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BY MIKE PRINCIPATO

Continue to be fruitful and multiply

Tuesday is deli day for me. So today, as usual, I drive to the deli during my lunch break and visit a bit with Gary the Deli Man, who makes me my usual roast turkey and Swiss cheese sandwich on a kaiser roll. While he slices, dices and lovingly wraps my order to go, I—also as usual—ruminate about the utter simplicity of Gary's life behind the cooler case. No daily shop floor schedule. No expensive capital equipment. No relentless demands from customers for lower prices. No late receivables. No global economic threat. It's just Gary the Deli Man and his nonCNC meat slicer, happily producing $4 sandwiches to die for.

For a short time afterward, I envy Gary and his apparently stress-free enterprise and wonder if the simpler life isn't for me, too—but only for a short time. That's because I believe there's a certain nobility to a manufacturing career. Maybe I even hold a kind of lunch-pail snobbery about it because a shop owner's work requires more personal and professional resources and skills than those demanded of many retailers or other service providers. Simply put, a manufacturing business is in almost every way a very challenging kind of enterprise, requiring both significant financial and intellectual capital.

No other sector can match the powerful, national economic force of a strong manufacturing base, thanks to what economists call the 'multiplier effect.'

The Chosen Path

I suppose lots of shop owners could make a living doing something simpler and even make more money doing it. Most, however, probably chose their career path because it makes them feel good about themselves.

Their choice matters for another important reason, one that likely appeals to their sense of nationalism—perhaps even patriotism: When it comes to economic prosperity, no other business sector drives a country's economy more than manufacturing. No other sector can match the powerful, national economic force of a strong manufacturing base, thanks to what economists call the "multiplier effect."

A manufacturer—even a small job shop—stimulates revenue and growth in other industries. U.S. manufacturing supports one in six jobs in this country. The stainless steel your lathes turn today started life as ore unearthed by equipment likely owned by an U.S. mining company and produced or serviced by Americans. You'll probably ship finished parts to customers on U.S.-made trucks, likely to a company that integrates those parts into a larger assembly or finished product. From front to back, manufacturing literally multiplies its economic effect far beyond the sale of one company's products.

Raising the Standard

Manufacturing also raises living standards. One way or another, market demands have forced manufacturers to increase productivity over the years. By meeting those demands, your company has prospered and your employees have been rewarded with higher wages and better benefits. Manufacturing jobs, on the whole, pay more than other major sectors, and that's a rightful and natural reward for success in a competitive, capitalist society.

Productivity in manufacturing has increased at a higher annual rate than in any other sector in this great country. Yes, I know it's hard to believe, but your shop is even more productive than Congress.

All we have to do now is make them understand that. But that's for next month's column.

About the Author

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Tools for engraving

BY LAROUX K. GILLESPIE

Machinists use engraving tools for parts marking, decoration and other applications. Typical engraving applications use rotary half-round engraving tools, but machinists also use lasers, EDMs, photochemical machining, ultrasound, spark-assisted chemical machining, ion beams, electron beams, small endmills and rotary burs.

Engraving cutters have a single cutting edge and are made of HSS or micrograin carbide. Some toolmakers coat their engraving tools with TiAlN or diamond.

For top-loading engraving machines, long-shank cutters drop into the chuck. A threaded knob is applied to lock in place the ⅛", 11/64", ¼", 4mm and 6mm shanks. Cutters for collet applications come in diameters from 1/16" through 1" and 2mm through 10mm.

A roughing cutter is generally flat on one side and its point sharpened to penetrate the workpiece similar to the action of a drill when it is down feeding to start a cut. The roughing cutter is ground with a tip angle, or slope, from 3° to 5° and an end clearance of about 10°.

A conical cutter is applied for finer work. It is generally ground to a cutting angle of 45° and is flat on one side. The cutting angle is half the point angle. Cutters for fine work have needle-like end tapers and square cross sections. They are only for operating against the side of an engraved surface and cannot be fed down into the workpiece.

Conical cutters produce a V-shaped wall with a flat bottom. This is in contrast to parallel cutters, which produce a cut with vertically straight walls.

A pointed cutter has to be carefully sharpened to ensure that the point of the cutter is true and the entire cutting edge has proper clearance. When grinding small pointed cutters, the cutting end must be true with the axis; they are generally ground with an indexing fixture and finished with an oilstone.

Table 2: Recommended spindle speeds for carbide slot milling.

Workpiece material	Cutter diameter		
	0.030"	0.060"	0.125"
Plastics	25,000	12,500	6,000
Aluminum	45,800	22,900	11,000
Brass	31,700	15,800	7,600
Steel	14,000	7,000	3,360
440 stainless steel	5,730	2,860	1,375

Based on *Machining Data Handbook* recommendations for soft materials.

Some engraving machines may not be capable of achieving the maximum speeds shown.

The clearance angle on an engraving tool provides chip clearance and determines the strength of the cutting edge. Clearance angles are selected based on workpiece material properties and, for engraving, are generally defined for groups of materials. Antares Inc., Horsham, Pa., a manufacturer of engraving tools, designates basic designs as ACR for acrylics; FLX for flexible soft plastics; PHN for phenolic, Formica, fiberglass and related rigid plastics; BAL for brass, aluminum or soft metals; and SSS for steel, stainless steel and harder metals.

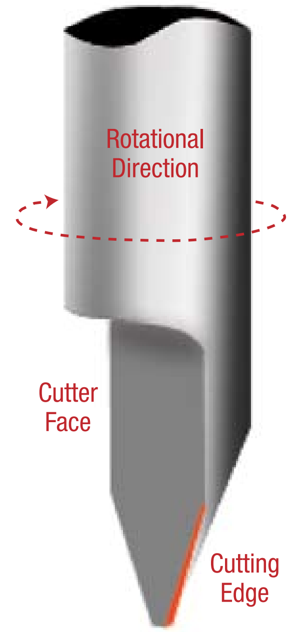
The high clearance angle required for flexible plastics results in a thin cutting edge, which can quickly become dull. Cutters designed for steels will not leave a clean edge in soft materials. Small cutting angles, such as 20°, can be used for soft materials, while hard metals demand a more robust tool with 40° cutting angles.

The engraving tool tip, despite its narrow surface, is a cutting edge because the tools are end cutting as well as side cutting. Cutting conditions are controlled by the tool tip diameter, which can be as small as 0.015". The cutting edge may be as large as ¼" in diameter on the same tool.

Feeds and speeds are based on tip diameter because it is the weakest portion of the tool and, as the smallest part, also imparts the roughest surface finish.

The tip is always making an interrupted cut. In harder materials, the shock created by this impact can destroy the edge if the tool is fed too fast. Engraving at too high of a feed rate also tears the material and leaves rough edges covered with burrs. Two or more passes of the cutter are recommended on hard materials to produce a smooth cut and remove the burrs produced on the first cut. The aesthetics of cleanly cut edges are important for engraving. Some tips are designated as "tipped off," which means that a 0.005" tip is offset 0.005" so the cutter actually produces a 0.010"-wide flat.

Engraving tool manufacturer Gravograph-New Hermes, Duluth, Ga., recommends engraving 300 and 400 series stainless steel with quarter-round cutters having tip sizes of 0.020" to 0.040" and cutting angles of 40° to 45° rather than traditional half-round cutters. A coolant or light oil minimizes heat buildup.



A typical engraving tool has a flat on one side and a cutting edge for marking or decorating parts.

Run wider cutters at slower spindle speeds. For example, depending on the workpiece, a 0.020" tip should engrave at 20,000 to 30,000 rpm, a 0.030" tip should engrave at 12,000 to 20,000 rpm, and a 0.040" tip should engrave at 8,000 to 12,000 rpm with a slow down feed.

Tip size is normally based on engraved character size. For a character 0.0625" high, a 0.015" cutter tip is used. A 0.005" tip is the smallest standard tip.

Table 1: Recommended tip sizes for producing specific character heights.

Character height	1/16"	⅛"	¼"	5/16"	½"	¾"	1"	2"
Cutter tip width	0.015"	0.020"	0.030"	0.040"	0.060"	0.090"	0.125"	0.250"

About the Author

LaRoux K. Gillespie is a retired manufacturing engineer and quality-assurance manager with a 40-year history of manufacturing and deburring. He is the author of 11 books on deburring and 200 technical reports and articles on precision machining. He can be e-mailed at laroux1@myvine.com.

You've got to know how to hold them

BY BILL KENNEDY,
CONTRIBUTING EDITOR

Shops usually focus on cycle times when seeking to control costs. However, the expense of devising and producing fixtures to hold parts during machining can often determine the true profitability of a job. That's especially true in the case of prototype work, where fixturing costs can't be amortized over long production runs.

R.E.F. Precision Products LLC, Deer Park, N.Y., performs prototype and precision machining for customers such as government agencies and makers of high-performance automotive components and medical rehabilitation equipment.

The shop employed cost-effective fixturing techniques when it was commissioned to machine just two copies of a 4⅞"×4⅛"×1⅝" aluminum bearing support used in a missile guidance system. While the part appeared simple, requirements included flatness within 0.001" and maintaining alignment of two bearing bores within 0.0005".

R.E.F Managing Partner Rob Fleece programmed the part in Mastercam, following a customer-provided blueprint. He began the job by clamping a 4¼"×5"×1¾" 7075 aircraft aluminum workpiece in a vise on a Bridgeport VMC 760 with a DX32 CNC. He roughed out the interior to 0.020" oversize with a Garr ½"-dia., 3-flute, square-edge endmill run at 7,000 rpm and a 65-ipm feed. A 1"-dia., 2-flute HSS endmill with custom-ground ¼" radii roughed the center of the part. Next, three 0.330"-dia. mounting holes were drilled with an OSG XL Gold TiN-coated, 2-flute drill run at 5,000 rpm and 70 ipm. Fleece said, "You have to rough everything out first and more or less let the stress out of the material. After taking the part out of the vise, it bowed about 0.004"." Roughing the part's outer shape and center and drilling the holes took about 15 minutes.

Fleece then flipped the part over and clamped it in a set of soft aluminum jaws custom-machined to match the shape of the part. "That way, I was holding onto a lot of surface area," he said. "Usually, I stock standard size soft jaws, but I had to use a larger size." Machining the jaws consumed about an hour. Held in the jaws, the back of the part was roughed flat but 0.020" oversize with the 3-flute endmill in about 3 minutes.

R.E.F. Precision

R.E.F. Precision devised a number of cost-effective fixturing methods to machine this prototype missile-guidance component.

Next, using a CAM program that mirrored the one used to rough the center of the part, Fleece machined a fixture block that exactly matched the roughed features. He held the part to the block, flat back side up, with double-faced tape. "Normally I would have used a vacuum plate to hold it down, but it would have taken me about 4 hours to make the fixture for the plate, where with double-faced tape it didn't take any time at all," he said.

To machine the back to the required 0.001" flatness, Fleece applied a Carboloy 3"-dia. mill run at about 5,000 rpm and 80 ipm. He said those parameters were "very moderate because I didn't want to take a chance of the tape letting the part free." He added that he took two passes—the first one light—so the part wouldn't move. The operation took 2 minutes.

Fleece allowed the milling to leave the part 0.005" thicker than the ¼" final requirement because "I wanted to make sure the inside was parallel to the back surface. I didn't have to do that—there was tolerance on the print—but I just wanted to make a perfect part."

Accordingly, Fleece put the part back in the machined soft jaws and finished the center section using a 1"-dia., 3-flute HSS endmill featuring a ¼" radius. "We brought the part to its final ¼" thickness and were able to hold the flatness callout of 0.001"," he said.

To machine the critical bore dimensions, Fleece produced another special fixture. The simple 2"×6"×8¼" aluminum block was designed to hold two parts. Cam-action Mitee-Bite fixture clamps pushed the parts against a ½"-wide ridge that ran down the center of the fixture face. A 2½"×5"×⅜" bar of aluminum, backed with a ⅛"-thick piece of rubber to dampen vibrations, screwed to the fixture to provide additional clamping force across the front of the parts.

Machining the fixture consumed 30 minutes, as did precisely aligning it in a vise in the machining center. "We indicated that fixture into a Kurt vise, so it was perfectly square in X and Y. That was important because I wasn't going to be able to hold 0.0005" if it wasn't perfectly square," Fleece said.

Applying the ½"-dia., 3-flute endmill, Fleece used a pecking cycle to drill through the part. Then, with the same tool, he circular-interpolated the bore to within 0.010" of a final 0.975" diameter. He next roughed 0.3125" of the bore to 1.26"-dia., again leaving 0.010" excess stock. With a Pinzbohr boring head featuring a Carboloy CCMT insert with a 0.007" nose radius, Fleece finish machined the bore to 1.25", +0.0000"/-0.0005", preparing it for a press-fit bearing. The boring head ran at 900 rpm and 1 ipm. At the bottom of the bore, he turned off the spindle and lifted the head out so it wouldn't back cut the bore surface.

Holding two parts in the same fixture permitted two bores to be machined in one clamping. On the Bridgeport control, Fleece programmed a G97 shift and drilled and fine-bored the second bore. "Then the only thing I have to do is take the parts and flip them over," he said. "That's why it was so important to get the fixture parallel and square to the table. As long as I have my location right, it will constantly repeat." Drilling, interpolating and fine boring each hole consumed 2 minutes.

The part had a wing-like triangular extension that tapered in thickness from ¼" to 0.156". For the last ⅝" of the feature, thickness stepped down to a constant 0.125" around the mounting hole. To hold the part for the taper cut, Fleece machined a 1½"×5½"×4½" aluminum fixture, including three holes situated identically to the holes drilled in the first operation.

In the hole on the end of the extension, he used a sleeve that expanded when a screw ran down into it, setting the screw head deep enough to avoid being hit when the taper was milled. In the other two holes, ¼-20 screws located and held the part. Fleece clamped the fixture in the vise at an angle of 3°, set with a protractor, and milled the taper with a Sandvik Coromant 2"-dia. facemill.

Deburring and blending was accomplished with a medium Scotchbrite pad. After the parts received a chromate Iridite coating, the bores were masked and the parts painted.

Fleece said total time invested in making the parts, including machining and fixture fabrication, was about 2½ days. "There was more fixturing time in this job than actual machining," he said. And he didn't machine just two parts. "I needed two; I made six," he said, "The tolerances were so tight I wanted to practice!"

For more information about R.E.F. Precision Products LLC, call (631) 242-4471 or visit www.refprecisionproducts.com.

Adobe Acrobat 3D simplifies design file sharing

BY BILL FANE

There has been much talk over the years about "interoperability" and compatible file formats, especially for CAD.

In the rest of the world, however, Adobe Systems Inc.'s PDF (Portable Document Format) files are pretty much the "universal" file format. However, PDF is not the native file format for any particular brand or type of software, but simply a file format in its own right. Adobe Acrobat can translate most word processor, spreadsheet, database and many other files into a PDF.

The true strength of the format comes from the fact that it does not vary between operating systems. You can post a PDF document for downloading from a Web page or e-mail a PDF file to people without knowing or caring what operating system they are using. All they need is the appropriate free Adobe Reader software, available at www.adobe.com. The document will look and print the same on any platform.

The bad news was that the first six versions of Acrobat 3D did not do a good job of handling most CAD files. The good news is that beginning with Acrobat 3D Version 7, 3-D PDF files can be generated from more than 60 different 3-D file formats. I never even suspected that so many 3-D file formats existed.

By way of clarification, there have not been six prior versions of Acrobat 3D. The "3D" designation was added to standard Acrobat when 3-D support was introduced with Version 7.

The introduction of Adobe Acrobat 3D Version 8 changes the game completely. The software has moved into the world of more general file format translations, and the translation of 3-D CAD files in particular. Version 8 now includes the export-to-3-D capability.

In a typical scenario, a designer creates a 3-D design model using any one of the long list of supported applications. A 3-D PDF file is then created and sent to a vendor, who opens it in Acrobat 3D. Using the current free viewer, the recipient is able to pan, zoom, rotate and otherwise manipulate the 3-D model. The recipient can also suppress display of individual parts, study exploded views and run animations.

If the recipient has purchased the full Version 8 program, he is able to export the solid model in one of three different neutral file formats for use in a postprocessor, such as CAM, finite-element analysis software or another brand of CAD software. Owning a copy of the original CAD application is not needed. Parametric information will be lost in the transfer, but this is not usually a problem in most shop situations.

Beginning with Acrobat 3D Version 7, 3-D PDF files can be generated from more than 60 different 3-D file formats.

Let's take a moment and define "neutral." There are two ways of translating files from one format to another. The first way is to go directly from one format to another. A human-language analogy would be the translation of French into English. Direct translation, however, requires a myriad web of translators to go from French to Italian, German to Russian, English to Italian and so on.

In the second scenario, any translation would go from the original language to a neutral one, such as Esperanto. Anyone needing the information only requires a single translator, from Esperanto into their language. This greatly simplifies the process, but it can cause minor glitches to creep in because different languages do not always have exact equivalents in the other language.

Now let's look at Version 8's 3-D export capabilities. Files can be saved in IGES, STEP or Parasolids formats. The first two are open, neutral formats in that they were specifically created by industry committees for the sole purpose of transferring CAD data from one program to another. They are standardized and well-documented.

Parasolids is a "semineutral" format in that it is a proprietary format that is used or supported by a number of CAD packages, including SolidWorks.

As mentioned earlier, imperfections can creep into translations. A story goes that at the height of the Cold War, the CIA wrote a computer program to translate from English to Russian. As a test, they entered "The spirit is willing, but the flesh is weak." What came back was "The booze is OK, but the meat's gone bad."

As you can imagine, Adobe is taking quite a leap in covering so many file formats. This is compounded by the fact that the software is effectively passing it through another level of translation, from CAD file to PDF to the export format and then into the receiving CAD or postprocessor program.

In addition, there is the possibility that problems may arise from the capabilities of the file formats rather than from anything wrong with Version 8 itself. You may get two files from the same source wherein one works but the other has problems, depending on the particular features used in the file. For example, I once had to translate AutoCAD files into Computervision. The problem was that AutoCAD allows nested blocks (a block can contain other blocks as components) but Computervision did not. The translator simply ignored the nesting without warning.

I have not had a chance to try all the possible input and output combinations in Version 8, but I suggest testing typical parts that match your situation. Given Adobe's historical success in obtaining accurate translations of other types of files into PDF, I would not expect many problems.

Acrobat Version 8 also adds a capability that goes beyond simple translation of a document into a PDF file. It is now able to create a PDF document that combines excerpts from Word or Excel documents, multimedia, audio and video files along with portions of 3-D CAD files.

This means that manufacturing and production departments can receive a single PDF file that completely documents a design. This can include 3-D part and assembly models, specifications, procedures and assembly sequence animations. In addition, they can extract the 3-D model to a G-code generator program.

All in all, Adobe has taken a giant leap from translating relatively simple text and image files into a single format to importing and exporting 3-D CAD models.

About the Author

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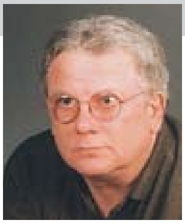
BY MICHAEL DEREN



Don't let the big one get away

Many small companies spend a lot of time and energy looking for that elusive "big" customer that will take them to the next financial plateau. With such a "meal ticket" customer, a shop won't have to look for another customer for quite some time. You shouldn't let this kind of opportunity slip away, but be prepared for the potential impact that landing the account can have on your operation.

Once that meal ticket customer is found, quite a bit of effort is made wooing the company. This includes wining and dining, plant tours and meetings with key personnel. Finally, if all goes well, a trial order arrives. Not large, but a first order nonetheless. Naturally, the customer wants to make sure your shop can deliver what it promised.

You go the extra mile to make sure the order is manufactured correctly, while making do with current equipment and manpower. Hopefully, you at least break even on the order. In the end, the customer is pleased with your performance and the final product.

As a result, the big order eventually comes in, which will fill the shop with work for months. Of course, nearly everyone panics because this is "the" order they've been waiting for.

At this point, ask yourself the following questions:

"Do I have the equipment necessary to handle the new work?"

Hopefully, during initial discussions with the customer, you correctly evaluated the equipment needs for this project. If you don't have the equipment, can you get it within a reasonable amount of time? Don't forget to allow time for equipment installation and operator training. Perhaps you can modify existing equipment to be more productive. Something that could make all the difference in the world might be adding a pallet changer to a machining center, such as a two-pallet unit, so while one pallet full of parts is in the machine being milled, the other is being loaded.

Another productivity-enhancing option, if the part is light enough, is an inexpensive robot for loading/unloading parts into and out of a turning center. A robot might even have the reach to handle a couple of turning centers facing each other.

"Do I have the personnel needed to handle this influx of work?"

If not, start advertising immediately. Assuming you won't be able to get all the help you need because of the lack of skilled machinists, fill the manpower gap by explaining to current workers the potential opportunity to earn overtime pay for an extended period.

There may also be the possibility of hiring unskilled labor and training them to be "button pushers" for some of the less technically demanding work. Your skilled machinists could be setup people for a while, giving less skilled employees the opportunity to learn on the job. Perhaps giving straight-time pay for additional hours worked by salaried staff would motivate them to put in the additional hours required to ensure success with your new customer.

If you don't make the right decisions and aren't proactive in ramping up for a large account, the customer will simply be a footnote in your company's history.

Also, don't forget your existing customer base. All too often, when companies land big accounts, they forget the little guys—the foundation of many businesses. Some large customers might not provide substantial work for months on end, so it's the existing customer base that allows you to weather those cycles. You may also have opportunities to get additional work from smaller customers by having more efficient equipment and additional personnel courtesy of a large customer.

By making some initial hard decisions, you can smoothly integrate a large new customer into your operations. You'll have a dedicated customer who knows you will do what is required to produce quality parts—on time. However, if you don't make the right decisions and aren't proactive in ramping up for a large account, the customer will simply be a footnote in your company's history. △

About the Author

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