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BY MIKE PRINCIPATO

Not to be petty, but …

Given the grief an internal theft from the company cash box can cause, it must have been an accountant who coined the term "petty cash." When someone's dipped his or her hand into your business' till, the consequences are anything but petty.

Granted, it's tough to run a business without having ready access to a few real greenbacks for unexpected expenses. Accordingly, most companies keep a few hundred to a few thousand dollars in a lockbox or safe, typically guarded with varying degrees of diligence by a bookkeeper or the accounting department. But having petty cash onsite can be both a blessing and a curse, as I've learned during my ongoing studies at the University of Hard Knocks.

When I found petty cash was missing, I immediately felt as though more than just money had been taken—I felt violated.

When I found petty cash was missing, I immediately felt as though more than just money had been taken—I felt violated. How was it possible, I thought, that one or more of my employees with whom I'd cultivated a deep, mutual trust and respect had ripped me off? These were guys I entrusted with megabuck machinery, customer relationships and confidential company financial data. Why would someone who works for me risk that trust—and his job—for 50 bucks?

That wasn't the worst of it, because when a minor internal theft occurs, you've got two choices: Eat the loss and chalk up the incident to experience or try to flush out the culprit. I opted for the latter, knowing I wouldn't be able to suppress my anger and disappointment. That's when the real, albeit temporary, damage to my business occurred, because there's no simple, clean way to identify a lack of character in an employee.

I called a quick floor meeting, during which I somberly described the theft and my disappointment. I told the crew that one among them was a traitor to our cause. I implored all honest, God-fearing employees to anonymously finger the guilty party or parties so we could put the incident behind us.

I may have also noted that the punishment for the theft would be immediate termination with extreme prejudice and, perhaps, a parting gift of my work boot inserted into the caboose of the soon-to-be-ex employee. If nothing else, I'm sensitive.

As a result, it quickly seemed apparent to my employees that everyone was guilty until proven innocent, a direct result of my ill-advised, Solomonesque approach to identifying the culprit. Therefore, nobody identified anybody, the thief was never found and an atmosphere of mistrust lingered like a gray cloud over the plant for the next couple of months.

Given the opportunity for a mulligan on this sordid little episode, I would have done many things differently. So, learn from my mistakes or suffer the same fate.

First, I never again keep my company's petty cash in anything other than a locked lockbox. No, I'm not stuttering. Ours was unlocked for convenience at the time of the theft. Stop snickering; I never said I was a genius, but I, generally, only have to be hit with a brick once to learn something the hard way. Now, only two people possess a key to the lockbox: my bookkeeper and me.

Second, no petty-cash transaction occurs without the quick and painless completion of a simple receipt form. The form contains one line each for the date, the expense for which the petty cash will be used, the amount removed from the box, and the signatures of the recipient and the key holder who opened the box. The petty cash is replenished once it's depleted to a specified amount.

These two steps would have likely prevented my theft from occurring in the first place. But, if they hadn't, one thing's for sure: With just two people responsible for the security of the lockbox—one of them me—it wouldn't be too tough to identify the crook unless someone swiped the key. No floor meeting, no general accusations and no exhortation to the employees to rat on a co-worker. And, most importantly, no poisoned work environment.

Simple steps, yes. But there's nothing petty about the grief they could save you and your company.

About the Author

Mike Principato owns a machine shop in Pennsylvania. He can be e-mailed at ctemag1@netzero.net.

Tool geometry: the two Rs

BY ROBERT CHAPLIN

Many elements make up a cutting tool's geometry. Two key ones are rake and relief.

The rake, or top face, is the area of the cutting tool that contacts the chip. The rake angle is the angle between the top cutting surface of a tool and a plane perpendicular to the surface of the workpiece.

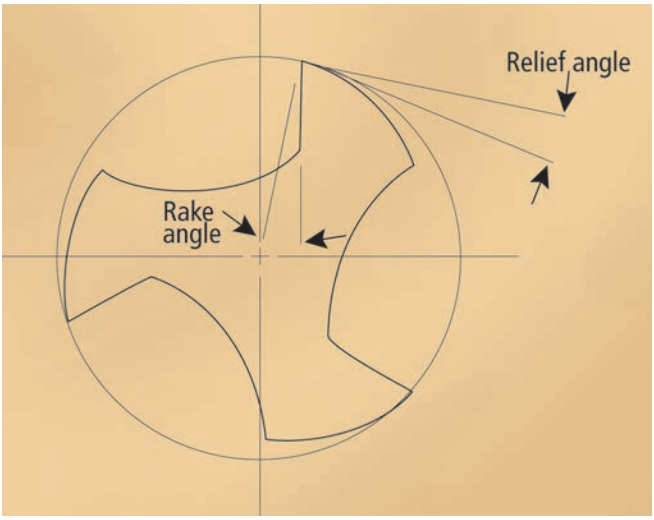
Relief, or clearance, refers to a space behind the cutting edge. This clearance prevents the tool from rubbing the workpiece. Relief angle is a measure of the clearance between the surface below the cutting edge and a plane perpendicular to the rake face.

Rakes can be negative, positive or neutral. A negative rake produces the strongest cutting edge, demands the highest amount of force to create a chip and generates a short, thick chip with high heat.

Negative-rake tools are recommended for roughing, interrupted cuts and "skin milling," where the surface material is hard or abrasive and chemically active. Because of a negative rake's tendency to generate BUE, which can cause galling on the surface, it is seldom used for finishing.

A positive rake directs the chip away from the workpiece surface, producing a thin chip with less heat-carrying capability, requires less force to create a chip and has a large shear-plane angle. Positive-rake tools can be applied to ferrous materials, as well as difficult-to-machine materials such as stainless steel, and are recommended for applications requiring fine surface finishes.

A neutral, or zero, rake gives a tool characteristics that fall between a negative and a positive rake. A neutral rake has less strength than a negative rake, but more than a positive rake. The chip is directed neither upward nor downward, but, in general, parallel to the workpiece surface.



The rake is the angle of inclination between the face of the cutting tool and the workpiece. The relief is the space in back of the cutting edge to prevent rubbing.

Choosing the correct relief is equally important to the success of an application. Too small a relief angle when cutting a soft, abrasive material compresses the back of the cutting edge. This causes premature tool wear. Increasing the relief angle relieves this condition. Conversely, if the material is hard and tough, a higher relief angle may cause chipping, due to insufficient support given to the back of the cutting edge. Decreasing the relief angle relieves this condition.

About the Author

Robert Chaplin has been active in the manufacturing industry for 67 years and recently published a book titled Metal Removal Technology.

Strategies, tactics and tools

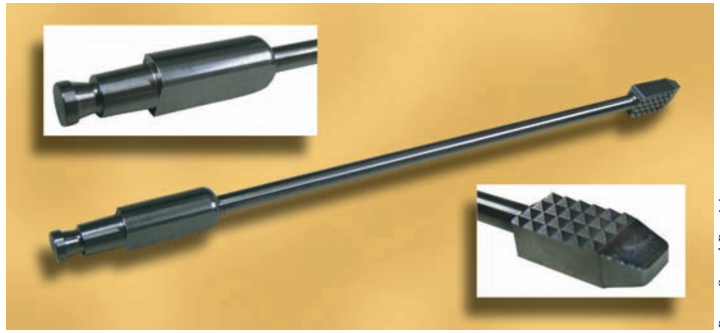
BY BILL KENNEDY, CONTRIBUTING EDITOR

Machining a part—profitably—involves more than just arranging a sequence of cutting operations. World-class parts making also requires fine-tuning shop strategies and tactics to maximize the efficient use of available tools, time and equipment.

Puget Sound Precision Inc., Poulsbo, Wash., is a machine shop that does prototype and production work for a diverse selection of customers, including waterjet equipment manufacturers, toymakers and medical equipment producers.

The shop's strategic and tactical capabilities were put to the test when it machined an order of prototype orthopedic surgical tools. The job involved making three copies each of eight sizes of five basic tools—120 parts total.

Puget Sound did much of the work on a 7-axis, 20mm-capacity Tsugami BS20C Mark III CNC Swiss-style lathe. The sliding-headstock machine is basically a CNC single-spindle screw machine that has a subspindle to grip the part as it comes out of the main spindle.



Puget Sound Precision

Although this 8¼"-long orthopedic surgical tool could have been machined complete on a Swiss-style automatic lathe with milling capabilities, two additional machines were used to reduce programming time.

One 8¼"-long surgical tool was made from ¾"-dia. 17-4 stainless steel bar stock, heat-treated to H900 (41 to 43 HRC). The stock was ground to ±0.0005" to enhance machining consistency. Kevin Lahn, Puget Sound founder and president, said, "If you're trying to hold close tolerances, your bar has to be ground or it will move around in the machine."

In the first operation on the lathe, a Kennametal CNMG 321MN, coated carbide insert faced the bar end and then turned it to a diameter of 0.2888" (-0.0000"/0.0003") for a length of 0.640". The cutting speed was 350 sfm and the feed rate was 0.0015 ipr. Lahn said cutting speeds and feeds were similar for all the operations on the Tsugami.

Tools in an automatic lathe do not move laterally along the part, as in a traditional lathe; instead, the automatic machine's sliding headstock pushes the workpiece through the spindle and past the tool. Because the bar's OD is held in a collet, "once you've turned the bar down you can't pull it back more than about ¾"," Lahn said. "You basically rough and finish ¾" at a time, taking all the stock off in one cut, and then the main spindle feeds out more material. You have to plan out what you are doing. It's a strategy-intensive kind of approach." To balance the relatively heavy DOCs required, feed rates were not more than 0.002 ipr, according to Lahn.

The next part feature, a 0.165"-wide, 0.035"-deep tapered groove in the 0.2888" diameter, was machined with a 35° DNM coated carbide insert and a S10P back-turning tool from Kennametal. The DNM insert machined the portion of the groove on the side away from the headstock, then the back-turning tool finished the groove on the headstock side.

Next, the CNMG insert turned a 0.442" diameter for a distance of about 1½". The back-turning tool then cut a ⅛" radius on the headstock side of the 0.442" diameter. Next, it plunged into a 0.234" diameter, also creating a 0.035" radius at the junction of the shoulder and the smaller shaft. At this point, the subspindle rose to grip and support the free end of the part. "Give the command to synchronize the two spindles and they move together," Lahn said. "Then we 'dropped' that CNMG in there again and turned the rest of the part."

The CNMG insert turned the 0.234" diameter for a length of 5¾", formed another 0.035" radius, and then made a 0.01"-deep skim cut over the last 0.85" of the part.

For the long cut over the small diameter, Lahn said, "we used pretty much the same surface speed as before, but because we were taking a pretty substantial DOC [0.258"], we slowed the feed down a little bit. We were able to achieve a 16 R_a finish, right out of the machine."

After a Seco-Carboloy CVD-coated LCMF cutoff insert, run at 300 sfm and 0.002 ipr, cut the part off, the machine was stopped and the part was manually released from the subspindle.

Lahn said: "We don't let the part drop. Virtually all the time we are parting off, we have a hold of it with the subspindle. We do that as a routine because then we get a nice part off." The operations on the lathe consumed 6½ minutes.

For the next series of operations, Puget Sound moved the part to the shop's Fadal 4020 vertical machining center. The part was held in a vise with soft jaws machined to grip the 0.442" and 0.740" diameters. A ½"-dia., 4-flute carbide endmill, run at 1,500 rpm and 5 ipm, cut flats on both ends of the part, and then did the same on the other side after the part was flipped 180° in the vise. After a group of three identical parts was milled, the first set of vise jaws was replaced with a set machined to grip the part's new flats. The endmill then machined two more flats on the 0.740"-dia. end of the part to make it square.

The top and bottom of the finished surgical tool's square end feature a gripper pattern comprised of tiny 45°-angle pyramids. Puget Sound cut the pyramids with ⅛"-dia., half-round, 90°-included-angle carbide engraving tools from Harvey Tool. Run at 9,000 rpm and 2 ipm, one tool was applied in a 90° crisscross pattern to rough the pyramids 0.002" short of full depth, and then an identical tool, run at the same parameters, finished the pattern at full depth. The part was flipped in the vise to machine the gripper pattern on the other side.

In the last operation on the Fadal, the ½"-dia. endmill tapered the end of the part and wrapped radii around the corners, perpendicular to the gripper pattern. It took 21 minutes to mill the part's gripper patterns and nose.

For the final operation, cutting two slanted "duckbill" flats on the top and bottom of the part's nose next to the gripper pattern, the part was moved to a Bridgeport mill.

"We cut the flats on a Bridgeport because you can tip the head," Lahn said. "With the Fadal, you'd have to cut it with the side of the endmill, but we couldn't get the endmill up next to the pyramids because there's not enough room." Using a ½"-dia., 4-flute endmill, run at 2,000 rpm and 4 ipm, it took 2 minutes to machine the slanted flats.

Lahn acknowledged that the Tsugami's milling capabilities would have made it possible to machine the part complete on that machine. However, the nature of the job—short runs of slightly different parts—made it more time-efficient, in this case, to create a "sophisticated" blank on the lathe and then complete the variations on the Fadal and Bridgeport.

Lahn said, "If we were to do the gripper ends for all the different sizes on the Tsugami, we would have had to write a different program for each size. It wasn't worth the programming time."

The single program that programmer John Beh wrote to machine the gripper pattern on the Fadal enabled changing the pattern for different-size parts by simply specifying a different Z-depth for the cutter. Lahn also felt that waiting until after the long shaft was turned to mill the flats on the part's front end enhanced part accuracy. "We felt the subspindle would hang on better and support the rest of the turning if we did not mill that material away."

For more information about Puget Sound Precision Inc., visit www.pugetsoundprecision.com or call (360) 297-3939.

AutoCAD problem solvers

BY BILL FANE

In theory, everyone who needs to access an AutoCAD drawing file owns a full, legal copy of the software. In practice, however, many users only need occasional or limited access. The designer needs a full working copy of AutoCAD to create and edit the drawings, but, often, the recipient only needs to view them and, possibly, print a copy. A classic example would be when the design department sends a drawing to the toolroom or to production. It's pretty difficult to justify the cost of a full copy for such limited use.

Moreover, if the recipient of a drawing file does have a copy of AutoCAD, it's difficult to ensure that he is working from the same version as the sender.

A number of third-party applications have been developed to solve these two problems, but now San Rafael, Calif.-based Autodesk Inc., the developer of AutoCAD, has come up with its own solutions. The good news is they are free and available for download at www.autodesk.com.

For the first situation, when someone receives an AutoCAD drawing file but does not own AutoCAD, all he needs to do is visit www.autodesk.com/dwgtrueview for the free download of DWG TrueView.

Once installed, it opens and displays any AutoCAD drawing back to version 2.0. Its interface looks remarkably like a subset of AutoCAD itself. This is no coincidence when you realize the DWG TrueView program is simply a subset cut from standard AutoCAD. For this reason, 100 percent compatibility is virtually guaranteed.

DWG TrueView supports almost all the viewing functionality of AutoCAD itself. It displays standard 2-D objects, as well as 3-D solids. It supports model space, paper space layouts, sheet sets and named drawing views. Users can pan and zoom as desired.

Three-dimensional objects can be displayed as wire frames or in any of AutoCAD's standard shading or hidden modes.

Layers can be frozen, thawed and set to plot or not plot. Named layer state sets are supported. Layer colors, line types and line weights can be changed. The result can be printed using AutoCAD's full range of options.

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Though DWG TrueView does not seem to support line weights, it does. If the original drawing was saved with "show line weights" turned on, then DWG TrueView will display them.

As indicated, the line weights assigned to individual layers can be changed. This does not change their appearance on screen, but it can have an impact on how they print, because line weights can be turned on or off when printing.

Revisions cannot be saved, but they can be published to AutoCAD's DWF format.

Like most application programs, earlier releases of AutoCAD cannot read a file produced by a later release. This is not a vicious plot to force people to upgrade, but is actually quite logical. At the time an earlier release was written, the programmers did not know what features would be in the next release. Autodesk remedied this a bit with AutoCAD 2004, which can read a file produced by 2005 or 2006.

The problem is there are a great many users still running Release 14 or AutoCAD 2000. It is true that later releases can "save as" back to earlier releases, but this does not help if you are the recipient of a drawing file and don't own the later release. This can also be a problem when you are not even trying to use AutoCAD. Many post-processor programs, such as stress analysis and CNC machining programs, can read an AutoCAD drawing file, but only from earlier releases.

Autodesk's new DWG TrueConvert program solves this problem. It is a free download at www.autodesk.com/dwgtrueconvert. (An important point to note is that AutoCAD does not need to be installed for DWG TrueConvert to work.)

This utility accesses any AutoCAD file up to the current 2004/5/6 release and translates it back to AutoCAD 2000 or Release 14. (The latter format is the same as AutoCAD LT 98.)

It can be used on a single file or in batch mode for a list of files. If you find that you are regularly converting the same set of files, you can create and save a named file list. The message in the dialog box warns that the original file will be converted and overwritten, so you might want to make a backup copy first.

Usually, no translation is perfect. As indicated, later releases contain features that did not exist in earlier releases, so one might expect them to be dumbed down into the best approximation. For example, tables did not exist in Release 14 and so they might be turned into a block consisting of lines and text. Similarly, fields might turn into Mtext or, perhaps, attributes attached to a block.

However, when this author translated an AutoCAD 2006 drawing into Release 14 format, the tables and fields displayed properly in Release 14. Moreoever, when the file was opened in AutoCAD 2006 again, the program correctly announced that it was opening a Release 14 drawing, and yet the tables and fields worked normally in AutoCAD 2006.

DWG TrueConvert also brings earlier releases forward, but this is not usually an issue because AutoCAD itself opens earlier releases. Once again, DWG TrueConvert is a subset of AutoCAD, so it should be as close to 100 percent compatible as possible.

All in all, these two utilities are quite useful, especially considering the price.

About the Author

Bill Fane is a former product engineering manager, a current instructor of mechanical design at the British Columbia Institute of Technology and an active member of the Vancouver AutoCAD Users Society. He can be e-mailed at Bill_Fane@bcit.ca.

BY DR. JEFFREY BADGER

Demystifying 'ceramic' grits


Archives MNATP, Collection Meillassoux

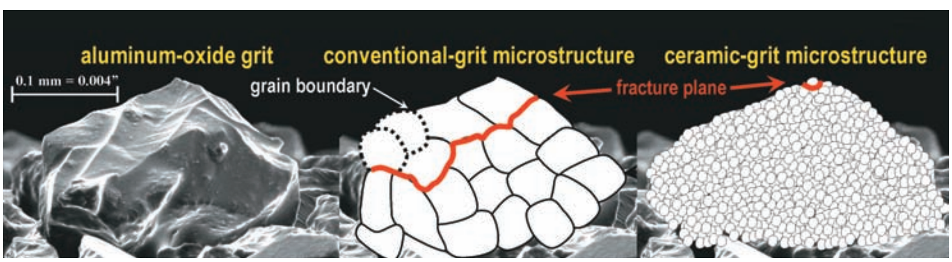
Dear Doc,

I hear ceramic grits referred to by different names. Can you explain why this is and when I should use them for fluting and threading?

The Doc replies:

"Ceramic" grits are aluminum-oxide grits that have a microstructure much smaller than conventional Al_2O_3 grits. They go by many names: SG, sol-gel, seeded-gel, sintered abrasive, ceramic abrasive, microfracturing grit and Cubitron.

Shifty salesmen will tell you a ceramic grit is a hybrid between Al_2O_3 and CBN. It's not. It's just regular Al_2O_3, with almost the same hardness but with a smaller microstructure. When a ceramic grit fractures along grain boundaries, it fractures in small pieces instead of large chunks.



J. Badger

A ceramic grit fractures into smaller pieces than a conventional Al_2O_3 grit.

Two companies produce ceramic grits: Saint-Gobain and 3M. Saint-Gobain produces the grits and then uses them in its own grinding wheels. 3M sells its products to companies that put them in their wheels. Saint-Gobain's trade name is SG and 3M's is Cubitron.

Although both SG and Cubitron fracture into small pieces, they are not produced in the same way, nor do they behave exactly the same during grinding. There is some debate about which one is better.

In addition to SG, Saint-Gobain produces TG, which is simply an elongated form of SG. Instead of having an aspect ratio of 1:1, as is the case with most abrasives, TG has an aspect ratio of 4:1 or more.

Ceramic-grit wheels are typically a mixture of 10 to 30 percent ceramic grit and 70 to 90 percent conventional Al_2O_3. It's often hard to tell by looking at the wheel whether or not it contains ceramic grit.

Based on my experience, I rate ceramic grits' effectiveness for fluting and threading as follows:

- small-diameter fluting (less than ¼"): it depends;
- medium-diameter fluting (¼" to ½"): yes;
- large-diameter fluting (greater than ½"): absolutely;
- single-rib threading with a resin wheel: yes; and
- multirib threading with a vitrified wheel: probably not.

In addition, the more difficult the material is to grind, the more benefit you'll see from ceramic grit. So, with low-alloy materials, you'll see some benefit, and with high-alloy materials, you'll see a great deal of benefit.

The price of a ceramic-grit wheel is anywhere from 25 to 700 percent higher than a conventional Al_2O_3 wheel. Most companies I know of that have tried ceramic-grit wheels tend to stick with them.

However, these wheels can be tricky to use properly. Take time to learn as much about them as you can.

Dear Doc,

I get more wheel wear when the wheel diameter becomes smaller. Why is this, and is there an easy way to figure out how much more I need to dress?

The Doc replies:

At a smaller diameter, you have several things working against you. First, if your grinding machine is running at a constant rpm, a smaller diameter means lower wheel surface speed. That means more wheel wear. Second, a smaller diameter means a shorter arc of cut, where

$$\text{arc length} = \sqrt{(\text{wheel diameter} \times \text{DOC})}.$$

This translates into more wheel wear. Third, you have a smaller wheel circumference, where

$$\text{wheel circumference} = \pi \times \text{wheel diameter}.$$

Consequently, you have less abrasive grit to do the work.

Here's a rough-and-ready way to figure out how much more you need to dress the wheel to compensate: Divide the initial wheel diameter by the final wheel diameter and then square it. That's the factor you'll use to determine how much to dress.

So, if the wheel diameter goes from 16" to 12" and you're dressing 0.002" at full diameter, then the factor is 1.78—$(16/12)^2$—and you'll need to dress about 0.0036" at the 12" diameter (1.78×0.002"). If your machine is running at a constant wheel velocity, as opposed to constant rpm, then this factor will be a little less. △

About the Author

Dr. Jeffrey Badger is an independent grinding consultant. His Web site is www.TheGrindingDoc.com. You can e-mail him at badgerjeffrey@hotmail.com. Send questions for The Grinding Doc to ctemag1@netzero.net.