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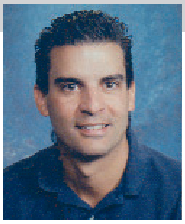
BY MIKE PRINCIPATO



Radio waves

I've tackled some pretty weighty issues in this space. The meaning of work. The importance of manufacturing to America. Foreign-trade policy.

But now it's time to address a subject of even greater importance, one that can generate more heated exchanges on the shop floor than all of those topics combined.

I'm talking about whether your company should allow radios to be played on the shop floor. If you've been in the business long enough, you know I'm only half-kidding.

Running a machine can be tedious—particularly during a production run—and music can provide a nice respite from the drone-hiss-click-drone-hiss-click cutting cycle.

Back when both my shop and I were a lot younger, classic rock blared all day long across my little 2,000-sq.-ft. workspace. I didn't mind it a bit; hell, I paid for the stereo system. After all, there were just five of us, and at the ripe old age of 31, I was a senior citizen among a bunch of kids barely out of high school. Most of the time—say, roughly until the popularization of rap—I enjoyed this workday soundtrack as much as the other guys did.

A few years and a few new and not-so-young hires down the road, however, things changed on the shop floor. It eventually became clear that Mötley Crüe, Metallica and Guns N' Roses, blasted at a volume level sufficient to knock machine tools off level, wasn't everyone's idea of a productive work environment.

Tim the toolmaker was right, too, though: We weren't producing paper clips or jelly beans, but rather complex parts that often required considerable focus. That focus, for many of us (and at 45, I'm now firmly part of that 'us'), meant QUIET.

I knew the radio had gotten out of hand when Larry, my near-deaf foreman at the time, complained. "That radio is so damned loud even I can hear it!" he thundered. His point was reinforced by Tim, the professorial and introverted toolmaker, who threatened to quit if I didn't intervene in what he believed to be an annoying and potentially dangerous distraction from the real work of my company.

Naturally, my original machinists and programmers rallied against the idea of Radio Free Workplace, characterizing the new guys as sticks in the mud infringing on their assumed God-given right to hear heavy metal at work.

Trouble is, both camps had valid arguments. Running a machine can be tedious—particularly during a production run—and music can provide a nice respite from the drone-hiss-click-drone-hiss-click cutting cycle.

Tim the toolmaker was right, too, though: We weren't producing paper clips or jelly beans, but rather complex parts that often required considerable focus. That focus, for many of us (and at 45, I'm now firmly part of that "us"), meant QUIET. The issue was becoming a real, but essentially trivial, bone of contention I didn't need, so I tried a couple solutions.

First, I allowed individual radios at workstations, not anticipating that this short-lived policy would inadvertently kick off the very first boom box war. Next, I tried an all-for-one-and-one-for-all approach, setting the shop's central stereo system volume at what was deemed by most to be an acceptable level. After about a week, the radio-free proponents recanted, noting that they'd come to the conclusion it wasn't only the volume of the music, it was the music itself: They hated it. I theorize to this day that they reached their conclusion during an "All Bon Jovi Thursday," but I could be wrong.

Exasperated, I finally called the whole gang together, told them I couldn't believe that we were actually spending valuable billable hours on this situation and pleaded for a solution. So, in the interest of sparing you the same learning curve, here's what we came up with.

Rule No. 1: The only music allowed in the shop will be played from the central sound system.

Rule No. 2: One day per week will be radio-free, which gives a break to the "silence is golden" camp while reminding the rest of the crew that we all have to get along to be successful.

Rule No. 3: Ozzy, Offspring and rap are out, adult contemporary is in. No talk radio, either. It's too distracting and politically divisive. We found a local pop station and literally duct-taped the FM tuner to discourage practical jokers.

Rule No. 4: Customers in, music off. I might modify this rule if the customer is Eric Clapton, but I'm not holding my breath.

The rules worked like a charm. Now if I could just stop the break dancing in the aisles.

About the Author

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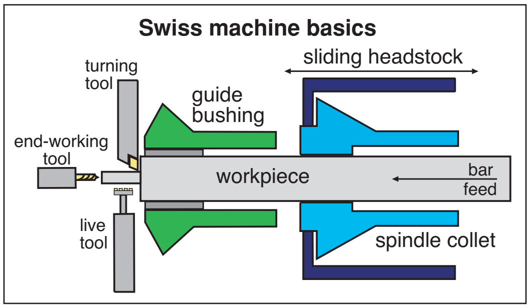
Turning the Swiss way

In Swiss-style turning, a sliding headstock, the part of the lathe the spindle collet is mounted on, acts to hold the rotating or nonrotating bar stock as it moves in the axial direction. The cutting tool moves along the X-axis, perpendicular to the workpiece centerline, while motion along the Z-axis comes from the bar stock itself.



A sliding headstock feeds the workpiece through a guide bushing, with turning, end-working and live tools cutting the workpiece as it moves.

The sliding headstock feeds the bar stock through a bushing. This bushing, usually with a carbide lining that matches the size and shape of the bar stock, acts as a guide. Stationary and, possibly, rotating side- and end-working tools cut the workpiece as it moves. The part can then be transferred from the main spindle to the back spindle for machining on both ends.

First developed for the Swiss watchmaking industry, Swiss-style machines have since come to be used to manufacture small, light and complex tools and parts for a host of industries. Early Swiss-style machines used a system of shafts and cams to govern workpiece and tool movement when turning and milling, with customized form tools cut to the shape of the contour they were meant to produce applied to the workpiece to produce complex part designs.

Cam-operated Swiss-style machines have a rotating or sliding component piece in a mechanical linkage that transforms rotary motion into the linear motion of the bar stock. There are two types of cam-operated turning centers, those where the headstock rotates the bar stock as it's fed and those where nonrotating coil or bar stock is fed into rotating cutting tools.

Cam-operated Swiss machines are being replaced by CNC Swiss machines, which are more flexible. On a cam machine, each new part to be machined requires customized cams and tools, while CNC machines can be programmed to machine any number of small, precise parts in one chucking. This eliminates secondary operations and minimizes part handling time.

Swiss-style turning centers permit the use of indexable, coated-carbide inserts instead of custom-made tools that are manually reground. The use of these inserts is becoming standard in Swiss-style CNC machining. They are more expensive than custom-ground tools but save time during operation, because the insert can be quickly indexed or changed.

Producing small, tight-tolerance parts is the primary purpose of a Swiss-style turning center. This level of accuracy is made possible by keeping the tool/workpiece interface extremely close to the guide bushing. The machines also allow for increased tool clearance to minimize pressure on the workpiece.

Modern Swiss-style machines have up to 12 axes of motion and can include live tooling, wherein the workpiece stays stationary as the tool rotates. These machines also have secondary subspindles that perform cutting operations on the back of a part once it's carried over from the main spindle. The positioning is accurate because the subspindle takes hold of the part before it's cut off. This increases the productivity of the machine by allowing it to work on the part in the subspindle's pickup collet, which is a secondary socket for holding the part, concurrent with the main cutting operation.

Swiss-style machines are able to apply a wide selection of tools in machining a part due to rotating tool turrets and gang-tooling arrangements, where a group of cutting tools is mounted side-by-side around the workpiece. After a feature in a part is cut, the next tool is immediately engaged.

Step saver

BY BILL KENNEDY, CONTRIBUTING EDITOR

Latronics Corp. deals with competition on a global basis. The company is a leader in the development and manufacture of ceramic-to-metal, glass-to-metal and metal-to-metal hermetic seals. Latronics' signature skill is the metallizing of nonmetals so they can be joined with metal via brazing or soft soldering.

The Latrobe, Pa.-based company's most popular products are housings for high-power semiconductors. The housings are shipped worldwide for use in electric power control applications ranging from locomotives to huge air conditioners. While the company is the only U.S. manufacturer of the housings, it faces low-cost offshore competition. As a result, Latronics continually pursues cost-reduction methods, while maintaining the top quality needed for high-reliability applications.

A typical housing consists of a short, high-alumina-ceramic cylinder with a copper lid brazed on one end and a copper flange brazed on the other. The end user puts a semiconductor wafer (a high-power electronic device that depends on the conducting power of silicon treated with impurities) in the housing and cold-pressure welds a one-piece copper lid to the flange, creating the required hermetic seal.

For years, Latronics made the lids in a multistep process that involved CNC machining a blank cut from an appropriately sized copper bar, assembling the machined part with a purchased flange stamping, then brazing the stamping onto the part in a hydrogen furnace. Because semiconductor disks must be hermetically sealed against moisture and contamination, the braze on every fabricated lid had to be individually leak-tested to 1×10^{-8}cc He/second using a helium mass spectrometer.

Brazing the lids took about 3 hours, not counting handling time for loading, unloading and transporting the parts within the shop. Leak testing required subsequent vapor degreasing.

Seeking ways to consolidate manufacturing steps, Latronics investigated the concept of orbital cold forging. As in conventional forging, the process employs upper and lower dies, which press a copper slug to shape. However, in orbital cold forging, the upper die is set at a slight angle and rotates around its axis like a spinning top. As the lower die is raised, the upper die moves around the slug and gradually kneads the copper into conformation with the shapes of the dies. Friction and force requirements are low, allowing a high degree of material deformation.

The upper die's angle and movement combine to concentrate the pressing force in one small area of the slug at a time. This enables a 200-ton press to accomplish the work of a press five times larger. Because the dies do not have to withstand the high forces of a massive press, they are less expensive to make and last longer than dies used in a more powerful press. In addition, the cold-forging process changes the grain flow and tensile strength of the copper, increasing its hardness by as much as 50 percent and eliminating porosity.

Latronics uses a Kasto Wagner HSS saw to cut CDA 101 and 102 copper bar stock for slugs. The saw cuts the bar to a length calculated to produce a slug weighing the same as the final lid. For a 2.85"-dia. lid, for example, a 1"-dia. bar is cut to a length of 2.430". This enables Latronics to inventory just two diameters of bar stock—1" and 1½"—to produce lids from 1.5" to 5" in diameter.

The saw cuts slugs to a tolerance of ±0.005" at a rate of up to 3,000 an hour. Slightly less flash excess on the forged lid can be attained at a higher precision of ±0.0005", but achieving that tolerance requires the use of a carbide saw with a capacity of only 100 slugs an hour. In the interest of saving time, and considering the lids will be finish-machined anyway, Latronics uses the HSS saw.

The cold-forging press features automatic loading and unloading, and produces a lid blank every 6 seconds. The blank is 0.040" larger overall than the finished part.

B. Kennedy

A copper bar is sawed to a length calculated to produce a slug weighing the same as the final lid for a hermetic seal.

After forging, Latronics finish-machines the lid. The most critical specification is flatness to 0.0005". Flatness is crucial because the lid acts as a heat sink and must mate flush with the semiconductor disk to prevent hot spots that could cause failure. Latronics measures the flatness of the lids with a Taylor Hobson Tallysurf surface-measurement instrument.

Latronics had previously machined the lids on a CNC lathe using carbide tooling and achieved the required flatness with abrasive lapping. When the company implemented high-accuracy Wasino CNC lathes and applied PCD tools for finishing, lapping became unnecessary.

To minimize workhandling, the Wasino lathes, which are programmed using GibbsCAM, are fitted with gantry robots and part carousels that enable lids to be stacked and processed in batches. The robot loads and unloads the lids from the lathe chuck, and a flip-over station enables machining of both sides of the part.

On the first side, an 80º-diamond, PVD-coated Kennametal carbide insert faces and contours the lid at a cutting speed of 1,400 to 1,800 sfm and a feed rate of 0.004 to 0.008 ipr. A 0.133"-dia. carbide drill, run at 2,800 rpm and 0.0015 ipr, then makes a 0.2697"-deep hole in the lid's center. Next, a 0.1405", flat-bottom endmill finishes the hole at 2,500 rpm and 0.0012 ipr. Then a ¼"x90º carbide countersink chamfers the hole to a depth of 0.012" at 2,800 rpm. Finally, the first side is finish-turned with an 80º-diamond, PCD-tipped insert from Poly-Tech Diamond Co., run at 2,000 to 2,800 rpm and 0.0014 ipr. Cutting time for the first side is 43 seconds.

After the lid is flipped and returned to the lathe chuck, the second side is faced and contoured with the same 80º-diamond, PVD-coated insert used previously and run at similar cutting parameters. Then the lid is drilled, finish-endmilled and countersunk, again at parameters similar to those applied earlier, but using a 0.183"-dia. drill and 0.185"-dia. endmill, with the same countersinking tool. After the 80º-diamond PCD insert finishes the face of the lid at the same speeds and feeds as before, a 0.060"-wide, solid-carbide slotting blade from O.G. Bell Co. makes a 1.540"-long, 0.20"-deep slot across the face of the lid. The Wasino lathe's live tooling capacity is used to run the blade at 600 rpm and 4.23 ipm. Machining the lid's second side consumes 83 seconds.

When machining is complete, selected areas of the lid are nickel-plated.

According to Ron Yurko, vice president of engineering, the consolidation of steps enables Latronics to produce the same number of parts in 1 week that previously required 3 weeks. At a production rate of 100,000 to 200,000 pieces a month, savings are considerable. "We eliminated handling and reduced cycle time," he said, "which also helps us reduce inventory."

For more information about Latronics Corp., call (412) 539-1626 or visit www.latronicscorp.com.

A career dedicated to metal-removal education

INTERVIEWED BY DANIEL MARGOLIS, ASSISTANT EDITOR

Robert P. Chaplin has been active in the manufacturing industry for 67 years, first as a lathe operator, then as a Navy machinist, next as an industrial technology salesman and finally as a metal-removal technology consultant. He recently published a book titled "Metal Removal Technology." Chaplin discussed this book, along with his views of the industry and its future.

CUTTING TOOL ENGINEERING: What big developments have you seen in the industry?

Bob Chaplin: Perhaps the largest development in the manufacturing field has been the design and development of machine tools controlled by advanced electronics that can produce more rapid motion to a closer tolerance. In earlier years, much emphasis was placed on the design of rugged columns and bases, without as much concern for the spindle rigidity and its capacity for speed and accuracy. Coolant was stored in the cored-out section of the base, which could never be efficiently cleaned.

CTE: Can you summarize your ideas about metal removal?

Chaplin: In metal removal, everything happens at the cutting edge. If the cutting edge fails, everything stops, no matter how high-tech the machine tool. The diagnostic process to find out why becomes the cure. This process resolves around four requisites: speed, feed, geometry and conditions related to a cause other than the cutting edge. Analyzing one or a combination of these four requisites forms a diagnostic approach to a resolution. The idea is to teach operators this method of diagnosis, using formulas that involve sound basics of speed, feed and geometry and recognition of conditions to arrive at maximum removal rates. To teach this approach is not an overnight affair. As the learning process never stops, this teaching method can only be as fast as time allows.

CTE: What is the primary purpose of the book?

Chaplin: The book can well be used as a textbook for classes or seminars for the workforce at manufacturing plants where machining is a prime function. It is written in a chronological mode, with a goal of maximizing production and predicting tool life and the cost per cubic inch [of metal removed]. The book also analyzes most work materials to generate starting recommendations. It then addresses milling, drilling, threading, reaming and turning, outlining approaches to increasing removal rates in each of these operations, with simple formulas and CAD drawings to illustrate calculations. Whether it be HSS, carbide or any cutting tool media, the book deals with the cutting edge.

CTE: How key is educating workers of the existing manufacturing workforce?

Chaplin: I totally believe education of the existing workforce in U.S. manufacturing plants will be the salvation of our manufacturing future. In today's market, educating workers is much more difficult than it was 10 years ago. It seems nearly every published article concerning problems of production in the metalworking industry mentions the lack of skilled craftsmen. And the complaint of those skilled craftsmen is that the pay scale is too low. In order to increase the number of skilled workers in the workforce, an educational program must be initiated. The training program should start at the cutting edge. Cost reduction in production from this effort is very effective. There is nothing I have found to increase efficiency better than in-plant training. There are those that look upon in-plant training as a waste of production time and dollars. However, these are the plants where the people responsible for production seem to say, "I don't know what's happening, but this place is going crazy." The reason it's going crazy is because more work is coming in than can be accomplished due to inefficiencies and because a majority of its workforce lacks skills. This may be one reason that "button pushers" seem to be accepted as operators, and companies depend on engineers, programmers and supervisors to be watchdogs for quality, daily quotas and costs, completely consuming time they could be spending on other projects. The reason I wrote the book was to present a training method that follows the method I have used in various plants. It apparently works, and I find the production force is hungry for knowledge.


Robert P. Chaplin

CTE: What are the pros and cons of today's manufacturing environment?

Chaplin: On the upside are design engineers who are developing advancements in production machines; cutting tool materials that can resist thermal and mechanical limits; and cutting tools, preset techniques and electronic inspection devices that can produce parts faster and with more repeatability than ever before. Hats off to these engineers and the companies that support them. They are the backbone of the future of metal-removal technology. On the downside lies the bureaucracy, which can throw blockades into the best plans to reduce costs based on the accomplishments of the workforce. If what goes out the door, on time, at a reasonable price, with acceptable quality, is what counts, then a successful bottom line is dependent on the workforce being equipped to use correctly, the contributions of all its departments. This takes long-range planning. Planning is quite easy. Implementing it is more difficult, and maintaining the results is even more difficult. How many times is a good plan offered, and implemented, then, when it is completed, things return back to the old, easier method of doing things?

There is nothing I have found to increase efficiency better than in-plant training.

BY DR. JEFFREY BADGER

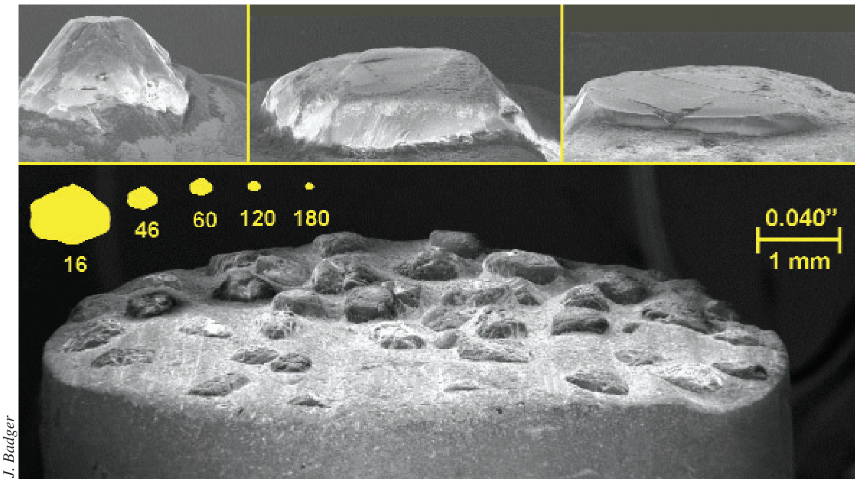
Dress and burn

Dear Doc,

I keep nagging our operators to rotate the single-point diamond dresser, but they just won't do it. Our grinding wheel salesman suggested switching to a diamond cluster. We tried it, but it didn't work for us. Why not?

The Doc replies:

Diamond clusters are great for operators who just refuse to rotate their diamonds. But because clusters are significantly larger, the traverse speed needs to be much higher. Otherwise, you'll dull the wheel rather than sharpen it. A rule of thumb is to run the cluster four times as fast as a single-point diamond.



J. Badger

Top: New, worn and very worn single-point diamond dressers. Bottom: A diamond cluster with relative sizes of grits in the grinding wheel. All images are on same scale. Note the relative sizes of the diamonds grits.

Dear Doc,

I read your February 2005 column and understand the concept of dressing depth as it relates to grit size, but I'm not clear on how the traverse speed of the dresser affects wheel topography. Can you explain?

The Doc replies:

In terms of wheel topography, the traverse speed acts in much the same way as the dressing depth. Just as a greater dressing depth means a sharper wheel, a faster traverse speed means a sharper wheel. However, the traverse speed has a much greater impact on sharpness than the dressing depth.

Remember, wheel sharpness varies proportionately with dressing depth, but the wheel sharpness varies proportionally to the square of the dressing speed. In other words, if you double the dressing depth, you double the wheel sharpness. But if you double the traverse speed, you quadruple the wheel sharpness.

Dear Doc,

I form-grind HSS and get lots of burn. I dress 0.0005" before every pass, and grind five passes for a total depth of 0.0070". What should I do to eliminate burn?

Archives MNATP, Collection Meillassoux

The Doc replies:

First, you need to figure out why you are dressing the wheel so much. Are you dressing to keep form or to sharpen the wheel? Of course, the answer is both, but usually one dominates.

Dress the wheel and then grind five parts without dressing. This is called the "no-dress test," or "Smith wheel-wear test." Then, measure the loss of form on each part, enter the data into a spreadsheet and plot loss of form vs. part number. You should get a somewhat linear curve that will tell you how much your wheel is wearing away.

Calculate a rough average of wheel wear per part and compare this to how much you are dressing. Is it about the same? My guess is it's probably a lot less. If your wheel wear is about 0.0005" per part and you're dressing off a whopping 0.0025" (5×0.0005") per part, that means you're dressing the wheel to keep it sharp, not to hold form. So, your wheel is dulling and creating burn.

Instead of consuming your wheel through dressing, choose a wheel that self-sharpens during grinding. Of course, it will wear more, but that's not a problem, considering how much you are dressing. Try a wheel with a more friable grit that self-sharpens during use or a softer-grade wheel in the same bond type, or even a less tough bond type.

Once you've got your new wheel, repeat the wheel-wear test to see if the self-sharpening properties are getting better and to determine how much you need to dress. If all goes well, burn will go down and you'll still be able to keep form. △

About the Author

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