wheel, each abrasive grain on the wheel's surface acts as a cutting tool and removes a tiny metal chip. When a grain becomes dull, frictional heat between the wheel and workpiece causes grains to break away and expose sharp, new grains, making grinding wheels a self-sharpening cutting tool. Before a wheel touches work, though, there are steps to follow to achieve efficient grinding.

Follow important steps to ensure safe grinding. Before installing a new grinding wheel, it should be ring tested to ensure it is free from cracks. Suspend a wheel from a finger or pin through its center hole and strike the wheel at the 2, 4, 8 and 10 o'clock positions with a wooden mallet or plastic hammer. A crack-free wheel will produce a clear,



resonant tone when struck; a damaged wheel will produce a dull thud.

Never exceed the maximum operating speed or the wheel may explode. This speed is marked on the wheel or, if it is small, on its packaging.

When mounting a new wheel, ensure the wheel-mounting flanges are clean, that the wheel fits over the spindle easily, and the nut holding the wheel on the spindle is snug but not tight.

Allow a newly mounted wheel to run for a minute or two before using it.

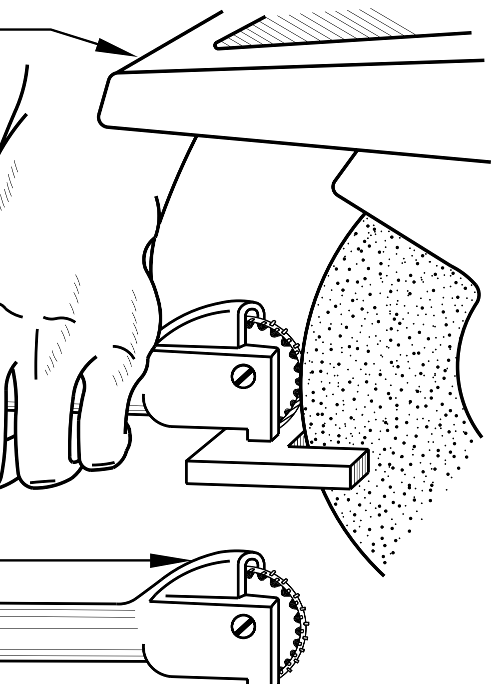
Always stand to one side of a grinding wheel when starting it.

Don't grind on the sides of a wheel.

Grinding on the wheel's face applies forces opposing the centrifugal forces trying to pull the wheel apart, but side grinding applies forces that add to the forces trying to pull the wheel apart and may cause wheel failure.

Do not abruptly force work into a wheel's face. Bring the work gently to the wheel and gradually increase the force against the wheel.

Always wear eye protection, position safety shields properly and set the tool support within 1⁄16" of the wheel's face.



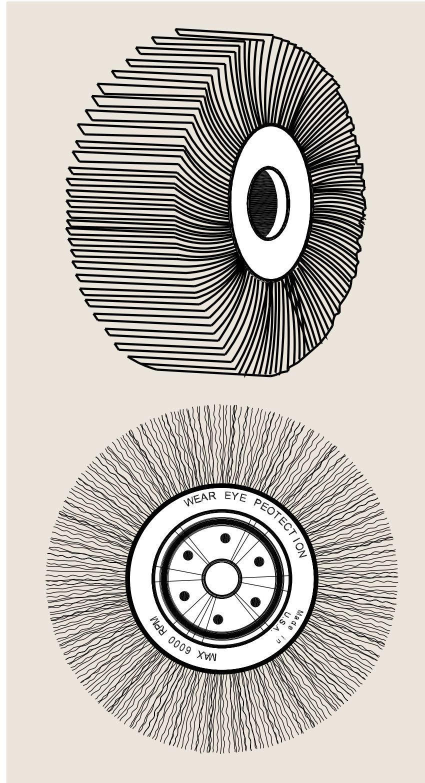
All images: Pamela Tallman

Manual truing of a grinding wheel is done with a wheel dresser.

There is a difference between truing and dressing an abrasive wheel and how these operations are performed. Truing removes enough wheel material from its periphery to bring the wheel back into roundness. That is, the wheel edge is again a "perfect" circle and its center is concentric with the grinder spindle. Manual truing is performed with a wheel dressing tool. Start the grinder and allow it to reach full speed. Position the handle of the wheel dresser parallel with the grinding wheel and bring the wheels on the wheel dresser in contact with the edge of the rotating abrasive wheel. Move the wheel dresser side to side along the wheel's face until the wheel surface is clean and approximately square with the sides. Considerable pressure may be required against the dresser on larger diameter wheels. Never apply the wheel dresser to the sides of the wheel. Dressing an abrasive wheel with an abrasive stick, also called a wheel dressing stick,

exposes a fresh cutting surface and flattens the wheel face. Dressing removes much less material than truing. Abrasive sticks are either made of boron carbide or silicon carbide.

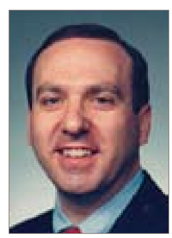
Abrasive cutoff wheels offer advantages. Abrasive cutoff wheels are available in a range of sizes, from 14" in diameter for use in cutoff saws to medium-size wheels for bench and pedestal grinders to ½"-dia. wheels for electric- and air-powered hand-held grinders. These wheels can cut hardened alloys, shapes, angles, pipe and tubing. The wheels are thin and therefore minimal material is lost in their kerfs. Abrasive cutoff wheels can cut new slots in damaged screw heads, shorten threads on screws and bolts and remove frozen nuts.



An example of a flap wheel (top) and a wire wheel.

Other wheels are available for bench, pedestal and hand-held grinders. Wire wheels are appropriate for removing dirt, rust and paint. Flap wheels are for smoothing welds, removing rust and working on large areas. Cloth and felt buffing wheels are for polishing, usually with a mild abrasive that is applied to the wheel itself. CTE

About the Author:



Frank Marlow, P.E., has a background in electronic circuit design, industrial power supplies and electrical safety and has worked for Avco Missile Systems, Boeing, Raytheon, DuPont and Emerson Electric. He can be e-mailed at orders@MetalArtsPress.com. Marlow's column is adapted from information in his book, "Machine Shop Essentials: Questions and Answers," published by the Metal Arts Press, Huntington Beach, Calif.

By Dr. Jeffrey Badger

Archives MNATP. Collection Meillassoux

CBN dressing and more

Dear Doc: I just switched from an $Al_2 0_3$ to a vitrified-bond CBN grinding wheel. I dress it with a diamond disk. Do I need to change anything when dressing? And do I need to stick the wheel?

The Doc Replies: All the principles of dressing $Al_2 0_3$ apply when dressing CBN. A synchronous dress provides a more open wheel, and an asynchronous dress gives a more closed wheel. The +0.8 ratio is effective for creating a sharp, open wheel. Traversing the wheel quickly opens the wheel and traversing slowly closes it.

All the principles of dressing $Al_2 0_3$ apply when dressing CBN. A synchronous dress provides a more open wheel, and an asynchronous dress gives a more closed wheel. The +0.8 ratio is effective for creating a sharp, open wheel.

The only difference is the depth. When dressing $Al_2 0_3$, you were probably taking about a 0.001" DOC; with CBN, you'll want to decrease that by a factor of 10 and take around 0.0001".

Finally, because this is a vitrified-bond wheel, you won't need to stick it. Sticking is for resin- and metal-bond wheels.

Dear Doc: My hobby is stained glass, and I'm currently working on a project that requires several 1-sq.-ft. sheets of art glass with a ⅛" standard thickness that must be ground down by about 1/32" to produce a relatively uniform final thickness of 3/32". Frankly, I'm at a loss to find any businesses where I live in Seattle that might perform this delicate job for me. Do you know of any company that might be able to do this type of work? If not, how can I tackle it myself? For what it's worth, I tried wet sanding the panels using a 220-grit diamond disk mounted on an orbit sander, but what little progress I was able to make took forever. Surface finish is not an issue.

The Doc Replies: That's one I've never heard before, but I'll take a stab at it.

If you stick with an orbit sander, use a larger grit, such as an 80-grit disk. This should cut down on time. The surface finish will be far from "glassy," but that's not an issue.

Or, find a shop with a surface grinder and have them stick on a diamond wheel so you can slowly grind off 1/32". Make sure the grinding machine has automatic in-feed, otherwise you'll be there all day turning the dial. Because glass is sensitive, take very light cuts. Set it to grind 1/32", head to the bar and hopefully when you return the glass won't be in a million little pieces.

Fixturing is another story. Glass isn't magnetic, so getting it to stay on the grinder's table will be a challenge. Putting 1/16" shims around it might work. You could also put some steel bars over half of it to hold it, grind the other half, move the bars to the ground half and grind the remaining half.

Dear Doc: I just purchased a No. 3 Cincinnati centerless grinder and need a manual. Do you know where I can get one?

The Doc Replies: I have found lots of cool grinding-related stuff on eBay and have seen quite a few manuals there. I suggest you do a "saved search," and eBay will automatically search for you every few days. When one is listed, you'll be notified by e-mail. **CTE**

About the Author: *Dr. Jeffrey Badger is an independent grinding consultant. His Web site is www.TheGrindingDoc.com. E-mail grinding questions to him at alanr@jwr.com. The Doc will be presenting his High Intensity Grinding Course this October in Switzerland.*

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