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BY MIKE PRINCIPATO

Business before ego

If I could get a mulligan on any strategic blunder I made as a machine shop owner, it would be on the process I used to decide whether to outsource or integrate certain specialized manufacturing processes. My youthfully naive discernment process (if it can be called that) went something like this:

Foreman: "We're outsourcing a lot of welding."

Me: "Really? How much?"

Foreman: "I'm not sure."

Me: "Never mind. What's a welding machine cost?"

Foreman: "Uh, that depends. TIG, MIG, stick …"

Me: "OK, never mind that, either. Does a welding machine look cool?"

Foreman: "I don't see how that …"

Me: "I like your idea a lot. Let's buy a welding machine. Oh, and find a welder, too."

Foreman (to himself): "I need to be more careful what I wish for around here."

After making a series of poor and costly business decisions, I looked around my shop and found, shall I say, an odd but nonetheless comprehensive array of equipment. From bandsaws to vertical turret lathes and sinker EDMs to rotary hand tools, we had it all. Whether or not we were actually making any money with all that stuff was another matter.

If a piece of capital equipment fits your strategic plan and you can keep it busy enough to—at a minimum—cover its cost, go for it. If not, send the work out, mark it up to a profitable level and focus on more lucrative pursuits.

Striking a balance between maintaining and enhancing a shop's core competencies and outsourcing to better-qualified subcontractors is an endless challenge, but one that every owner and manager must accept. When cash flows freely, it's all too easy to make expensive decisions and overreach into manufacturing processes better left to others. If sales go south, even temporarily, you'll find yourself sitting on a bunch of underutilized capital equipment. Worse still, the specialists you hired to run the "boutique gear" will become bored, frustrated, worried or all of the above when their departments' work slows down and, likely, will quit for greener pastures.

Outsourcing is an obvious necessity for super-specific applications such as gundrilling, powder coating and low-production EDMing. Unless you're young and foolish (I was both, once) and determined to build a complete, vertically integrated shop, take advantage of the expertise of subcontractors. Choose reliable ones and they'll meet specialized manufacturing needs faster, better and more economically than your shop—and you will eliminate the financial burden of owning boutique gear.

Often, however, the decision for contract manufacturing shops to outsource or not isn't quite so clear-cut. Here are a couple of guidelines to consider before you jump off a financial cliff and purchase the next GeeWhiz 12-axis virtual reality-enabled ray gun metal annihilator—or even just a bandsaw.

First, evaluate the manufacturing processes you're currently outsourcing. Are the processes limited in frequency, quantity or profitability, yet highly skill- or specialized equipment-intensive? If so, it's a no-brainer: Continue to outsource the work.

Second, even if the outsourced process isn't limited in these ways, does it fit strategically into your current or future operation? It wasn't a bad move for me to introduce a CNC wire EDM into my shop, because it was a natural complement to our already-busy 3- and 4-axis vertical machining centers.

Not so with the sinker EDM, which I acquired for our then-new injection mold building department. "We are a mold builder," reasoned I, who rationalized that no self-respecting mold builder farmed out sinker EDM work. I realized, too late, that it was a big mistake when I saw that technological marvel sit idle 75 percent of the workweek after quickly blasting cavities in metal blocks at a much faster rate than we could feed it orders.

If a piece of capital equipment fits your strategic plan and you can keep it busy enough to—at a minimum—cover its cost, go for it. If not, send the work out, mark it up to a profitable level and focus on more lucrative pursuits.

Last, but far from least, never outsource your core competencies. If you're a top-notch turning shop, by all means stay that particular course and increase your capacity and capabilities every time it makes financial and strategic sense to do so. And guard your market share in that core competency like a jealous lover.

About the Author

Mike Principato is a metalworking industry consultant and former owner of a midsized CNC and EDM shop in Pennsylvania. He can be e-mailed at ctemag1@netzero.net. Meet Mike in person at the CTE booth at IMTS. He will be at Booth E-2765 from 12:30 p.m. to 4:30 p.m. on Sept. 6 and Sept. 7.

A note about knurling

BY JAMES A. HARVEY

Knurled surfaces are commonly seen on cylindrical parts such as handles, knobs and rollers. Knurling is a process that creates an easy-to-grip geometric pattern on a part's surface.

When knurling, machinists apply a tool with two freely rotating rollers that deform, or push, the material rather than cut it. Creating a crisp, clean knurl on a lathe is easy.

■ First, understand the relationship between a knurling tool and the diameter of the part to be knurled. Some machinists get into trouble when they start a knurl over an arbitrary diameter and find that the knurl doesn't track properly because it's repeating itself in the previous grooves.

A proper diameter to knurl is any diameter that is a multiple of the spacing, or distance, between the teeth of a knurling tool divided by π (3.14159). The relationship is the same whether the knurl is diamond or a straight knurl. However, you must measure the spacing of a diamond knurl's teeth along the axis of the part or roller for the relationship to hold true.

Suppose you want to impress a diamond knurl on a 1"-dia. shaft and the distance between each tooth of the knurling tool measured, with calipers, along the roller's axis is 0.060". The measurement is not extremely critical in that ultimately you will determine the final diameter by trial and error. However, the measurement will give you a decent starting point.

Following the formula stated previously, 0.060 divided by 3.14159 is 0.019. Therefore, any multiple of 0.019 should provide a diameter for a perfect knurl. For example, 0.019 times an arbitrary number such as 40 equals 0.760. In theory, then, if you turned a shaft to 0.760", you should be able to create a perfect knurl.

However, because you want to knurl a 1"-dia. shaft, you have to find a multiple of 0.019 that gets you close to 1", such as 52 (0.019 × 52 = 0.988). Based on experience, though, the chances of producing a perfect knurl on the 0.988"-dia. shaft are not great. An error occurs as a result of an imperfect measurement between the teeth of the knurling tool, which isn't a big deal because ultimately you are going to sneak up on a usable diameter. Therefore, begin by machining the part about 0.010" larger than the calculated diameter.

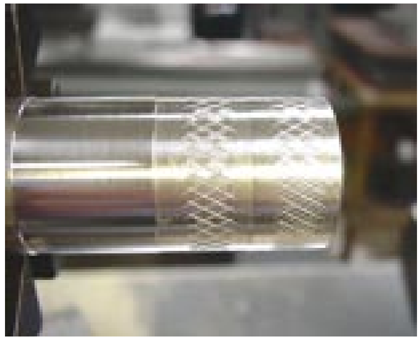
■ Lay a short test knurl by hand. Once you've machined a diameter that is a few thousandths of an inch larger than the calculated diameter, you can begin testing. Mount the knurling tool approximately perpendicular and on center to the workpiece. It is not critical that the tool be exactly perpendicular or exactly on center.

Start a test knurl by lightly pressing the rollers of the knurling tool against the workpiece. Start knurling close to the headstock—where the workpiece is most rigid. Rotate the lathe spindle slowly by hand as you watch the pattern being impressed on the workpiece.

After you complete one turn of the spindle, the pattern will start to repeat itself on the workpiece. If the grooves impressed on the part near the beginning of the second rotation don't line up with the previous grooves, you'll have to adjust the workpiece's diameter.

Machine 0.002" off the shaft's diameter and perform another test. A little over one turn lets you see if you have a winner. Once you find a diameter where the grooves fall on top of each other, record it and proceed.

Put some pressure on the knurling tool and feed the tool slowly along the length of the shaft on the first pass.


J. Harvey

Lay a test knurl by hand to see if the diameter produces a knurl that tracks in previously laid grooves.

■ Use feeds, speeds and pressures you feel comfortable with. Start with slow to moderate settings and then increase them as you see fit. A lot depends on part rigidity and setup. In areas where the knurl comes in shallow, you can dwell and concentrate the tool in that area to help balance groove depth.

■ Use lightweight lubricating oil and air when knurling. Because knurling is a material-displacement operation, it's best to use a lubricant that aids in slipping—not cutting. You want the knurling tool's teeth to slip back into the previously laid grooves. Select an oil that doesn't retain flakes created during knurling.

Blowing a hard stream of air over the rollers and workpiece during knurling helps prevent those flakes from being pressed into the knurled surface.

■ Run a smooth file over the top of the knurl to remove sharp points.

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," published by Industrial Press Inc., New York.

Spindle speeders, special heads

BY LAROUX K. GILLESPIE

Using the right spindle speed for a job reduces cycle time and prevents a host of machining problems, including broken or chipped carbide tools, chatter, plowed surfaces and poor surface finishes. Standard machine tool spindles often do not reach the high speeds required for applying small-diameter tools. Spindle speeders provide a cost-effective way to machine at the most efficient spindle speed.

Spindle speeders come in a variety of shapes and sizes. Most fit into automatic toolchangers, but some may require manual loading into the machine spindle. Speeders typically increase a machine spindle's speed two to 10 times.

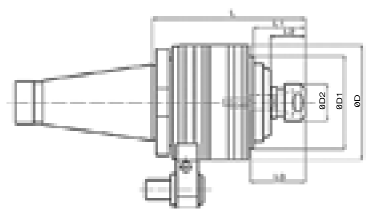
Spindle speeders provide higher speeds with a few mechanisms. "True" speeders use a planetary gearhead within the module. Planetary gears multiply the speed provided by the machine spindle.

The second means of increasing speed is to chuck an air turbine motor in the spindle. With this scenario, the machine spindle does not rotate, and the speeder requires an air supply to operate. Air turbine motors for this use deliver speeds up to 90,000 rpm and higher. End users can set speed ranges for the air turbines on some models, but not all. Like the planetary gearheads, air turbines attach to the spindle via a variety of tool shank designs.

Both types of speeders are sealed, so lubrication is not required.

In addition, in-line heads, which provide a low-cost way to convert a conventional lathe to one with live tooling, can also function as a spindle speeder on machining centers. These units are coolant-driven and typically increase the rpm to about 15,000.

The concentricity between the shank and collet for high-quality speeders vary from 1µm to 10µm (0.000040" to 0.0004"), depending upon the design and manufacturer. Less precise units may have as much as 50µm (0.002") eccentricity. (Taking a 0.001" DOC with a 2-flute cutter at a 0.002" eccentricity causes one tooth to cut air while the other takes a 0.003" cut.)



Spindle speeders typically increase a machine spindle's speed two to 10 times.

Speeder manufacturers provide an antirotational pin to enable the speeder to function. They also provide written certification of performance for many of these devices. Because spindle vibration can be a major source of small-tool breakage, speeders—which usually weigh 3 to 9 lbs.—have to run smoothly. This also reduces noise.

In addition to eccentricity differences between designs, duty cycles differ. A duty cycle is the amount of time the speeder can run before it needs to be stopped to cool down. One manufacturer might provide a 6-minute duty cycle at maximum speed while another offers 8 hours at maximum speed. However, coolant-driven speeders have no duty cycle.

In addition to gear quality, the number and quality of internal bearings impact performance and price. Some units require several special bearings costing $500 apiece.

Using Special Heads

Special heads are another problem-solving machine tool accessory, and many are produced by the same companies that make spindle speeders. Special heads for CNC and manual machines include angle heads, reverse spindle heads and multispindle drill heads.

As with spindle speeders, end users of special heads place angle heads in automatic toolchangers or manually insert them into the machine spindle. A right-angle head is a common method for orientating a tool other than straight out the spindle. Like the name implies, right-angle heads provide powered cutting at 90° to the spindle centerline.

Additionally, angle heads are available to cut at angles other than 90°. They can be fixed or adjustable (universal).

Reverse spindle heads hang from the toolholder like a giant "C." Gears drive an upward-pointing cutter located on the bottom of the "C," allowing the part to be machined from the bottom.

When a manufacturer needs to drill, say, 20 holes in a precise pattern for hundreds of parts, one option is to add a multispindle drill head to its CNC machine spindle. It may be bulky and require manual insertion, but the drill head cuts drilling time by a factor of 20 or more.

In addition to machining centers, end users can also place multispindle drill heads in lathes. The insertion of the heads is manual. Having a lathe produce 20 holes at a time might be unusual, but these overlooked devices can do it.

About the Author

LaRoux K. Gillespie is a retired manufacturing engineer and quality control manager. He is the author of 10 books on deburring and numerous articles on precision machining.

Continuous consistency

BY BILL KENNEDY,
CONTRIBUTING EDITOR

The world of automotive manufacturing is one of continuous production runs as well as continuous pressure to improve productivity and quality. Tier 1 automotive supplier Ryobi Die Casting USA Inc. successfully deals with that pressure on a regular basis as it casts and machines a range of automotive components.

Typical of the parts Ryobi makes is a torque converter housing for a large truck transmission. The approximately 18"-dia. × 10"-long, A-380 aluminum casting is finish-machined on Mori Seiki and Makino horizontal machining centers. Each casting is clamped on a rotating tombstone, facemilled and subjected to more than 70 hole-making and finishing operations. Total machining time is 9 to 10 minutes per housing.

Ryobi engineers decided that the housing's oil filter mount represented an opportunity for process improvement. Finishing the mount previously involved milling three faces and machining a chamfered port, followed by a thread milling operation. Running at a spindle speed of 9,550 rpm and a 2,000 mm/min. feed rate, a 1"-dia. endmill tooled with PCD-tipped inserts first machined the face of the filter mount flat, milling a diameter of 92mm and a width of 11mm. Then the cutter stepped in 6mm and down 3mm and machined a 70mm-dia. × 5mm-wide seal face. To prevent leakage, the seal face has to be extremely flat and round; the tolerance on the diameter was ±25µm.

Next, the endmill moved to the center of the casting, milled a 36mm-dia. × 9mm-wide flat around the central bore and chamfered the mouth of the bore. Then a ¾"-dia. chamfer tool with a PCD-tipped SPG insert, run at 8,000 rpm and 5,994 mm/min., formed a 45° chamfer at the step between the 11mm- and 5mm-wide flats milled earlier.

Brian Murphy, Ryobi Die Casting

To improve productivity and part quality, Ryobi Die Casting developed this combination tool that replaced three tools in the machining of an oil filter mount (inset) for an aluminum transmission housing.

A standard M20×1.5 port tool, applied at 4,075 rpm and a 9,500 mm/min. feed, then opened up the 19mm-dia. × 20mm-deep bore and machined a 30° angle at its bottom. Ryobi applied a solid-carbide thread mill to complete the oil filter mount.

Brian Murphy, senior machining tooling technician, pointed out that the variety of tools employed and the degree of precision required added up to "a lot of adjustments, a lot of downtime." Ryobi inspects 100 percent of the parts after machining, and when coordinate measuring machine data determined that tool adjustments were needed to maintain tolerances, the milling machine had to be shut down for 5 to 10 minutes to make the changes. Adjustments were needed twice a day, in the morning and at midnight.

To decrease downtime and make the process more consistent, Murphy investigated consolidating the milling, chamfer and port tools into one unit. Designs from outside suppliers consisted of a solid bar with an HSK or 50-taper spindle connection. However, instead of a fixed connection, Murphy said, "We wanted modular capability to allow the tool to be easily adapted to different machines in the shop." Murphy conceived the idea of a cutting head mounted on a modified shell mill holder. Designing the tool, Murphy said, was "a very intriguing thought process."

The cutter has a total of eight PCD-tipped cutting edges. Each feature is machined by two inserts, located 180° from each other on the circumference of the tool "to stabilize the tool in the cut so it won't chatter," he said.

One pair of edges machines the first two faces, another pair machines the face that surrounds the bore, a third pair forms the chamfer between the first two faces, and the two cutting edges at the tip of the tool's porting element bring the bore walls to size for threading and machine the 30° angle at its bottom. In addition, a pair of thin carbide strips on the edge of the porting element further stabilizes the cutting action. The tool design includes six coolant ports.

Custom toolmaker Superion Inc. machined the HSS tool body, brazed on the PCD cutting edges and provided engineering assistance regarding cutting edge geometries.

The new cutter ran at 1,500 rpm and 9,500 mm/min. One pass with it replaced three passes with the inserted endmill and single passes by the chamfer mill and port tool. "We took away two tool changes and the maintenance of those tools," Murphy said.

Tool life is comparable to the tools used previously, with the PCD tips lasting up to 50,000 parts. Cost savings result from eliminating the need to buy multiple holders and maintain multiple tools. The tool can be used in different machines by fitting inexpensive but precise shell mill holders with appropriate spindle connections. Cycle time decreased 46 seconds, a "modest" saving, according to Murphy, but important considering the high part volumes.

The major benefits of the custom tool are downtime reduction and increased part quality. Minimizing downtime for tool adjustments is crucial, Murphy said, because "you have to have the machines running."

Part quality benefits from the consistency the tool provides because "everything is on center," Murphy said. "You don't have to worry about alignment, concentricity, runout and all that business because it's all in one tool." Troubleshooting is easier, too, he said, because the cutting edge relationships are fixed in one tool and there's no chance of adjusting the wrong tool in a sequence and then "chasing your tail" to keep the part in specification.

Regarding tool consolidation and standardization, Murphy said: "We've done a lot of this type of tool. In doing a long production run, when you standardize your tools, you get rid of unnecessary tool changes and adjustments. That reduces cycle times, and that's the way you make a lot of parts in a little time."

He emphasized that improvement at Ryobi is a team effort, including the people who set up the machines, the manufacturing engineer who fine-tunes the cutting parameters for the new tools and the outside suppliers who build them.

For more information about Ryobi Die Casting USA, Shelbyville, Ind., visit www.ryobidiecasting.com or call (317) 398-3398.

BY MICHAEL DEREN

The sky is not falling

My recent columns about manufacturing layoffs, jobs going overseas, and hourly pay and overtime have stimulated some exciting feedback and I would like to take the opportunity to respond.

Some readers expressed concern about the massive layoffs plaguing our industry. We've all seen headlines about corporations laying off hundreds or thousands of workers at a time. Unfortunately, the mainstream media likes to focus on the Chicken Little claim: "The sky is falling!" But, upon closer scrutiny, the layoffs often occur as a result of a merger or acquisition. Typically, when companies are acquired, the result is layoffs.

Looking at news stories about layoffs, you'll find many occur in the computer and telecommunications fields. This is not to say manufacturers don't have their own share of layoffs. Workers in the aerospace and automotive industries are typically hit the hardest. And, usually, thousands are laid off at once.

Every industry has layoffs, though. It is a fact of life—pure and simple. About the only field exempt from layoffs that I have seen has been the health care field. They can't seem to get enough help.

Readers also expressed concern about manufacturers closing their U.S. operations and moving them to foreign countries, primarily in the Pacific Rim. It's true that many jobs have gone across the border and overseas. Companies figure that they can profit by using cheaper labor forces in Mexico, China and other low-labor-cost countries. A business owner I know in India pays engineers $3,000 to $5,000 and machinists $1,000 to $2,000 per year.

But, many companies are finding out that you get what you pay for and are bringing production back to the U.S. For example, Tempo Products Co. Inc., a Solon, Ohio, manufacturer of marine fuel tanks and accessories, recently discontinued its relationships with two companies in Taiwan. Why? Mainly poor quality control, high transportation costs and long lead times, because products took weeks to ship.

Other readers indicated that manufacturing industry wages were low for the first 10 to 15 years of their career and that they did not see overtime as a benefit. My view is that many employers value their employees and pay them accordingly. Sure, manufacturers may not pay well at first, but at least you'll start at a decent wage. As you gain experience, the money follows. And, yes, someone with minimal skills can make $10 to $12 an hour waiting tables or working at the checkout line. But 5 years from now, those skills will still be worth $10 to $12 per hour. Five years from now, that entry-level machinist will earn at least 30 percent more because of his experience.

Overtime, you have to remember, is a benefit. It doesn't happen all the time.

Overtime, you have to remember, is a benefit. It doesn't happen all the time. By working that 50- to 65-plus-hour week, you bring home a larger paycheck. This is not guaranteed, so don't count on it. Too many times I have seen overtime shrivel away to nothing, and hear employees complain that they aren't bringing home enough money. I have always believed it's best to live on 40 hours of pay per week; when the overtime is there, save that additional money for goodies like vacations or extras you would not normally buy.

I value all readers' comments, even if their views differ from mine. The exchange of ideas and opinions is why I enjoy writing this column, so keep your comments coming. △

About the Author

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