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BY KEITH JENNINGS

As the machining world turns

Wow! You never know when a past meeting or experience provides an unexpected opportunity—like becoming the new writer for this column. Back in 2005, CTE Contributing Editor Bill Kennedy contacted my shop, Crow Corp., about a possible article covering one of our more interesting machining projects. As an avid reader of serious trade magazines like CTE, his request interested me.

Not wanting to pass up a great opportunity to highlight our machining capabilities, I helped him develop some topics and arranged for him to interview our lead machinist about a customer's challenging-to-machine seatbelt parts. The result was an informative article about a seatbelt spindle we finally optimized after several years of development, production and revisions.

As a result of the interview process and my numerous discussions with Bill, he remembered my expressing an interest in writing about our shop's experiences. Well, more than 2 years later, those comments led to an opportunity to do just that by taking on this column. So, as the communicator and spokesman for the family biz, here I am today.

My background includes being a business manager, company officer and entrepreneur. Being the oldest son in a manufacturing family, I have worked with my stepfather (who I call Dad) and mother, Chuck and Pat Stevens, full time since 1992. I started working in the shop many years earlier, though, when I was 12. I've worked back-to-front in the business, starting as a kid when my young dad extolled the lofty virtues of the hands-on education I would receive working in his shop. As far as he was concerned, the skills and lessons learned there far outweighed the merits of a public school education. Although my mom made sure my brothers and I didn't drop out of school, we occasionally missed a day or two while earning our keep at the plant and coming home dirty.

And so it began, with tasks like counting, cleaning and deburring parts, organizing areas of the shop, packaging and shipping parts, sweeping and whatever else needed a 12-year-old's attention. In 1992, after military service and college, a vacancy arose that my parents felt I was a logical candidate to fill. They made me an entry-level offer, and my wife and I returned to Texas after an 8-year absence.

Eventually, this entry-level opportunity evolved into more responsibilities, like implementing company business strategy, developing better work flow through the shop, interpreting customer requests, streamlining processes with technology, screening employees, hiring, firing and lots more. Ironically, as a child, working in the family business wasn't my primary goal in life, but as an adult, I discovered the enormous potential of manufacturing through my dad's passion for shop work.

It became clear that my lifelong interest in "business" could be manifested in our own family company. Once I was mature enough to understand this, my own passion for manufacturing was lit. Over the years, traveling has been an eye-opening experience for me, since it has allowed me to meet many remarkable people who manufacture real products and quietly juggle the numerous challenges thrown at them. These people are true entrepreneurs, working relentlessly, making payroll, providing health insurance and paying taxes while taking on many financial risks. They certainly have my respect and admiration.

As of 2007, our company is a 45-year-old machine shop, fabrication and stamping business in metro Houston. The family dynamics and a dad who continues to work make things interesting. Fortunately, Texas has endured and our company has with it, growing and adapting to an increasingly competitive market.

Like many places, the Houston metro area is in the midst of tremendous growth and this brings about things both good and bad, but we work to make the most of it. While we have enjoyed the fruits of a robust economy, we will never forget the tremendous stress from 2002 to 2004, when we quoted and attempted to make just about anything to pay the bills.

Of course, the contract-manufacturing roller coaster will continue, but with the free exchange of ideas and some good ol' American innovation, I'm confident we'll have many years of brainstorming and shop production left to compete domestically and internationally. Please contact me at the e-mail below with your thoughts and ideas, and tell me about the topics you would like to have me cover. I look forward to discussing them with you.

About the Author

Keith Jennings is president of Crow Corp., in Tomball, Texas, a family-owned company focused on machining, laser cutting, metal fabrication and metal stamping. Founded in 1962, the company employs 50 people. He can be e-mailed at kjennings@jwr.com.

Moldmaking pointers

BY JAMES A. HARVEY

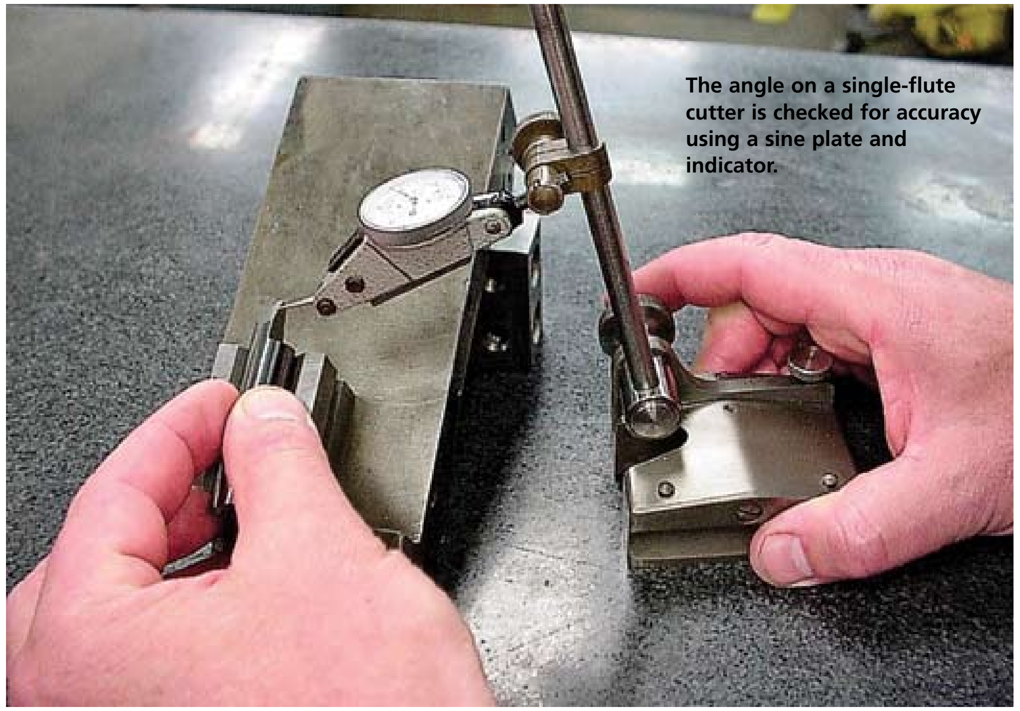
Mothers, don't let your sons and daughters grow up to be moldmakers. Plastic-injection-mold making can make you grow old fast. Moldmakers live in the worst of all worlds. They work on projects that require the most precise machining on one-of-a-kind, expensive parts while being pressured by people who generally don't understand the difficulties moldmakers face.

Modern machinery, no doubt, has simplified moldmaking; still, there is little room for error or sloppy work.

The following are tips for accomplishing this demanding work.

■ **Machine graphite dry with high spindle speeds and moderate chip loads.** Graphite is abrasive and should be cut with carbide or diamond-coated cutting tools at high spindle speeds. Cut graphite dry and keep the cutting area clean by vacuuming the dust. Chip loads should be from 0.003" to 0.005" when roughing and 0.001" to 0.002" when finishing. Smaller chip loads can wear tools prematurely. For example, set the feed rate at 60 ipm to achieve a 0.0015" chip load using a 4-flute endmill running at 10,000 rpm.

■ **Scribe accurate layout lines on workpieces before EDMing.** Plunging the electrode in the right location is half the battle when EDMing. Normally, electrode position is determined by using either depth micrometers or the machine's "beeper" system in combination with digital readout or dial settings. Sometimes, you'll be able to position an electrode by sweeping a circular feature with an indicator. If you have the capability, it is not necessary to scribe lines. Otherwise, scribe accurate layout lines on the workpiece to double check electrode position, especially when


The angle on a single-flute cutter is checked for accuracy using a sine plate and indicator.


A split bushing can be used to hold ejector and core pins for easy insertion into a lathe.

All images: J. Harvey

cavities are offset.

■ **Check the angle of a single-flute cutter by indicating across the cutting edge.** If you need a precise angle ground on a single-flute cutting tool, you must inspect the angle and make adjustments. One way to inspect the angle of a single-flute tool is to put the tool in a V-block mounted on a sine plate and indicate over the cutting edge. You can also inspect the angle in an optical comparator. Don't rely on grinding machine settings to provide precise angles.

■ **Use hardened pins when lapping to avoid galling.** Occasionally, a hole will need lapping to bring it to final size. Lapping should be used when only a few tenths of material needs to be removed. I prefer lapping a hole with a close-fitting dowel pin instead of an adjustable lap to avoid the possibility of bellmouthing. Soft materials gall easily. It is best to use a hardened dowel pin or ejector pin for lapping to reduce the risk of galling. Use a lot of oil when lapping and run at slow spindle speeds to avoid generating heat or drying out the hole. Hand lap when possible. A pin galled in a hole can be difficult if not impossible to remove without scrapping the work.

■ **Make a bushing to slide over core pins and ejector pins for easy handling in a lathe.** When working on a number of core pins, the heads of the pins can make it difficult to get them in and out of a lathe quickly. One way to overcome that problem is by holding the pins with a bushing. Otherwise, you'll have to remove the collet each time you want to change pins or you'll have to crank the chuck in and out an excessive amount to clear the heads of the pins. The bushing OD needs to be slightly larger in diameter than the heads of the pins. Be sure to make the OD a standard collet size. You can make these bushings out of a hard T-6 aluminum, but just about anything will work. You can cut slits in the bushing with a bandsaw or hack saw because the size of the slit is not critical. One side of the bushing must be cut through and the bushing's opposite side may need a partial slit to flex easily. It is best to make the partial slit from the outside of the bushing so you don't lose too much material from the bushing ID.

About the Author

James A. Harvey is a machinist and plastic-injection-mold maker based in Garden Grove, Calif. Machining Tips is adapted from information in his book, "Machine Shop Trade Secrets: A Guide to Manufacturing Machine Shop Practices," published by Industrial Press Inc., New York. He can be e-mailed at HarvDog42@aol.com.

Crash prevention

BY BILL KENNEDY, CONTRIBUTING EDITOR

The answer is: Brent Bowman. The question is: What do machine shop owners and mountain bike racers have in common? By helping both groups maintain control and avoid crashes, Bowman boosts their competitiveness.

As president of High Tec Industrial Inc., Polson, Mont., Bowman provides manufacturers with a range of automation equipment, software and application consulting services. His custom, integrated systems enable shops to run lights-out production with maximum productivity and crash-free reliability.

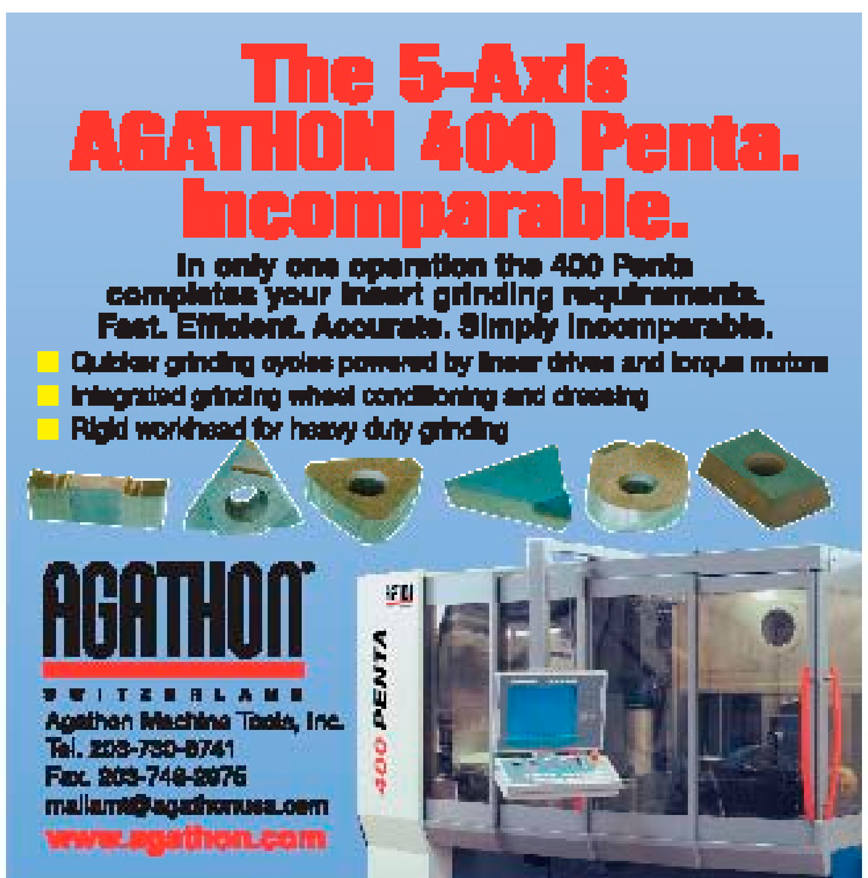
For mountain bikers, Bowman manufactures the GravityDropper seat post at Kimir Seatpost LLC, also in Polson. The patented device allows riders to adjust the height of a bike's seat on the fly using a handlebar-mounted switch. Dropping the seat gives a biker a lower center of gravity, increasing stability and speed on steep descents and facilitating negotiation of tight courses. Raising the seat maximizes power to the pedals when climbing.

The patented device allows riders to adjust the height of a bike's seat on the fly using a handlebar-mounted switch.

The seat post has about 25 components, the most critical of which is an 8.1"-long, 7075 T6 aluminum "inside tube" with a ¾" OD. Tolerances for the part's diameter, perpendicularity and concentricity are generally within 0.001". Among the tube's key features are three specially shaped location holes that enable the seat to be consistently dropped or raised as much as 4".

The part is machined complete on a 7-axis Ganesh mill/turn machine fitted with an LNS bar feeder. The process begins when the bar feeder pushes 3¾" of the 1.01"-dia. bar stock into the machine. A Sandvik Coromant CCGX insert, run at 4,000 rpm with feed rates of 0.011 ipr for roughing and 0.003 ipr for finishing, turns the bar to a diameter of ¾" for about 3½". Then a Titex 0.4375"-dia., TiCN-coated drill, run at 4,000 rpm and 25 ipm, drills a 3¾"-deep axial hole to lighten the part.

Next, Bowman mills two of the three cross-holes, which determine the



increments of seat adjustment. The holes have to be milled "because of their tolerance and shape," Bowman said. "They're elliptical, basically a 0.320" square with a 3/16" corner radii." The holes are not round because achieving a "slip fit, no shake" match of a round pin in a round hole requires both the hole and pin to be perfect. "We don't want it perfect, especially after the post gets used for a while and dirt gets in it. And we've got to allow some wear variation in there so it will still seat even though the pin is no longer running true on center," Bowman said.

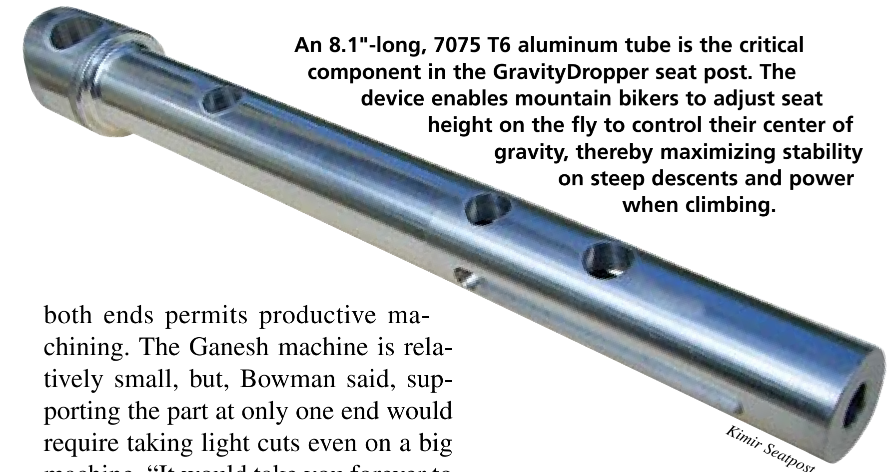
As a result, each cross-hole has 0.020"-wide flats on its two "sides" and 0.005" flats on its top and bottom. "We want a nice flat surface for the pin to seat on," he said. "If you contact a cylinder against a flat surface, the contact area is actually very small."

The 0.005" clearance on the sides allows the pin to "fall right in. It has to fit right every time," Bowman said, because his customers include "a lot of those guys you see on the Discovery Channel racing down the side of mountains." Hole location tolerances are tight: ±0.002" in the Z-axis and ±0.001" on the radial axis. The holes are milled with a Hanita 5/32"-dia., 3-flute, high-helix, TiCN-coated carbide endmill, run at 6,000 rpm and 15 ipm.

Next, on each side of the tube, at 90° on the circumference from the positioning holes, Bowman mills a 3/16"-wide × 1¾"-long × 0.100"-deep slot. The slots are sized to hold hybrid-plastic shims, which provide a bearing surface and align the seat post's moving and stationary components. The slots are cut with a Hanita 3/16"-dia., 3-flute, TiCN-coated carbide endmill run at 3,000 rpm and 10 ipm.

The mill/turn machine's subspindle then comes into play, gripping the end of the tube and pulling it 5". To provide clearance between the cutting tools and primary spindle, the bar stock protrudes slightly farther than the part's finished length.

The two spindles hold the part between them and their rotation is synchronized. Gripping the part on both ends permits productive machining. The Ganesh machine is relatively small, but, Bowman said, supporting the part at only one end would require taking light cuts even on a big machine. "It would take you forever to cut the thing down, or if you tried to take a heavy cut, you'd risk having the part grab onto your tool. You'd have too much flexing."



An 8.1"-long, 7075 T6 aluminum tube is the critical component in the GravityDropper seat post. The device enables mountain bikers to adjust seat height on the fly to control their center of gravity, thereby maximizing stability on steep descents and power when climbing.

Extending the previously turned ¾"-dia. section, a Sandvik Coromant DCGX insert, run at the same parameters as the previous turning operation, cuts 4" more of length of the ¾" diameter and then steps up to a 0.980" diameter on the end of the tube that fits into the seat post clamp of the bike's seat.

Next, a Sandvik Coromant N123E2 cutoff insert, run at 3,000 rpm and 0.002 ipr, cuts a 0.100"-wide × 0.125"-deep groove around the tube circumference 7.1" from the end of the part in the subspindle. The groove has 0.030" corner radiuses in the bottom, formed with a rough and finish pass. Then, with the same 5/32"-dia. endmill applied earlier, Bowman mills the final elliptical positioning hole. The three holes are spaced to provide 4" of adjustment in two steps.

The subspindle then releases its grip on the part, which is still clamped in the main spindle, and reclamps it 3½" closer to the main spindle. The Sandvik Coromant cutoff insert, run at 3,000 rpm and 0.002 ipr, frees the tube from the bar stock.

Now, only the subspindle holds the tube, and a Hanita 3/8", 3-flute carbide endmill, run at 2,000 rpm and 10 ipm, cuts a half-moon-shaped radius in the end of the part and machines a ½"-dia. hole, the main pivot point for the seat clamp. A 6-flute, HSS reamer finishes the hole to its final diameter of 0.501", running at 1,000 rpm and 25 ipm.

From start to finish, machining the tube takes about 9 minutes. Bowman noted that the cutting parameters employed, while not the most aggressive, were chosen to permit unattended machining for long periods of time without changing tools.

For more information about Gravity Dropper seat posts, call (406) 883-3555 or visit www.gravitydropper.com. To contact High Tec Industrial Inc., call (406) 883-5651 or visit www.machinetoolprobe.com.

An American success story

INTERVIEWED BY ALAN ROOKS, EDITORIAL DIRECTOR

Yukiko Hendrich is president and owner of HSP Inc., a 16-employee machine shop in Wichita, Kan. After growing up in Japan, Hendrich came to the U.S. in the early 1970s to study English. She married an American, became a citizen and, after starting out at HSP as the receptionist, bought the company in 1991.

In September 2006, Hendrich was named Minority Small Business Person of the Year by the Wichita District of the Small Business Administration. Other awards include Kansas Minority Owned Manufacturing Business of the Year in 2000 and 2002, Cessna Supplier Performance Award for 2003 and 2004, and a nomination as SBA Top Woman Entrepreneur in 2004. She is also a member of the Rotary Club of East Wichita, the World Trade Council of Wichita, the Wichita Manufacturing Association and the Wichita Metro Chamber of Commerce, where she has served on the board of directors.

Yukiko Hendrich

CUTTING TOOL ENGINEERING: How did you learn the metalworking business?

Yukiko Hendrich: After starting out as a receptionist at HSP, I volunteered for many different jobs. I ended up working a half day in the front office and a half day on the shop floor, which allowed me to learn the machining jobs.

CTE: What made you want to buy the shop?

Hendrich: I just really love this industry. My father and uncle owned a manufacturing business in Japan, so I grew up in that type of atmosphere, plus my brother is an engineer. In 1991, the owner of HSP was retiring, and I've always liked big challenges, so I decided to take a chance. I always strive to find new solutions. I also like the people side of the business, working with employees and talking with customers every day.

CTE: Was your family in Japan surprised by your decision to purchase the shop?

Hendrich: Many of them couldn't believe what I was doing. Even today they don't talk to me about it. However, they find out about the business by talking with my two sons.

CTE: What are your machine shop's specialties?

Hendrich: Originally, our main product line was curtain tie-downs for aircraft applications, but then we started to get a lot of competition for this product from China, so we transitioned to subcontracting for OEMs. Today, we have one aerospace customer, Cessna Aircraft, but the rest of the business is nonaerospace. We perform work for a customer that makes components for the auto industry, and we have many smaller customers in other industries, such as chemicals and agriculture.

CTE: How do you keep up with trends in the metalworking industry?

Hendrich: Mostly, I listen to people with more experience and knowledge. I also belong to many manufacturing organizations and have met many people who are willing to help. They have given me good advice on business areas that I should get into.

CTE: What types of machine tools does your shop have?

Hendrich: We have seven CNC machines, including one multispindle unit, as well as many manual machines. We just purchased a new 5-axis Fadal machine in May.

CTE: You and your shop have won several awards. What are the reasons for your success?

Hendrich: I have been very lucky and have very good people working for me. People stay with the shop because they like working for a small company. People get to do many different things here; they are cross trained, so if someone calls in sick or is on vacation, someone can take his spot. Our people like being flexible and working independently.

CTE: What are your plans for the future?

Hendrich: I plan to keep operating the shop, and I am crossing my fingers that my sons will join the business. Both are engineers, and when they were going to college, they worked in the shop.

CTE: How would your characterize your life in the United States?

Hendrich: I have been very fortunate, because, throughout my life, I have always seemed to meet the right person at the right time. Since I came to the United States, people have always been wanting to help me. I have been very lucky to live and work here.

BY DR. JEFFREY BADGER

Machine stiffness

Dear Doc,

I have two old but reliable Jones & Shipman surface grinders. They're identical, except one has a wheelhead that's only a few years old. It grinds a lot better, possibly due to a higher wheelhead stiffness. I'm considering redoing the wheelhead on the other machine. Is there a way to determine the difference in wheelhead stiffness for these two machines?

Archives MNATP, Collection Meillassoux

The Doc Replies:

Getting a reasonably accurate idea of wheelhead stiffness is easy. Take a dial gage and mount it on the magnet. Put the plunger against the wheelhead so the gage moves vertically. Then, take a spring scale and pull upward on the wheelhead, say, with 50 lbs. of force. Divide the 50 lbs. of force by the displacement on the dial gage. That's the wheelhead static stiffness.

If you pull with 50 lbs. of force and the dial reads a deflection of 0.001", the stiffness is 50,000 lbs./in. That's a reasonable value for an older surface grinder. The value for a more modern production grinder should be from 60,000 to 600,000 lbs./in., and even higher for modern high-speed grinders.

Dear Doc,

I grind the ODs of long cylindrical shafts. I have a superb steady rest that I set near the grinding zone, but I still get push-off and have trouble holding tolerances. What can I do?

The Doc Replies:

Push-off is caused by the normal force generated during grinding. If you have a high-quality steady rest, the next step is to reduce this force.

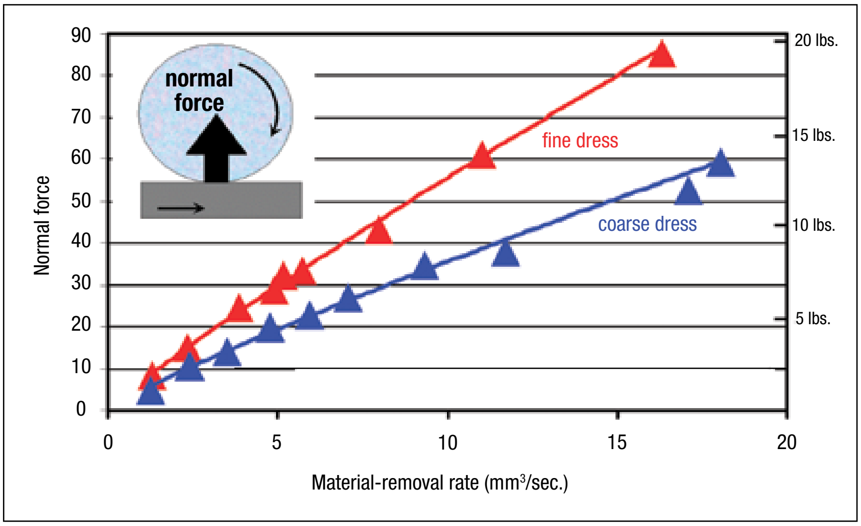
Normal force increases as the material-removal rate increases. So, begin by reducing the mrr in finishing passes. When cylindrical grinding, you can do this by reducing the plunge speed—the speed at which the wheel plunges into the workpiece. Or, if traversing the workpiece, grind with a smaller DOC and slower traverse rate. Because a lower mrr causes the wheel to glaze over the workpiece, dress the wheel immediately before taking finishing passes to sharpen it.

Also, a wider wheel means a higher mrr, so using a thinner wheel reduces the mrr and, in turn, the normal force.

If you don't want to switch to a thinner wheel, dress the wheel so less of it is active. For example, dress a 2"-wide wheel down by taking 0.003" off the radius so only, say, ¼" is active.

Next, sharpen the wheel with a more aggressive dress. When single-point dressing, dress with a deeper DOC or, preferably, with a faster table traverse. A sharper wheel means a lower normal force.

The down side of a sharper wheel is it imparts a rougher finish. But, because the mrr is so low during finishing, you can probably get away with it, as a lower mrr imparts a finer finish. Finally, if the wheel appears to be glazing over and, consequently, riding over the workpiece during finishing because of the shallow cut and low mrr, increase your work rpm. This won't affect the mrr, but it will decrease the length of the arc of contact, allowing the wheel to bite a bit harder into the workpiece. △



J. Badger

Grinding of EN31 with a hardness of 736 HV using a WA60HV wheel, a dressing lead of 0.2 mm/rev., a roughing dressing depth of 0.030mm, a finishing dressing depth of 0.005mm, a 10mm wide workpiece, a grinding DOC from 0.0025mm to 0.25mm and applying Castrol Hysol X cutting fluid at 4 percent concentration.

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 3-day High Intensity Grinding Course Oct. 30 to Nov. 1 in Chicago.