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BY MIKE PRINCIPATO

CTE meets reality TV

Believe it or not, reality television may have helped reinvigorate our country's flagging interest in manufacturing.

The same odious television producers who brought you *The Bachelor*, *The Apprentice*, *Survivor* and dozens of similar shows may have actually done us all a favor. Like the proverbial pony found under the pile of manure, the ever-growing, steaming pile of truly atrocious reality shows has made *American Chopper* possible.

Accountants- and ex-cons-in-training have *The Apprentice: Martha Stewart*. Contractors-to-be have Ty Pennington and *Extreme Makeover: Home Edition*. Future divorcees have *Newlyweds: Nick and Jessica*.

We metalcutting types have *American Chopper*'s main characters, the Teutuls—Paul Sr. and Paul Jr. They're a couple of average joes (no relation to that excremental reality show), a father and son team who somehow manage to design and build jaw-dropping, six-figure custom choppers in between petty squabbles painfully familiar to any of us who own or work in a family machine shop.

***American Chopper* has done more to inspire and educate kids and their parents about the potential rewards of a career in manufacturing than 1,000 high-school guidance counselors.**

The Teutals aren't as pretty as *America's Next Top Model*, but they know their way around a machine shop, and that's more interesting to me. More importantly, it's interesting to a whole lot of viewers who likely wouldn't otherwise know a Bridgeport from a carport. *American Chopper* is, according to TV.com, one of the most popular reality shows on cable.

It's certainly one of the most popular shows in my house. My teenage son and daughter often watch the show with me and know the major players by name. Although I'm not especially thrilled to hear that my daughter thinks Paul Jr. is "hot" (we haven't yet broken the news to her about her early enrollment at the convent), I'm ecstatic that my son thinks the shop's CNC waterjet machine is "cool."

Look, I think most of what's on television is dreck, and for the last 20 or more years, I can't think of a single show that made manufacturing, much less the people who make things, look cool. *American Chopper* has done more to inspire and educate kids and their parents about the potential rewards of a career in manufacturing than 1,000 high-school guidance counselors. Every time Paul Jr. and the gang at Orange County Chopper bring a chopper design from concept to finished product using their creativity, talent, experience and machine tool technology, they score another run for all of us by making the manufacturing process look like exactly what it is: way cool.

This is why I'm so excited to announce CUTTING TOOL ENGINEERING's new "Made In America" series of feature articles. I've managed to convince the publisher of this august journal that you, dear reader, would be interested in reading about companies around the U.S. that manufacture other similarly fascinating products—products that are kicking butt around the world. These articles won't be written from a technical standpoint—CTE's already got the feeds-and-speeds angle well covered—but rather from the perspective of a manager experienced in the machining industry world you occupy.

I admit it: I'm a manufacturing junkie with a childlike—my wife says "childish"—fascination with how complex products get made. So, starting next month, I'll be focusing on the manufacturing processes, technologies, people and business philosophies that are unique to some of America's best, and best-known, products.

Of course, that doesn't mean this column is going away. I'll reserve this monthly space for the kind of practical "Manager's Desk" topics you've come to expect. But, in the meantime, if you think your company's signature product might qualify for one of my "Made In America" profiles, e-mail me. If your business makes a product that's the best of the best, there's no better way to inspire future generations of craftsmen, engineers and manufacturing executives than to show 'em how you do it.

About the Author

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

Creep-feed grinding

The initial rationale for developing creep-feed grinders was to machine difficult-to-machine materials, such as cobalt and nickel-based superalloys. They are abrasion-resistant, heat-resistant, creep-resistant and crack-sensitive. When machined conventionally, they cause substantial tool wear. Grinding these materials is comparatively easy.

By applying a grinding wheel as one would use a milling cutter, even the most difficult superalloy can be machined more economically and in equal, or less, time than by either milling or broaching. Additionally, CF grinding yields a precise and repeatable form with virtually no burrs.

Most of the wheels used for CF grinding are made from aluminum oxide or silicon carbide. However, CBN wheels—both plated- and vitrified-bond styles—are growing in popularity. Diamond wheels are used to CF-grind ceramics.

Compared to conventional reciprocating grinding, vibration is less of a problem in CF grinding. The reason is because the area of contact between the wheel and workpiece is greater in CF grinding, which dampens vibration. The greater area of contact means a larger DOC and larger arc length of contact for CF grinding compared to conventional reciprocating grinding. A 1" DOC is not uncommon when CF grinding tool steel materials.

The wheel speed when CF grinding needs to be variable to keep the wheel surface speed constant. The feed rate needs to be precisely controlled as well. If the feed is too slow, the wheel tends to rub more than it cuts, generating a high degree of frictional heat. Depending on the type of material being machined and the part configuration, the feed rate when CF grinding is as low as 75mm/min. or as high as 1.5m/min.

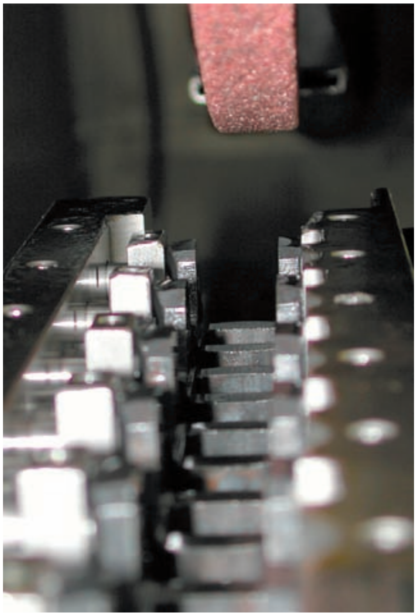
A high volume of cutting fluid is applied when CF grinding. Typically, a cutting fluid system's pressure is up to 150 psi and flow rate is 80 to 160 gpm. An exception to this is when applying a plated CBN wheel, which has no porosity. There is a very small gap between the wheel and the workpiece, so less fluid may be used.

The porosity in a CF grinding wheel provides a fairly open wheel structure, which enables clearance for the long chip produced. More importantly, the large pores take more cutting fluid into the arc of cut to assist in the dissipation of the grinding energy. The structure of these wheels is such that, by volume, approximately 30 to 40 percent is abrasive grain, 5 to 10 percent is bond material and 50 to 60 percent is air-induced as porosity.

CF grinding initially appealed to those in the aerospace industry, which, during the 1960s, saw an increased use of difficult-to-machine materials. Jet engine turbine blades, for example, were once produced with formed milling cutters. The process would result in significant tool wear, compromising the cutter's ability to meet close tolerances. CF grinding provided a way of producing the blades more economically while reliably meeting specified tolerances. The latter is critical, because failure of a part can have catastrophic consequences.

Since then, CF grinding has seen further application, displacing milling and broaching processes as other industries seek to make tight-tolerance parts from materials ranging from the mundane to the exotic.

It is generally accepted that CF grinding was first developed in Germany in 1958 by Gerhard Lang, who was working with his father, Edmund, at Edmund Lang Babenhausen, their family-owned machining company that



Abrasive Form

U-joints were produced three times faster when the CF grinding process was used.

evolved into the present-day grinding machine builder ELB-Schliff Werkzeugmaschiner GmbH. The two were experimenting with electrolytic grinding when they accidentally made a deep pass with the grinding wheel without the electrical current on, resulting in an abnormally large DOC.

This revelation led Gerhard Lang to propose CF grinding, in which the wheel makes a single pass on a workpiece at a heavy DOC at a relatively slow feed rate.

ELB then introduced the first creep-feed grinding machine. Hauni-Blohm, now a division of the Schleifring Group, followed suit in 1962, with the introduction of its HFS 6 machine.

Special thanks to Dr. Stuart C. Salmon, author of the book Modern Grinding Process Technology *and president of Advanced Manufacturing Science and Technology, an independent consulting firm based in Rossford, Ohio. He can be reached at (419) 662-9551; e-mail: drsalmon@buckeye-express.com.*

Help for novices

BY JAMES A. HARVEY

What is the best way to learn something? For my money, it's hard to beat the "just do it" method, which may land you in hot water once in a while. So be it.

The following are some basic shop practices for newcomers. The information is also about avoiding blunders. Not all mistakes in a machine shop are of the dimensional type. Blowing chips on the guy next to you is an example of a nondimensional mistake. By learning some of these basics, newcomers will be in a better position to work independently and with other shop personnel.

■ **Avoid using the support table of a disc sander to deburr thin plates.** I've worked with two people who severely ground down their thumbs trying to deburr the edges of a thin plate in a disc sander. As they were sanding an edge, the plate got sucked into the small opening between the table and the disc, which pulled the plate and their thumbs into the disc.

If you are going to deburr a plate with a disc sander, make sure you hold the plate above the support table.

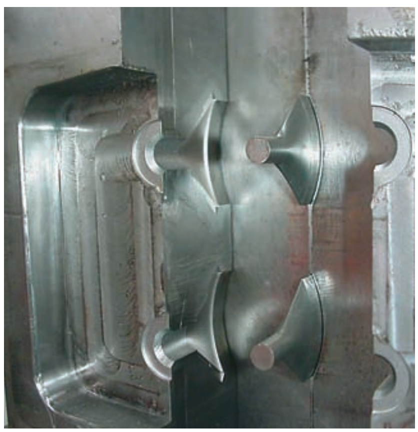
■ **Understand nominal sizes.** Nominal sizes are convenient labels used to discuss part sizes that, in reality, nobody will ever hit. However slight, there is always some tolerance or error in every machined part.

People sometimes say, "Just shoot for the nominal." That means if the nominal size you're working to is ½", then you need to do your best, within reason, to machine the part to ½", taking into account the type of machining process being used. You wouldn't be expected to hold ½" nominal size as closely with a milling machine as you would with a surface grinder.

All images: J. Harvey

Deburring the edges of thin plates can be dangerous if the support table of a disc sander is used, because the plate can get sucked into the small opening between the table and the disc. This pulls the plate and the machinist's thumbs into the rotating disc.

■ **Know the difference between 'absolute' and 'incremental.'** Absolute dimensions refer to distances from a single origin to a point or feature. Incremental dimensions refer to distances from one feature or point to another. Most digital readouts can be switched back and forth. One example where switching can be useful is if the centers of a series of bolt-circle patterns are dimensioned from one corner of a plate. The centers of the patterns can be dialed off in "absolute" and then, by switching to "incremental," the holes can be dialed off incrementally.



This mold's core is an example of a lofted surface.

■ **Understand what lofted surfaces are.** Lofted surfaces are surfaces created by sweeping or blending different profiles from different planes. For example, a lofted surface can be created by blending a square in one plane with a circle in another parallel plane.

■ **When making molded parts, be careful about what edges you file.** I prefer leaving all edges sharp when making mold parts until I can carefully examine and detail them on a bench. Most machinists are so accustomed to filing edges that they do so automatically. However, when making mold parts, filed edges can spell disaster—especially on core and cavity details.

Parting lines, shutoffs and other corners and edges on mold parts may have to be perfectly sharp to prevent flash and maintain part integrity.

About the Author

James A. Harvey is a machinist and plastic-injection-mold maker based in Garden Grove, Calif. He can be e-mailed at HarvDog42@aol.com. Machining Tips is adapted from information in his book, Machine Shop Trade Secrets: A Guide to Manufacturing Machine Shop Practices, *which is published by Industrial Press Inc., New York. The publisher can be reached by calling (212) 889-6330 or visiting www.industrialpress.com.*

Joint venture

BY BILL KENNEDY, CONTRIBUTING EDITOR

CADCAM Systems Inc. has been selling, supporting and training customers in the application of CAD/CAM software for 20 years. About 10 years ago, the company purchased a CNC mill. Since then, the shop's capabilities have expanded to include three 5-axis machines.

Recently, the machining of an aerospace part included a mutually beneficial collaboration between CADCAM Systems and one of its key tooling suppliers. The part was an isolator mount made of 17-4 PH stainless steel with a hardness of 44 HRC. Cut from 3.495"-dia. bar stock, the part's main feature was an approximately 3"-dia., ⅞"-thick ring with a 1½"-dia. central hole. Perpendicular to one edge of the ring was a ¼"-thick flange with four bolt holes. A ¾"-dia., ¾"-long boss protruded from the bottom of the flange.

Rockford, Ill.-based CADCAM Systems is located near the production and marketing campus of Ingersoll Cutting Tools. During a meeting with Jim Epperson, CADCAM Systems president, Don Yordy, Ingersoll's technology center manager, noted a crate of isolator-mount workpieces. Yordy pointed out that the hardened, high-strength material would provide a way of thoroughly evaluating the prototype of an extended-flute endmill called S-MAX that Ingersoll had developed, and Epperson agreed to source the roughing of the part's main feature to the technology center at Ingersoll.

Epperson provided Yordy with bar stock cut off to a length of 4". Using the technology center's Mori Seiki MV-65 vertical machining center, the stock was clamped in a vise with soft jaws modified to grip the bar diameter. The 4.00"-dia. S-MAX cutter body, tooled with Ingersoll's IN2005 inserts, milled flats 3" long on opposite sides of the bar end. The cutter ran in a climb-cutting mode at a cutting speed of 400 sfm and a 5.2-ipm feed rate. Two 0.63"-WOC passes per side produced a flat-sided section 0.975" thick in 6 minutes.

Yordy noted that the limiting factor to increasing any of the machining parameters was the part configuration, which dictated less than 1" of contact between the soft jaws and part.

Ingersoll also rough-drilled a hole through the machined flat section with a 1.25"-dia., indexable-insert Quad Drill+ run at 1,295 rpm and 0.0012" ipr. Machining time was 1 minute.

Returned to CADCAM Systems, the part was finish-milled on a Deckel Maho DMU 50 eVolution machining center. An Ingersoll 2"-dia. Hi-Pos facemill, tooled with TiAlN-coated indexable inserts and run at 200 sfm, 11.5-ipm feed and 0.040" DOC, finished the flat section to a thickness of 0.875". Then the machine's table was pivoted up 90° to permit the top surface of the flange to be finished using the same tool and cutting parameters.

Next, the part was returned to a horizontal orientation and the OD of the ring was machined with a Garr ½"-dia., TiAlN-coated, solid-carbide VHM roughing endmill, run at 200 sfm and 12 ipm. The mill cut the ring's full ⅞" thickness, stepping in, in 0.100" increments, for each of nine passes, which together consumed 4 minutes. Then it took 2 more minutes at the same cutting parameters for the ½"-dia. cutter to enlarge the existing 1¼" hole to its final 1½" diameter.

Epperson pointed out that while tolerances on the part are generally in the ±0.010" range—"not real fussy"—the crucial factor in aerospace parts is the blending of one cut into another. This is imperative to avoid producing sharp edges, where cracks could initiate. "We don't want to use sharp cutters. We want to use corner-radius and ball-end cutters," he said.

The part then was rotated to present the edge of the ring to the machine's spindle, and a 0.430"-wide groove was machined into the edge with a Garr 0.375"-dia., TiAlN-coated endmill with a 0.030" tip radius, run at parameters similar to those employed earlier. "We used that tip radius because it generates less force than a ball does," Epperson said.

Collaboration between the CADCAM Systems machine shop and toolmaker Ingersoll Cutting Tools provided productivity and tool-development benefits.

Machining the slot, Epperson said, was the biggest challenge. The operation employed the Z-level roughing feature of the Delcam PowerMILL CAM software, which was used to program the part. "We went into that groove and back out, stepping down about 0.050" at a time," he said. "The cutter goes all the way in, does a little turnaround and comes back out again and cuts both directions."

The nominal depth of the groove is ½", although it effectively becomes 1" deep where the ring joins the bottom flange. It took 10 minutes to rough the groove on one side of the part, turn it 180° and rough the other side.

The bottom of the groove was round with a tiny flat in the bottom. It was finished with a Garr ⅜"-dia. ballnose endmill, and the tilting spindle of the 5-axis machine played a key role in imparting a fine surface finish. Epperson pointed out that the cut gets deeper and heavier as the cutter descends to follow the contour of the ring. "When it hits up against the flange, that's a little over 1" deep, and you've got full cutter engagement in the corner at that point," he said. That's normally "a nasty, vibrating, ugly situation!"

So Epperson tilted the machine spindle back 15°, enabling the cutter to follow the same toolpath but not become so deeply engaged at the end of the pass. As a result, he said, "the finish down there was actually gorgeous." Total time required to finish the groove was 7 minutes.

The last operation in this setup simply removed excess material to lighten the part. A Garr 8mm-dia., 2.5mm-radius endmill, run at 200 sfm and 8 ipm, thinned portions of the support ribs between the ring and flange. Together, the four areas took 6 minutes to machine.

For the final series of operations, the machined ring section was clamped in a vise set on a 3-axis Takumi Seiki VMC. A Garr VRX series, ½"-dia. finishing endmill, run at 200 sfm and 75 ipm, machined a ¾"-dia., 0.700"-long boss on the bottom of the part. The operation was one continuous cut, with the cutter milling the full depth of the boss and stepping in 0.020" each time it circled the part. In this case, cutting forces were low and no finish pass was necessary. The cut took 7 minutes and 40 seconds.

Next, two passes of an Ingersoll 45° chamfer cutter, run at 200 sfm and 20 ipm, created a chamfer on the end of the boss in about 30 seconds.

To make four 0.307"-dia. bolt holes in the flange, Epperson applied powder-metal drills. The Garr drills ran at 800 rpm and 3 ipm. A Garr 0.440"-dia. P/M drill then ran at 300 rpm and 2 ipm to make a lightening hole in the center of the boss in 54 seconds.

The full part run actually consisted of two different part numbers, distinguished by different flange configurations and bolt-hole arrangements. Epperson said the irregular outer contours of the 0.200"-thick flanges did not lend themselves well to the full-depth cutting technique used on the boss. Instead, the Garr ½"-dia. endmill was programmed to spiral down 0.020" each time as it passed around the flange, running at 200 sfm and 20 ipm. A final 0.010"-deep pass at 50 ipm was made over the full depth of the flange edge to enhance the edge's final finish. Machining the flange consumed 4.5 minutes.

For more information about CADCAM Systems Inc., call (815) 399-4433 or visit www.cadcamsystemsinc.com.

BY MICHAEL DEREN

Sometimes, change is a good thing

In my July column I wrote about being in a rut. I was finally jump-started by one of my tooling vendors. If you recall, he got me hyped about some cutters. It turns out that was only the beginning of me getting out of my rut. Unbeknownst to me, it apparently was time for a change.

In the beginning of October, I was contacted by a recruiter I have known for more than 10 years. "Mike," he said, "I have an opportunity for you. There's a growing company not too far from where you're working, looking for a project manager/manufacturing engineer."

Once again, I am eager to get to a job in the morning and see what the day brings.

After he explained what the position entailed, I told him I would go for the interview. Three days later, I was in for my first interview. During the next 3 weeks, I was brought in for two more interviews with different staff and management teams. Subsequently, I was offered and accepted the position. After 8½ years, I moved to a different workplace.

I left my old job with some trepidation. It's easier to stay in the same place. It becomes routine. A workplace can be like a marriage. It's somewhat comforting going to the same place at the same time and leaving at the same time every day. You know your job and what's expected of you and you do it well. There are no, or at least few, surprises.

You see and talk with the same people. You've been there so long, you almost know what others are going to say before they say it. You've found common interests and shared them with one another. I miss my old position. I especially miss the working relationships I had with individuals there, along with the friendships I developed.

Now, I'm the "new kid on the block." This usually is a stressful time in a new-hire's career. You're kind of discombobulated. You don't have a routine yet, you don't know anyone and you're not sure of what is expected of you—other than the fact they needed you for your expertise.

At first, I could barely find my way around the shop, let alone find the pop machine or where the bathrooms are. Fortunately, I found a plant layout, made a copy and carry it with me at all times. (It's a large facility).

The people at the new company have done a good job of welcoming me. They actually started during the interview process. At that time, my soon-to-be-new boss, the engineering manager, sat down with me and we just chatted. Of course, he was finding out what I knew, what I had done and what some of my philosophies are. We even did some what-if scenarios. But it was done informally, which made it less stressful. I believe this makes for a better interview process. Every person I met during the interview process made me feel at home. It was almost as if I belonged, which, when the offer was made, made the position easier to accept.

As I write this column, I've been here 2 weeks. I am slowly getting into the groove. I've been assigned one project already, with more to follow, and I look forward to the challenges.

A workplace can be like a marriage. It's somewhat comforting going to the same place at the same time and leaving at the same time every day.

Once again, I am eager to get to a job in the morning and see what the day brings. This was one thing that was lacking in my old position. I had reservations about leaving the other company, but as time goes by, those reservations are falling by the wayside.

I will still keep in contact with my friends there, for they are good people. However, I believe that this move couldn't have come at a better time. Change can be a good thing. △

About the Author

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