JANUARY 2008 / VOLUME 60 / NUMBER 1

BY KEITH JENNINGS

Growth by gut instinct

The new year has arrived and—if you're like me—you're excited to start working on some new projects. This includes adding new customers. Shops love repeat work, but customer diversification is essential to expanding a business and taking it to the next level.

Are your managers and supervisors also excited and ready to tackle the many new opportunities that should materialize throughout 2008? Maybe yes and maybe no. After all, if repeat work is strong, why impose additional development hours on new jobs? Therein lies the problem. Complacency and comfort can be dangerous to a business.

It's no secret that cash-flush Chinese and European conglomerates are aggressively targeting U.S. OEMs for investment and ownership. One day, you may get a letter from a great customer informing you that "new ownership is making changes that may affect the business relationship with your shop." Then the new owners are free to take your expertise and component improvements and pass them onto a new supplier. That's why it's essential for a shop to diversify its customer base as much as possible and to aggressively pursue new accounts.

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But what happens if a lead engineer or shop manager says "no" to some of that diversification? What if they're not thinking aggressively and don't recommend taking a job that you've evaluated and determined is worthwhile? After all, you value their input.

There are times, however, when your instincts tell you to pursue something anyway and ignore employee feedback. Whatever the reason, sometimes going it alone and taking a risk is necessary. This inevitably leads to the occasional disappointment or wrong decision, and you'll likely remember that original discussion when someone said not to take this or that job. You may question your judgment, but don't. Even if an occasional situation doesn't work as planned, it's not a failure. Nobody's right all the time. But being decisive and going against the advice of others can pay off.

Should you consistently ignore or follow employees' advice? No, but I remember a situation in which my father, Chuck, the shop's owner, decided to hold his own against a large account that was giving us a pricing ultimatum. The company explained that it would take this work from us if we didn't comply with its pricing demands. Although most of our employees recommended complying with the customer's request, my dad didn't flinch. He and I went to the customer's corporate offices and politely said we weren't changing any pricing patterns, and if it couldn't accept that, then thanks for the business and find a new supplier. Not only did the customer remain with us, but it accepted a price increase to remain in our top tier. My dad followed his instincts, and I learned from that experience.

I also remember when allowing an employee to make a judgment call that differed from management's view proved beneficial. A large engineering company contacted our shop about our machining capabilities and requested a quote on some of its work. Because our experience with large corporations wasn't previously successful, my dad had little confidence the engineering company would follow through on its promises of sizable production jobs if our price was right.

Our lead estimator, however, insisted we could do it and patiently worked to provide a thorough review and quotation in spite of my dad's insistence that this prospect was a waste of time. After the usual haggling and revisions, the engineering company placed multiple orders and is still placing orders—more sizable than ever—today. Initially, it didn't seem to be a good use of the estimator's time, but it was.

All of us can recall decisions that were contrary to prevailing opinion and probably considered crazy, but were successful nonetheless. It's not always easy to be decisive or allow employees to follow their instincts when it differs from yours, but a diversified customer base and bigger backlog could be the result.

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.

Defining 'world class'

BY EDWARD F. ROSSMAN, PH.D.

The first in a series of columns drawn from the book "Creating and Maintaining a World-Class Machine Shop."

Being a successful supplier requires more than just average capabilities in personnel and equipment. Many of the traits that define a world-class machine shop apply to any fabrication factory, but the core thought here is to define the characteristics of a shop that machines titanium alloys. The following are some of those characteristics.

■ **Select employees carefully and train them properly.** Employees—especially managers—should be selected for their "fit" with the rest of the team. A machine shop must be willing to take risks and let the staff make mistakes. Everyone should have a say in the operation, which must be open to change. Companies have discovered that the quality of all personnel, not just machine operators, must be high to meet customer demands. They therefore establish training programs that include machine operators and other staff. This training is sometimes linked to a community college that can become a conduit for recruiting. In world-class shops, in-house training equipment and software is exchanged about every 3 years to stay abreast of the latest technology. Training in all facets of manufacturing and management has to be ongoing and not just a one-time happening. Grouping managers and operators together for training helps to break down communication barriers and boundaries between labor and management.

■ **The workplace must be clean and safe.** The entire shop needs to be clean with carefully marked areas. Titanium can burn when machined and the fires are difficult to extinguish, so special care is needed when making and storing chips.

■**Be flexible to quickly create work cells.** The ideal shop has solid concrete floors at least 6" thick and provisions for quickly moving light equipment to form efficient work cells. This flexibility is most efficient in a shop with a thick floor because machines do not require foundations or being bolted to the floor. When I designed a factory a few years ago, we hung all electrical lines with receptacles just above head level. Every machine used 440v, 3-phase current, and all machines and outlets were phased alike so the machine motors would rotate in the proper direction regardless of where they were plugged in. All air lines were routed with one kind of fitting—tees. No couplings or elbows were used. This allowed us to add extra airdrops without major expense. Using all tees is not an extra cost because elbows, tees and couplings cost about the same, and the initial labor for installing them is about the same as for other fittings. With solid floors and a useful grid of air and electrical outlets, equipment can be rearranged into work cells in minutes without having to bring in outside contractors.

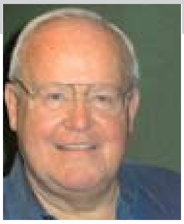
■ **Focus on continuous improvement by growing appropriately.** Several companies I know have allowed too much growth—greater than 50 percent in a business year—to maintain proper quality. The influx of fresh people couldn't be trained properly. One company I worked for had a strict policy that limited growth to a maximum of 30 percent per year to help ensure that ambition would not overtake the ability to add properly trained employees. Technology is moving at a high pace, and a shop needs to stay competitive by investing in research. The amount spent on research depends on the characteristics of a shop's products. The ideal shop performs some internal research, such as testing new cutters, but they are also benchmarking their competition and are learning to share technology when appropriate.

■**Keep equipment well maintained.** Equipment should be maintained and calibrated on a regular basis. A preventive maintenance program that involves the machine operator is also required. Policies need to be in place to minimize spindle and toolholder runout to within 0.001" TIR to meet the drawing specifications of most airframe manufacturing. These policies also extend spindle and cutter life.

About the Author

Edward F. Rossman, Ph.D., was an associate technical fellow in manufacturing R&D with Boeing Integrated Defense Systems, St. Louis. Known as "Dr. Titanium," he passed away Oct. 7. 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.

BY GEORGE WEIMER



Machine tools: every economy's heartbeat

Ask anyone what is the most important part of the economy, the most essential part? Answers vary, depending upon the person's own work experience.

Few—very few—will point to machine tools as a vital part of the economy. I am one of those few. Machine tool consumption is one of the major reasons the U.S. is still the world's leading manufacturing nation. China may pass us next year or the year after in terms of total output. Consider, however, its 1.4 billion people vs. our 300 million. Machine tools are central to the success of both economies and any others that want to stay competitive in the global manufacturing arena.

I have been covering the manufacturing industry for some 40 years as an editor with industrial magazines and as a consultant. Even after 4 decades, however, I am still amazed at how many Americans are completely unaware of this small, but absolutely essential industry. No machine tools? No modern economy. It's that simple to me and to you, but it's a mystery to most Americans.

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So how do we stack up in terms of this superessential industry? Several groups, governmental and private, provide annual statistics about machine tool production and consumption by country. The following statistics were assembled for CUTTING TOOL ENGINEERING by AMT—The Association For Manufacturing Technology. They show the 2006 per capita consumption (purchasing) of machine tools in some 30 countries.

So which countries do you think are at the top in terms of investing per capita in its productive future?

Well, it's not Japan or Germany. It's certainly not the U.S.—and hasn't been for a couple of generations. Three nations, all small, have been leading the rest of the world in this crucial measure for several years—Switzerland, Taiwan and South Korea. In other words, those three are the leading nations in terms of increased productivity. Simply put, that's how they got rich and plan to stay rich.

Taiwan led in 2006 at $127 per citizen. Next came Switzerland at $109, followed by South Korea at $105.

China, Germany and Japan in 2006 were, as you might expect, among the leading countries in terms of total expenditures, but not in terms of per capita numbers. Japan's per capita consumption was only $33, while Germany's came in at $62. Italy, always a leader in machine tools, came in at $65 per person, and Canadian industry spent $53 per person.

Of course, these numbers may seem irrelevant when compared to the total amounts spent by countries like China, Japan, Germany and the U.S. Indeed, the People's Republic of China spent far more than any other country on machine tools in 2006, well over $13 billion compared to the U.S. (surprise, we're No. 2 in this category) at $6.4 billion, less than half the Chinese total. Germany? $5.2 billion. Japan? $4.2 billion, which is less than South Korea's $5.1 billion, according to AMT's calculations. Italy? Nearly $4 billion.

Russia's per capita consumption? A paltry $6 per citizen and a total of $142 million. That per capita number is near the bottom of the list. The bottom country was India, at a little over a dollar per each of its 1 billion-plus people.

Of course, there are the countries that buy hardly any machine tools. Those nations are almost entirely poverty stricken. The message is clear. A powerful, successful economy must have a thriving market for modern machine tools. The U.S. has a great one, but I think we can do better.

Our per capita number? $21. Not in the top class, but not in the bottom group either. It's about the same as France. In terms of total expenditures, our No. 2 spot means we need to try harder.

I will be discussing just how we might do that in terms of new technologies, R&D and new ideas about automation in this column every month. Let me know what you think, pro or con.

Editor's Note: CTE is delighted to welcome George Weimer as the author of this new monthly column. Based in Lakewood, Ohio, Weimer has an extensive background in the metalworking industry's business press, having served on the staffs of Steel, Iron Age, Industry Week, American Machinist and Automation magazines. Contact him by e-mail at gweimer@jwr.com.

A better dam part

BY BILL KENNEDY, CONTRIBUTING EDITOR

Primarily a job shop, Cascade Machine and Supply, Great Falls, Mont., also handles military contracts and stocks bearings, hoses, belts and other supplies related to its repair and replacement work for local agricultural and processing companies. "If someone brings a shaft in and it's got bad bearings, we can make them a new shaft right away and provide the bearings," said co-owner Bob LaRance.

The business's job shop work leads to dealing with "some strange stuff," LaRance said, such as reverse engineering and machining a replacement for a century-old assembly used on a hydroelectric dam. At the same time, the shop upgraded materials and added features intended to increase the new assembly's longevity.

The assembly, called a gate screw actuator flange, is part of a system that lifts and lowers flow-control gates on hydroelectric dams. The actuator flange consists of a 6"×6"×1¾" plate with a 3⅝"-long × 3½"-OD × 1¾"-ID internally threaded, cylindrical insert screwed into its center. In operation, a 7'-long threaded shaft turns in the insert when the gate moves.

Cascade's customer provided a rusty sample assembly. The flange was made of mild steel. The yellow brass insert had no tensile strength, and the steel shaft had pulled the threads off of it. "In fact, the insert threads were still on the shaft," LaRance said.

At first, LaRance made two new emergency replacement inserts. Because the replacement inserts were needed quickly to resolve a breakdown, the dam operator reused the original flanges.

LaRance took apart the sample assembly, and the customer supplied a sample of the threaded steel shaft. With those parts he was able to obtain the needed dimensions.

To increase the insert's strength, LaRance upgraded the stock material after he found a source for 1¾"-ID × 3½"-OD aluminum-bronze tubing. Having the workpiece material dimensions so close to the final part dimensions helped, and the alloy machines well. "It's not gummy, and it's not real hard," he said.

Mounting a 3⅝"-long piece of the tubing in a 3-jaw chuck on a Haas SL30 CNC lathe, LaRance applied a Kennametal CNMG-432 PVD-coated carbide insert at 800 to 900 sfm to face the end, mildly radius the edge and perform a cleanup turning pass

Cascade Machine and Supply

Cascade Machine and Supply reverse engineered and machined a replacement for a gate actuator assembly from a century-old hydroelectric dam and simultaneously upgraded materials and added features intended to increase the assembly's longevity.

on the 3½" OD. The insert screws into a 3¼"-12 thread in the flange, so LaRance next flipped the insert in the chuck and turned it to a 3¼" diameter. "Right where it butts up against the larger diameter, it's grooved a little bit, so when I thread it my thread runs into the groove," he said. He cut the external threads with a Sandvik Coromant 1015-grade TLPP-3R threading insert.

Next, in preparation for internal threading, LaRance used an 80° diamond insert to clean and enlarge the insert bore to a 1.758" diameter. The 2¼"-2 internal thread was a challenge because it was "a weird Acme thread, not exactly a 29° angle; it came up to be about a 40° included angle," LaRance said. "I had to rig something up to make it."

To cut the thread, LaRance ground a ⅜"×⅜"×1⅝" piece of HSS to match the shape of the shaft thread.

Then, LaRance had to make a special boring bar to hold the custom threading tool. "I needed something small enough to fit through the bore, but stout enough so it wouldn't chatter," he said. The bar had to extend through the insert bore's 3⅝" length. LaRance made the 9"-long bar from 1½"-dia. cold-rolled steel. "I milled the face with a ⅜"-wide Woodruff cutter far enough to get that HSS insert in there," he said.

He drilled and tapped a small hole and used a screw and washer to secure the insert. "Pretty crude, but it did the job," LaRance said.

To minimize chatter, cutting the threads required a delicate approach. "You can set a minimum DOC with the threading G code on the machine, so I set it to about 0.001" per pass," LaRance said. "I was running it at about 60 rpm. I didn't push it; I wanted a nice clean thread." Chips were "almost feathery," he added, and broke easily. Flood coolant was applied through ports in the toolholder.

Turning operations consumed about 10 minutes, but making the thread took about 2 hours. “There was a little bit of a chatter but not bad,” LaRance said. Initially, he had to grind the HSS custom threading tool to achieve the proper relief angles and avoid generating burrs.

After threading the insert into the flange, LaRance put the assembly on a Sharp VH-25 mill and drilled two ⅜"-dia. holes 180° opposed into the seam between the insert and flange. To lock the two parts together required ¾"-long ⅜"-16 setscrews in the holes. Also, on the mill, LaRance drilled and tapped a ⅛"-dia. hole in the insert’s 3½" OD to hold a Zerk grease fitting. Adding the fitting was his idea. “It’s out in the weather,” LaRance said, “so I figured if they put grease in there it might last a little longer.”

Regarding thread tolerances, LaRance said: “I tried to stay consistent on the insert’s male thread. I normally like to go 0.003" under nominal wire size. If I stay there, everything is interchangeable. If I need to replace the insert, I can turn a new insert down to 0.003" under wire size for the 3¼"-12 thread, and it will go right in.”

The first upgraded replacement inserts worked well. For later versions of the assembly, which were to be used as proactive replacements for old assemblies, LaRance upgraded the flange itself by changing the stock material to hot-finished 303 stainless steel.

To machine the flange, he cut 1¾"-thick stainless bar stock into 6" squares. He mounted each square on the mill in a Parlec vise and lightly chamfered the edges with a 45° inserted endmill run at about 300 rpm.

Then he found the center of the square and drilled a 1¼"-dia. pilot hole with a Morse cobalt-HSS drill run at 90 rpm and a 0.003-ipr feed. After zeroing the mill’s digital readout, he drilled four 15⁄16"-dia. mounting holes with an OMG drill at about 50 sfm.

LaRance next put the flange in a 4-jaw chuck on a 21"×80" Clausing-Colchester flatbed lathe. He enlarged the pilot hole’s diameter to 3.166" using a WNMG-432MA insert held in a Sandvik Coromant 1"-dia. boring bar run at 340 rpm and a 0.012-ipr feed. Then he cut 3¼"-12 internal threads with a Sandvik Coromant TLTP-3L threading tool held in a 1"-dia. boring bar. Thus, the flange’s internal threads matched the insert’s external threads. While the flange was on the lathe, LaRance faced the mating area between the flange and insert so the insert shoulder could seat on a smooth surface. Drilling the holes took about 45 minutes, and dialing in, boring and threading the flange consumed another 90.

To date, Cascade has made six inserts and four of the upgraded flanges to create four complete assemblies with stainless steel flange parts. *For more information about Cascade Machine and Supply, call (406) 453-8100.*

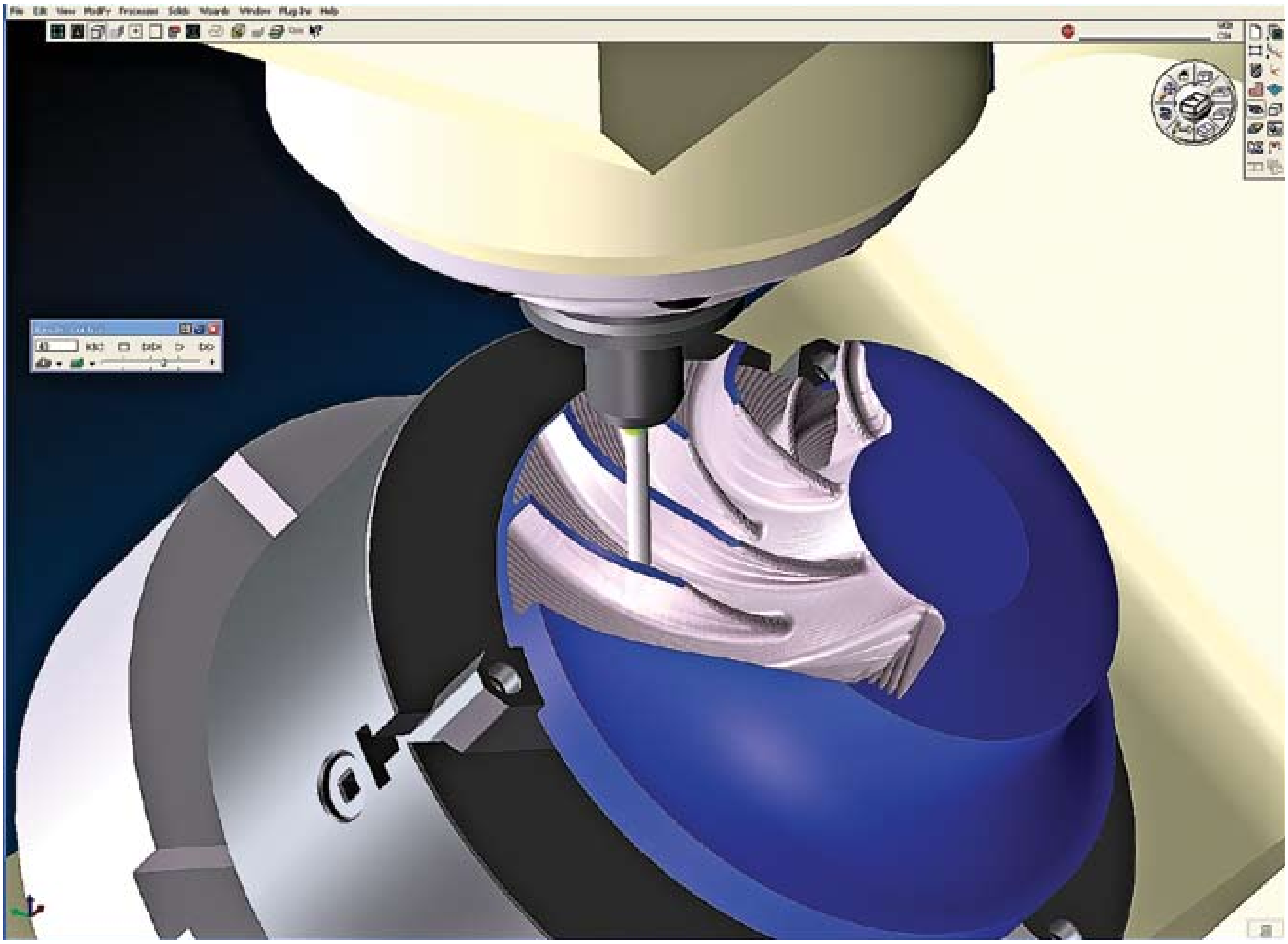
The art and science of CAM software

Software is a way to increase manufacturing professionals' productivity—not a means to replace them. To increase their productivity, they need CAM software designed based on the idea that going from engineering drawing to final product, going from art to part, is as much craft as it is science and involves creativity as much as calculations.

A software family designed based on that idea is GibbsCAM from Gibbs and Associates, Moorpark, Calif. The suite of programs supports a range of machining, from basic milling and turning to 5-axis and multitask machining. Modules can be added to an existing configuration, so customers can start with a basic configuration and expand their systems as their expertise and product requirements grow.

The following is an overview of the GibbsCAM product family.

- GibbsCAM Milling supports 2- through simple 3-axis wireframe machining with full functionality for face-milling, contouring, pocketing with unlimited bosses and islands, tapping, boring, thread milling, 2-D and 3-D spiral creation and drilling with support for many drill cycles.
- GibbsCAM Turning is for 2-axis wireframe machining with full functionality for contouring, automatic roughing, plunge roughing, threading, repetitive shape roughing, drilling, tapping and boring. Advanced functionalities, such as maintaining an awareness of the current stock condition, make it easier and more efficient to program lathes. When the milling and turning modules are used together, support for turning centers with live tooling is enabled.
- GibbsCAM Advanced CS supports the definition of local coordinate systems in any orientation and location over and above the default-standard, primary-plane coordinate systems. This allows the user to work in local coordinates that are relevant to the part's geometry.
- GibbsCAM offers a range of rotary, simultaneous milling functionality. GibbsCAM Rotary Milling supports machining wireframe geometry on rotary tables. GibbsCAM 4-Axis supports machining radially prismatic parts, and GibbsCAM



Gibbs and Associates

GibbsCAM 5-Axis provides an efficient way to machine impellers, engine ports, turbine blades and other objects with complex surfaces.

5-Axis provides an efficient way to machine impellers, engine ports, turbine blades and other objects with complex surfaces.

■ GibbsCAM also offers a range of solid-based machining capabilities arranged over three incremental levels. GibbsCAM Solid Import supports importing and orienting solid models. Wireframe geometry, extracted from the solid or created by slicing the solid, is then machined using the milling or turning modules. GibbsCAM 2.5D Solids supports directly machining 2.5-D solid models. Basic solid modeling functionality is also provided to build models from scratch, modify existing models or turn surface models into solids. GibbsCAM SolidSurfacer provides advanced surface/solids modeling functionality and 3-axis multisurface and solids machining. SolidSurfacer is suited for making mold cavities, cores and dies, as well as aerospace, medical and automotive parts.

■ GibbsCAM MTM (MultiTask Machining) supports creating optimal programs for complex multiturret, multispindle multitasking machine tools, fully utilizing their capabilities. Factory-built posts ensure error-free G-code output, according to the company.

■ GibbsCAM TMS (Tombstone Management System) provides support for programming multiple parts fixtured on tombstones. Once the parts are positioned on the tombstone, corresponding program offsets and rotations are automatically generated.

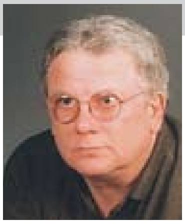
■ GibbsCAM Machine Simulation, an extension to GibbsCAM's integral Cut Part Rendering process visualization and verification capability, uses animated machine tool models to identify program errors before they cause mistakes on the shop floor. Setup time can also be reduced by performing a virtual setup with Machine Simulation's machine model.

■ GibbsCAM Wire-EDM supports programming 2- through 4-axis wire EDMs, ensuring program optimization and machine efficiency through the use of advanced technologies, such as EPAK settings and machining strategies.

■ GibbsCAM data exchange modules, which support a range of industry standard and propriety formats, ensure proper receiving and reformatting of part data. GibbsCAM has also received certification from a number of CAD vendors based on meeting their interoperability requirements.

GibbsCAM has featured a graphical user interface from its beginning, providing a natural, intuitive way for the user to work with the system, according to the company.

BY MICHAEL DEREN



Road map to processing success

I've worked for several companies and visited countless others while on business, so I've seen how various shops manage their processes. Some run on a wing and a prayer, while others are quite sophisticated.

Some companies spend a lot of time wooing a customer, slave over a quote and finally get the job, but then drop the ball. They give cursory thought on how to run the job, run it, deliver the parts or assembled goods and forget about it. When it's time to repeat the job, everyone involved either forgets how the job was set up or the lead person for that job is on vacation or—worse—has left the company.

Typically, this scenario describes smaller shops that do whatever it takes to get the job done. This is at times a benefit, but it can also be the undoing of many small companies because they don't give enough thought to repeat orders. Notes about the job may be scribbled on a piece of paper or the person running the job simply takes mental notes. Unfortunately, when it's time to retrieve the notes, they generally can't be found. Having a formal process plan is the only way to ensure repeatable part processing.

Think of the process plan as a road map to processing success. The sheets of paper for the plan should provide a detailed method of processing a component or building an assembly. Let's look at a simple part, say, a 4"×4"×2" workpiece with a 1"-dia. through-hole and a four-hole bolt pattern on a 3"-dia. bolt center. On the process plan sheet, the operations might read as follows:

Operation	Work center	Description of operation
05	Stock	Pull 2"-thick × 4" × 10' stock.
10	Saw	Cut to 4" length.
15	Mill	Hold in vise. Spot drill (5 places), drill, bore 1"-dia. through-hole, drill 27/64"-dia. through-hole (4 places), countersink (4 places), tap ½-13 (4 places).
20	Bench	Deburr and clean completely.
25	Inspection	Inspect bored and tapped holes.
30	Ship	To customer XYZ.

Next, you want to have specific

sheets for each process step involved in manufacturing the part, providing more detail. At a minimum, the sheet should include the customer's name, drawing number, drawing revision, part name, material type, process number and revision.

The following are process sheets for the previous example, telling what additional information could be on each sheet.

Process sheet for operation 05: This is for instructions pertaining to this operation number. It could also have the location of the stock that needs to be pulled.

Process sheet for operation 10: This indicates what saw and blade to use and how square the cut needs to be.

Process sheet for operation 15: This indicates what milling machine and tools to use. It could also indicate the appropriate feeds and speeds and fixture. A setup drawing is helpful, but a photo is even more valuable because it leaves nothing to the imagination.

Process sheet for operation 20: This specifies which deburring tools to apply, the areas to deburr and how to clean the part.

Process sheet for operation 25: This tells the inspectors what GO/NO-GO pins to use for the bored hole and what GO/NO-GO thread gages to use for the bolt pattern holes. An area on the process sheet could be allocated to recording inspection data.

Having a formal process plan is the only way to ensure repeatable part processing.

Process sheet for operation 30: This indicates where to ship the parts and what paperwork needs to be included.

Remember, there can be multiple sheets per operation. Don't skimp. The more information the process sheets contain, the easier a repeat job will run. Machinists will find it much easier to set up the job and run good parts right off the bat. As the job is repeated, you may find there are new tools, a new method or a new machine in your shop to run this job. If so, change the process and revise the process sheets.

By planning and then breaking operations into logical process steps—especially larger projects—needed information will always be available to run initial and repeat jobs. △

About the Author

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