SEPTEMBER 2008 / VOLUME 60 / ISSUE 9

STAYING SHARP

manager's desk

By Keith Jennings

Chain of command

While serving in the military years ago, I became accustomed to adhering to a chain of command, which instills a sense of order and respect and provides a way to address issues of importance. A soldier or sailor knows not to burden a high-ranking officer with something that can be handled by a junior lieutenant.

Following this same logic in a shop, the owner shouldn't be dealing with tasks that a CNC operator or maintenance technician is supposed to handle, but it happens and can create problems. A clear and well-understood chain of command is critical if you want to ensure all employees, including management, are making the best use of their time. Because many machine shops are small businesses with 10 or fewer employees, the thought of an actual chain of command may seem like an unnecessary concept. But even small shops can reap benefits.

A clear and well-understood chain of command is critical if you want to ensure all employees, including management, are making the best use of their time.

Perhaps the owner is handling most administrative functions, making the chain-of-command chart mostly straight lines from workers to management. This is common and may be all that's necessary because employees understand their responsibilities. However, many shops have more than 10 employees, so this chain of command becomes an important concept to establish.

Our family-owned company has a hands-on owner at the top of its chain of command. To diagram this would show many lines going directly to the owner because he desires to be in charge. Although not typical, this is workable as long as employees know and understand the arrangement. However, overlap of responsibilities can creep in and muddy the machining waters. After all, when an event occurs requiring some oversight or disposition, the employee involved in the incident may find everyone from his junior co-worker to the QA manager to the vice president hovering around, asking questions and barking commands. If you've ever been in this situation, you'll understand why the military enforces the chain of command.

The multiple opinions and analysis can create more problems than they fix because everyone wants to add their two cents' worth. If such a scenario is common at your shop, it's probably time to dust off the policy and procedures manual and review the company's chain of command, ensuring it's accurate and embedded in the minds of all employees. The chain will provide a sense of relief to employees because they'll understand how to deal with situations and who should be involved.

As much as possible, give employees the opportunity to resolve problems before moving up the chain. Procedures should be followed, involving others only when necessary, and workers should be given an opportunity to explain uninterrupted what occurred and how it was handled.

Because many shops are certified by ISO or another organization, a clear chain of command is required. After a while, however, responsibilities tend to overlap and the chart becomes a pretty, but obsolete, diagram that's rarely followed. At that point, any situation, good or bad, tends to bring out anybody and everybody clamoring to inform the world how the situation should be resolved. Watch out! That can damage worker confidence. Also, the situation will be handled inefficiently because it should've involved only three or four people. While the desire to "fix" things may be intense, it may be better for the manager to back off and allow the chain of command to dictate who should take care of something. If a shop follows this technique that the military demands, all employees should find themselves making much better use of their time. CTE

About the Author: *Keith Jennings is president of Crow Corp., Tomball, Texas, a family-owned company focusing on machining, laser cutting, metal fabrication and metal stamping. He can be e-mailed at kjennings@jwr.com.*

Making it simple

By Bill Kennedy, Contributing Editor

Full-service machining services provider Sadler Corp., Stow, Ohio, routinely handles big parts. Its MAS vertical milling and drilling machine has an 8'×36' table, and on it Sadler processes large components for the oil, hydroelectric power and processing industries. However, the shop machines small parts, too, and some of those constitute a big challenge to produce in a cost-effective way.

A good example is a 1"-dia., ½"-long nylon cap used in food processing equipment. As a favor for a steady customer, Sadler managed production of the part by subcontracting it to a CNC turning shop. Owner Ron Sadler said, "Ordinarily, because of all the diameters, you would look at this as being a turned part." But outsourcing it was expensive. "Based upon what they were charging, my guess is that the turning shop probably had 12 to 15 minutes in each part," Sadler said. To reduce the cost for his customer, Sadler developed a process incorporating a simple but innovative fixture and a machining program that enables the caps to be completed in about 1 minute each.

Sadler machines the parts on a Haas VF-1 vertical machining center from 12" lengths of 1⅛"-dia., general-purpose 6/6 nylon rod stock. The fixture consists of a right-angle steel plate clamped on the machine table. An 18"×2½"×2¼" bar screwed to the side of the plate has eleven 1⅛"-dia. holes drilled through the 2¼" dimension, perpendicular to the table. Each of those holes features a radial ½"-dia. hole drilled and tapped to receive a setscrew.

To set up the job, the operator pushes a piece of nylon rod up through each hole in the fixture. He places an aluminum cap counterbored to a depth of ⅝" over the top of each rod (one at a time) to act as a stop and establish the correct extension of the rod above the fixture and


Sadler

This simple but innovative fixture permits seven parts to be machined in one setup.

B. Kennedy

Ron Sadler developed a process incorporating a simple but innovative fixture and a machining program that enables these 1"-dia., ½"-long nylon caps to be completed, burr free, in about a minute each.

then tightens the setscrew. Said Sadler, “It’s not critical whether we push the rods slightly sideways or not, although we hold it pretty close, because we machine all of the bores, ODs and undercuts at the same time so everything is exactly concentric.”

According to Sadler, the workpiece material presented one of the job’s stronger challenges. “The nylon is stringy and very difficult to properly deburr. When you run a knife along a sharp edge to try to cut the burr off, you are left with little slivers of plastic. In this setup, sharp tools work every edge,” he said.

All the tools are HSS except for a ¼"-dia., solid-carbide, PVD-TiN-coated, 3-flute Dataflute endmill that does much of the finish profiling. Modification of two of the tool’s shanks is necessary to enable them to perform some of the internal profiling operations. “We have to grind the shank of one Woodruff cutter to 0.250"-dia. and a dovetail cutter shank to 0.200"-dia., because otherwise they would interfere with the part. We do that on our OD grinder,” Sadler said.

Flood coolant is used throughout. In the first operation, a 1¼"- dia., 6-flute HSS finishing endmill faces the top of all seven rods at 5,000 rpm and a feed rate of 120 ipm. Next, at 5,000 rpm and 60 ipm, a 2-flute cobalt-HSS drill with a 135° tip drills a 0.531"-dia. radial hole 0.56" deep in the center of each part. The hole is a rough bore finish milled by the next tool.

That tool is the ¼"-dia. Dataflute endmill, running at 7,500 rpm and 45 ipm, and it performs three operations: finishing the ID and OD by circular interpolation, and cutting a 0.31"-wide × 0.28"-deep notch through the side of the part. Between each operation, the tool rolls around the notch’s sharp edges. “We are not only putting in the notch, we are deburring it at the same time,” Sadler said.

Next, a ½"-dia. Woodruff cutter with a ⅛"-thick blade, running at 2,000 rpm and 40 ipm, descends into the bore and circular interpolates a counterbore at the bottom of the part.

Then a ½"-dia., 45° dovetail cutter—“it looks like an umbrella that the wind has blown inside out,” Sadler said—enters the bore and simultaneously circular interpolates 45° angles at the bottom of the part and on the lower side of an ID step. The tool also circular interpolates a 45° chamfer ring groove at the bottom of the part’s OD to prepare it for cutoff. The dovetail cutter runs at 2,000 rpm and 45 ipm.

In another multifunction pass, a ¼"-dia., 90°, 2-flute chamfer cutter follows the geometry of the part’s top surface,

creating a chamfer and deburring it at the same time. Sadler said, "It catches the ID, the OD and the top part of the notch, chamfering everything on the top side."

In the final operation, a 1"-dia., 0.062"-wide Woodruff cutter circular interpolates the part's OD to cut it off. At cutoff, tool and coolant pressure slide the parts off the fixture, generally in the same direction. "We put a basket down in the VF-1 mill, and I'd say 85 percent of the parts go into the basket," said Sadler.

After seven parts are completed, the operator loosens the setscrews, pushes each rod against the cap and starts the process all over again. Cutting time for all seven parts in one fixturing is 6 minutes, 35 seconds; "including rapids and tool change time, I figure my cycle time for seven parts is somewhere in the area of 7 minutes," Sadler said. The part is made in lots of 200.

The process "really makes a nice part, because everything is deburred," Sadler said. "All that remains is a little tip on the bottom. We hit that on a piece of flat emery cloth, and with two swipes it's gone and the part is done."

"There would be nothing wrong with doing it on a mill/turn center but we don't have one," Sadler continued, "and frankly, since this runs so well, even if I had a CNC lathe with live tooling, I don't think I'd run it there. This runs too perfectly."

Sadler added that this degree of thought and focus on reducing complexity is typical at his shop. While a seemingly simple job can turn out to be a nightmare, he said, "If you do it right, you can take a nightmare and make a nice, simple job out of it." CTE

For more information about Sadler Corp., call (330) 688-0009.

contact us

If you have manufactured a part that would make a good candidate for a Part Time article, contact Contributing Editor Bill Kennedy at (724) 537-6182 or billk@jwr.com.

Educating for manufacturing

By George Weimer

"Our failure to address America's adult education and workforce skills needs is putting our country in great [economic] jeopardy," according to a report from the National Commission on Adult Literacy, New York. Some 90 million workers in this country didn't graduate from high school or attend college, can't speak English adequately or have had no access to special skills training.

Shop managers know the problem. So where do shops go for the needed technical training and education? The machine tool industry is one great source.

Consider Haas Automation Inc., Oxnard, Calif. The Haas Technical Education Center (HTEC) network now has 725 partnerships with schools, colleges and universities throughout the U.S., according to said Bob Skodzinsky, manager of the program. "Our single biggest goal is to make sure there are enough skilled people for our customers," he said.

The program is a cooperative effort with the Haas Factory Outlet (HFO) network and manufacturing-oriented training centers. HFOs are independently owned distributors of Haas equipment. HTEC members participate in local and regional meetings and a national conference. HTEC membership also provides access to vendor products, including tooling and CAM and training software at deep discounts. The HTEC program is open to accredited educational institutions that have manufacturing-oriented programs.

Haas also has a Web-based training program, LearnHaas.com, which teaches CNC operation and programming specific to Haas machines as well as general manufacturing skills.

Haas loans machine tools to participating schools "to improve the level of technology offered in those schools," said Skodzinsky. "Schools can purchase these same machines at a significant discount." Details on the HTEC program are available at htecnetwork.org.

Another builder with an extensive educational program is Mori Seiki USA Inc., Rolling Meadows, Ill. "We're very concerned about employees, distributors, customers and suppliers in terms of education," said Rod Jones, the company's chief learning officer. Mori Seiki devotes 1 percent of its revenue to education. The company established its own education center with a dedicated 9,000-sq.-ft. facility near Chicago. "Mori Seiki University was established to keep the expertise of our employees, distributors and customers on par with today's rapid rate of technological advance," Jones explained. The program is online at MSU ondemand.com.

The company's educational efforts are aided by nine tech centers in the U.S., and the ones in Chicago, Dallas, Detroit and Monroe Township, N.J., provide training. The company also offers extensive online training. Online courses include machine operator training and advanced manufacturing skills, including reading blueprints, shop math, metrology, 5-axis machining, lean manufacturing and statistical process control. Course fees vary, but Jones said a typical set of courses for 25 employees might cost $500 per month.

Other machine tool builders offer various levels of training and education. Like other machine builders, Mazak Corp., Florence, Ky., delivers training with each machine it sells. "We have user group classes and seminars on topics like multitasking," said George Yamane, Mazak marketing manager. "We offer hands-on training as well." Mazak also works with Northern Kentucky University and Gateway Community College on technical training courses.

"Training is going on all the time," he added. "New machines? That means new training needs. We don't have standard training with our customers because they are all different."

While it's gratifying to see such educational efforts from machine builders, challenges remain in the U.S. and around the globe. Germany, long known for its engineering and manufacturing prowess, is reporting severe shortages of young people interested in manufacturing. To increase interest, companies are donating materials and money to kindergartens to interest youngsters early on in science and technology to help ensure that Germany's workforce retains its legendary engineering excellence.

For example, Siemens AG, Munich, Germany, an electronics and electrical engineering conglomerate, has delivered some 3,000 "discovery boxes" to nursery schools and kindergartens at $775 per box. These contain various science experiments for children 3 to 6 years old.

So while U.S. machine tool companies are providing excellent training and educational opportunities for their employees and customers, it seems the Germans have some other ideas about when to start interesting people in engineering matters. Simply put, the manufacturing industry needs an even bigger effort in terms of education in the U.S. **CTE**

About the Author:

George Weimer, a freelance writer based in Lakewood, Ohio, has an extensive background in the metalworking industry's business press. Contact him by e-mail at gweimer@jwr.com.

Procuring a milling machine

By Edward F. Rossman, Ph.D.

Manufacturers need to have long-range plans to guide them in making capital investments, such as a large machine tool for milling titanium. The following are specific examples of what three different companies did to solve the same milling need for an aircraft weldment application. The part envelope was about 10'×4'×4' and required a 5-axis machine.

- Company A purchased a new mill with many bells and whistles for $6 million and installed it in a lowlands area where pilings and a foundation brought the total cost to $9 million.
- Company B bought a more modest machine for $2 million and installed it on a special foundation, but in a location where pilings were not required.
- Company C modified two existing horizontal boring mills and did not have to redo foundations. The company converted the 3-axis boring mills to 5-axis ones by changing to a nutating head that added the A and B axes, changing to a 5-axis controller and extending the Z-axis along the floor to allow the part to move up to 6' away from the head in the axial direction. The total cost was $500,000 per machine.

After 10 years, Company A no longer exists because of high costs. Company B had to buy a second machine for $2 million to increase capacity for a total investment of $4 million and is still running the parts. Company C reworked a third boring mill for a total investment of $1.5 million and is also still milling the parts.

The point is that many solutions exist for a given problem, and companies can certainly learn from others' experiences. Do your research and homework and it might save you a lot of money.

The company that spent $9 million got caught up in a trap—the people entrusted with the task of specifying the machine to be purchased wrote the specifications so tightly that there was only one machine from one machine tool builder that could meet the specifications, eliminating competition among machine suppliers.

Because every factory has its own culture, it should develop its own strategy for machine procurement. The following are examples of some companies' strategies.

One company buys only used machines, and it also buys extra machines for spare parts. Its policy is to minimize capital investment to achieve lower overhead and bidding wrap-rates than its competitors. This company is lowering capital costs by purchasing less new technology.

Another shop buys new and rebuilt machines from only one company. The agreement with the machine tool builder means the shop doesn't have to start paying for the machines until 1 or 2 years after they are installed. Costs are further reduced by stocking spare maintenance parts and training for machine maintenance. There is no interest accumulated and the rates are below 7 percent. This gives the shop a year or two to get work loaded on the machines to establish income from which payments can be made. The obvious risk here is in being able to get new work for the machines, but all shops face that challenge.

Other companies may buy various new and old machines and competitively bid each order. This allows them to acquire new technology at competitive prices, but they must start payments for the machines early.

Finally, if a newly acquired machine requires a special foundation, then it is important to consider where to place the machine relative to other machines and processes. Sometimes, more consideration is needed for where a facility is located. For example, one machine with a special foundation was located about 20' from a busy railroad, and 54 trains passed the machine each day. Unfortunately, the milling patterns on parts became a permanent record of the trains passing. Milling variations can cause part rejections or, at best, require sanding and bench work to salvage the parts. This factory abandoned the property and paid for a new foundation in a location away from the railroad.

Another factory was built on a flat floodplain; it is 60' down to hard pan soil. Therefore, special foundations under heavy machines require pilings that are more than 60' deep. The cost of the foundation for one machine 100' in length was about $3 million. **CTE**

About the Author: *The late Edward F. Rossman, Ph.D., was an associate technical fellow in manufacturing R&D with Boeing Integrated Defense Systems, Seattle. Rossman's Shop Operations column is adapted from information in his book, "Creating and Maintaining a World-Class Machine Shop: A Guide to General and Titanium Machine Shop Practices," published by Industrial Press Inc., New York. The publisher can be reached by calling (212) 889-6330 or visiting www.industrialpress.com.*

Multiaxis machining myths

By Karlo Apro, CNC Software Inc.

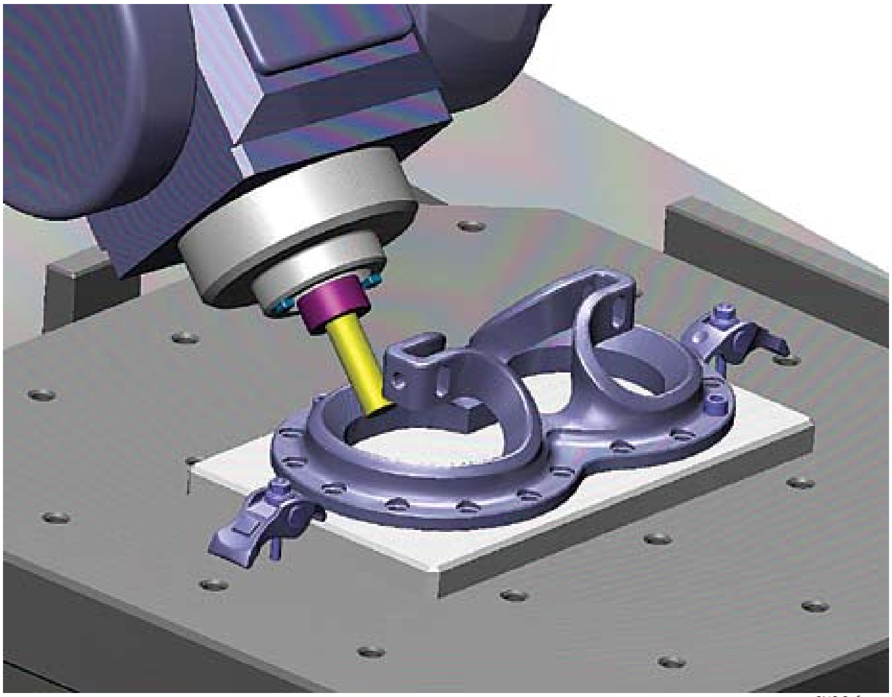
Many misconceptions exist regarding 5-axis machining. This column will dispel a couple of them and explain when it makes the most sense to use multiaxis machining.

Misconception No. 1: 5-axis machining is not for me; I do simple parts.

Most people associate the term "5-axis" with complicated motions and programming techniques. This view is reinforced by visits to trade shows where attendees see machine builders and CAD/CAM vendors showing their most complicated creations, including impellers, racecar engine heads and induction pumps. Most 5-axis users never make those types of parts. Shops typically machine parts using simple 3-axis drilling, contouring and pocket milling routines, while rotating the part occasionally in a rotary indexing mechanism.

Elaborate parts can be machined by applying 3-D surfacing toolpaths and engaging the part from different angles using an indexing rotary table. Using a multiaxis machine greatly simplifies the motions required, the programming effort and the amount of fixturing needed for machining complex workpieces.

Many shops are making parts by moving them manually to different fixtures on 3-axis machines. Compared with this procedure, production can be increased significantly without much effort by using a 4- or a 5-axis machine tool. If a single- or dual-rotary indexing table were added, only slight edits would be needed to the CNC-code files.



CNC Software

Moving to multiaxis machining requires thinking in 3-D instead of in a flat plane.

Moving to multiaxis machining requires thinking in 3-D instead of in a flat plane. Once you enter the multiaxis realm, new doors will open for your shop. Your company will quickly become more adept and able to tackle more complex work.

Misconception No. 2: Multiple-axis CAD/CAM is too complex and expensive.

That may have been true in the past, but not anymore. If you own a CAD/CAM system, there is a good chance you already have 5-axis positioning capabilities. Most CAD/CAM systems include these capabilities in their base packages. Many times, it is just a matter of training to get up and running.

When shopping for a CAD/CAM system, make sure to choose one from a reputable company with a commitment to training and local support. Remember that a CAD/CAM system is just another tool in your tool belt. You can buy fancy tools that are capable, but they are worthless if you don't know how to use them. Having local support may be the most important feature of your new tool.

If you do a lot of simultaneous multiaxis work, the CAD/CAM system is only a small cost factor. More training will be needed, but you will be able to charge almost double for your hourly machine time. The "hard to use" part always comes down to training. Think back: Was it easy to learn how to operate your first CNC machine?

Don't enter the multiaxis world by starting with a complex, simultaneous job. If you own a 3-axis machine, start with a single- or dual-rotary table and apply indexing techniques. You will make parts faster and more accurately, and you will be able to invest in more equipment. When you decide to buy new equipment, see if you can bundle a CAD/CAM purchase with the machine's purchase order. This is also a good time to make sure the CAD/CAM system speaks your specific machine's language—in other words, that it has the correct post-processor.

Multiaxis machines can reduce setup time, eliminating costly and time-consuming custom fixturing for secondary operations. Most parts can be manufactured in one or two setups on a multiaxis machine.

Every time you move a workpiece from one fixture to another, there is a risk of misalignment—either during the setup itself or during machining. It is easy to build up, or stack, errors between machined surfaces when they are milled in multiple setups. Indexing rotary tables and dedicated multiaxis machines can allow use of shorter and more rigid high-speed cutters than may be possible on less sophisticated machines. More aggressive cuts can then be taken at higher spindle speeds and feed rates while high levels of accuracy are maintained.

Using shorter tools causes less tool deflection, which minimizes vibration. When a shop applies ballnose cutters, toolmakers recommend that the contact point be moved from the cutter's tip, which isn't spinning. By tilting the tool, the workpiece can be engaged by a desired cutter area, which not only improves surface finish and repeatability but also extends tool life.

On a 3-axis machine, some parts are impossible to produce while others require too many setups to be profitable. Once your shop gets comfortable with indexing work, you can start machining parts using simultaneous multiaxis motions and open your business to new possibilities. **CTE**

About the Author:

Karlo Apro is senior applications engineer for CNC Software Inc., Tolland, Conn., and author of the book "Secrets of 5-Axis Machining," published by Industrial Press Inc., New York. For more information about the company's Mastercam CAD/CAM software, visit www.mastercam.com, call (800) 228-2877 or **enter #360 on the Information Services Card.**

By Michael Deren

The art of cost reduction

Things are going good in the shop, and your company is making money on parts you're running. But you're probably still not maximizing profits by realizing savings. In some cases, achieving savings takes a concerted effort. In others, it's like picking low-hanging fruit.

Typically, production houses can achieve savings by reducing cycle times by seconds or fractions of a second. This is especially true at facilities running screw machines or Swiss-style machines where lot sizes can be in the thousands or tens of thousands.

The math can be simple. A part costs, say, 10 cents to make, and the cycle time is 10 seconds. The production house produces six parts per minute, or 360 parts an hour. That equals $36 per hour. An order of 10,000 pieces takes 27.78 hours and costs about $1,000 to make. Reduce cycle time by 1 second per part, and part throughput becomes 400.2 parts per hour. That order of 10,000 pieces then takes 24.99 hours to run and costs nearly $899.64, a savings of $100.36. The piece costs and hourly costs are hypothetical, but you get my drift.

You're probably still not maximizing profits by realizing savings. In some cases, achieving savings takes a concerted effort. In others, it's like picking low-hanging fruit.

Savings in "nonproduction" or low-production settings are more difficult to achieve, but they are achievable and can be just as dramatic—especially for repeat jobs. For example, I worked at a company that machined one or two large stamping dies and molds each month as part of its workload. As time passed, we tried different approaches to reduce cycle time. First, we increased the amount of step-over by 50 percent when finish milling the molds. That reduced the finishing cycle time by about 50 percent, from more than 24 hours to 12.

At $100 per hour, we saved $1,200 per mold—without any additional upfront costs. The mold had a male and female component, so the total savings was $2,400. Not only did we save 24 hours of machining center time, but we opened 24 hours of time on those machines for other work. However, each mold required about 30 more minutes of polishing than previously because of the increased step-over.

We also investigated the roughing tools and found that by changing toolmakers and using a different insert grade, we reduced our roughing cycle times and insert costs.

Sometimes by taking little steps you wind up covering great distances. Say you mill a part and need to use quite a few cutters. Target a cycle time reduction of, say, 10 percent. (I just happen to like 10 percent because it's an easy number to work with.) One way to achieve this is to increase each cutter's feed rate by 10 percent. If you're feeding at 10 ipm, try 11 ipm.

Another way to reduce cycle time by 10 percent is to increase the DOC by 10 percent. If you're going 0.250" deep, try 0.275" deep. After using these two techniques a few times on various parts, it will become second nature. One or the other will work. In some cases, both work on the same cutter.

When implementing cost reductions, you don't have to get all the reductions by focusing on just one method. You'll find that by trying several different little things, you can save more than by targeting one big item. **CTE**

About the Author: *Mike Deren is a manufacturing engineer/project manager and a regular CTE contributor. He can be e-mailed at mderen1@roadrunner.com.*