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STAYING SHARP

manager's desk

By Keith Jennings

Promoting talent from within

Unless you've been living in a cave, you're aware of the shortage of skilled manufacturing workers and its impact on job shops. It's not a good situation when a company's potential is limited by its inability to fill critical positions.

Unfortunately, many young adults perceive a manufacturing career as uninteresting, dirty and dull, but the design, development and creation of a machined part involves creativity and workmanship and is worthy of a competitive salary.

Educating high school and college students about metalworking is the responsibility of all of us and requires consistency. When I teach Junior Achievement classes to elementary school students, explain my business and show them sample parts, they are captivated. They have no idea what these parts are used for, but they enjoy holding them, examining them and hearing about them. They're like little sponges, soaking up my excitement.

Of course, the skeptics quickly state that a lot of parts production has moved to China and the students' opportunities in manufacturing are limited. I point out that virtually all industries are susceptible to outsourcing, but demand will be strong for domestic production in the years to come.

When I leave a class, the students are more knowledgeable and excited about manufacturing than before. If it wasn't for me explaining it to them, they probably wouldn't hear it. Evidently, many educators have an inaccurate impression of the industry and what it contributes to our economy.

I'm optimistic and want to educate others about manufacturing's potential. Still, many challenges remain when it comes to filling critical positions. Instead of recruiting outside, consider that your own workforce potentially offers untapped talent and creativity. Sometimes, the best candidate is right under your nose. Perhaps they're quietly working in the shop and are unaware they have valuable skills. Or perhaps you've never contemplated they could do anything other than what they've always done. Or maybe they were never properly interviewed or evaluated to ensure they were placed in the right position.

Taking a fresh look at existing personnel and carefully examining their true talents can be eye-opening and may provide a cost-effective solution to a worker shortage problem. In small shops or if business is flat, this may not be possible.

In my company's case, we've tapped internal resources several times. Recently, we moved two shop employees into new positions. A 19-year-old had been working in our shop for about a year when we discovered his technical prowess with CAD software. He wasn't aware he had such a valuable skill worthy of advancement, but thankfully we noticed. After a thorough interview and a few weeks of training, he's learning advanced CAD and programming skills that will be enormously valuable to our company. He's excited about his future and eager to take on more responsibility.

Removing yourself from the daily grind and taking a new look at the talent you already have can reap rewards.

The guy he replaced was a CAD programmer with 6 years of experience who was relocated to our estimating department to help with project engineering. Again, it was a promotion that generated renewed enthusiasm for his role within the company.

Occasionally, attempts at promoting from within don't work. Candidates may have talent and expertise, but they're immature and don't effectively manage their new responsibilities. However, many shop workers are tremendously talented, but have never been taught how to utilize all their skills.

It's up to you to discover those skills. Removing yourself from the daily grind and taking a new look at the talent you already have can reap rewards. CTE

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Creativity and the machine tool industry

By George Weimer

What industries say creativity and high tech? Semiconductors? Aerospace? Cinema? They do, but I include the machine tool industry as well. Here are just a few examples. (Some of the experts interviewed here discussed innovations in more detail in "Light-Heavyweight Machining," by Bill Kennedy, CTE, December 2007, p. 54.)

Greg Hyatt, vice president and chief technical officer for machine tool builder Mori Seiki U.S.A. Inc., Rolling Meadows, Ill., points to remarkable developments in which some 5-axis machines that have used high-speed linear motion drives for years now achieve comparable acceleration and velocity in the rotary axes with the direct-drive motors that his company produces and uses. These machines, which have important aerospace applications, use both direct-drive rotary and high-speed ballscrew linear motion.

Another example is the use of carbide or ceramic spinning tools (axially loaded rotating tools jointly developed by Mori Seiki and toolmaker Kennametal Inc., Latrobe, Pa.). "The tools' high-speed rotation distributes the heat of cutting around the circumference so that there's no single hot spot in this kind of operation on the tool or workpiece," Hyatt said.

> *It's the creativity and innovation of industrial research—especially machine tools—that keeps us moving forward in virtually all aspects of modern life.*

"The concept has been around since the early 1940s but has only recently been enabled by new machine tool features," Hyatt said. These include large Y-axis travels, precision, motorized tool spindles on lathes and electronic gearbox synchronization of rotational speed for the tool and the workpiece.

"This brings almost an order of magnitude to productivity increases in aerospace, especially in machining titanium," Hyatt continued. "Our observations are that in many applications the cutting speed recommended by Kennametal for static tools can be tripled with the spinning tool and the strength of the large nose radius allows a very high feed per revolution."

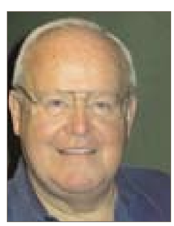
Indeed, machining titanium for aerospace requires constant innovation. "Consider that the new Boeing 787 Dreamliner will use some 16 different grades and formulations of titanium, which together will account for up to 14 percent of the plane's total weight," said Scott Walker, president of machine tool builder Mitsui Seiki (U.S.A.) Inc., Franklin Lakes, N.J. In contrast, a 737 contains 2 percent titanium by weight.

Machining titanium alloys for aircraft applications required a new design for machine tools that took into consideration side-load issues and other difficulties, according to Walker. The point is that the technologies and materials that go into modern commercial aircraft are made possible only by equally advanced production technologies.

While traditional machining of titanium tends to be low-speed work, at the other end of the rpm spectrum is the need for ultrahigh-speed machining of aluminum. "Many customers, particularly in aerospace, are applying high-speed machining," said Alan Hollatz, proposal engineer for machine tool builder Makino Inc.'s Aerospace Div., Mason, Ohio. He points to his company's MAG series machines, which can be 5-axis and operate at speeds of up to 33,000 rpm at 107 hp. Typically, when machining aluminum structural parts, Hollatz explained, standard machines would run at 18,000 to 20,000 rpm.

Consider also the National Center for Manufacturing Sciences (NCMS), Ann Arbor, Mich. One of its programs intends to "provide a tool for mapping position errors on very large parts," said Chuck Ryan, Ph.D., vice president-technology. The tool will map position errors over the entire working volume of the machine and then apply active "real-time error compensation so that accuracies of 0.005" can be maintained," Ryan said.

It's the creativity and innovation of industrial research—especially machine tool research—that keeps us moving forward in virtually all aspects of modern life. So next time someone seems to feel sorry for you because you are not in law, medicine or the movies, you might reply that without successful and ever-advancing high-tech manufacturing, service industries would have nothing to serve. CTE



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30-minute shop assessment

By Edward F. Rossman, Ph.D.

A thorough assessment of a machine shop usually takes several days and involves extensive review of process plans, operator buy offs and investigation of internal operating procedures. But sometimes one doesn't have several days, so what can be accomplished in a short pass through a shop?

When taking a walk through a machine shop, the intention is to collect notes and develop a mental picture of the factory that can be reflected on later. The following are some areas to observe and ask questions about during a 30-minute shop assessment.

General shop cleanliness and orderliness. A shop should be reasonably clean and uncluttered. Orderliness usually means marked-off areas with labels and signs. Elements to worry about include too many tubs of chips and excess parts and pallets scattered throughout the shop. People have to walk around them and move them to get at whatever it is they are working on. Safety is also an issue if the chips happen to be titanium, which is a fire hazard.

Equipment condition. Does the equipment look "well groomed?" What is the uptime of the machines? How often is the equipment calibrated? What spindle runout is tolerated? TIR should be no more than 0.001". One shop tolerated TIR of 0.007" and only called maintenance if it was above that, but the shop was also rejecting almost every part! The problem with high spindle runout is poor part quality and short tool life, sometimes causing the teeth on milling cutters to completely wear out on only one side. In addition, what is the spindle drawbar's pull setting on large machines with 50-taper toolholders? It should be about 8,000 lbs. to prevent cutter pullout. When a machine is roughing titanium, 2,000 lbs. is certainly not enough.

Shop efficiency. Are staffed machines cutting chips? In one Boeing machine shop, shortly before its demise, studies showed that chips were being produced 40 percent of the time when operators were clocked in to the job. Most of the other, nonproductive time was due to delays for setup, no operator present and unplanned machine downtime. Many good shops are cutting chips about 60 percent of the time when operators are clocked in.

Milling productivity. As a baseline, when a shop is rough milling titanium, the cutting speed should be 50 to

60 sfm when using HSS-cobalt cutters. These are nearly always made from M-42 material, which contains 8 percent cobalt. Expect a cutting speed of 100 to 120 sfm for carbide cutters, either solid carbide or carbide inserts. Efficient shops cut titanium at speeds from 400 to 800 sfm when finish milling with TiAlN-coated carbide tools. All cutters for titanium should have a positive rake, be quite sharp and be run with flood coolant during milling.

NC programming. What NC programming language is used? The answer is important if a job is moved between shops or even within one shop. In one shop, half of the machines had unique controllers and the other half had standard controllers. There was no software for reposting NC programs when it was necessary to move jobs between machines. In this shop, reprogramming was necessary to move a part between controller types or to machine a part from an outside shop. Nonstandard controllers can result in high costs, lost time, additional programming and a new first-article inspection each time the job is reprogrammed.

Many machine shops use CATIA or Unigraphics programming with Vericut or similar electronic checking to look for potential crashes. Some top shops also add CATIA models of fixturing, spindle and machine features into the models for Vericut checking. Can the programmers work from a supplier's CATIA models? A shop in Los Angeles had six programmers, but they were programming in five different languages. Each NC programmer programs in the language he is comfortable with. How do they back each other up when vacationing or when a programmer quits? What happens with overload when contract programmers are hired? What is the turnover rate among programmers, and are contract programmers ever used? The importance of standardizing on one programming language is the efficiency of using the latest high-speed milling techniques and cutters with consistency. You want your costs and flow time to be as low as possible.

A person looking for these things and asking these questions should be able to form a good first opinion of a shop by the end of his 30-minute walk. **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.

Farm aid

By Bill Kennedy, Contributing Editor

Kos Machine LLC, Canute, Okla., does a lot of work related to the local petroleum industry, including jobs as challenging as machining 12"-tall × 17"-dia. steel rotating head components to tolerances of ±0.001". However, the machine shop also does repair and replacement work for local farmers.

A typical repair job involved a cast iron air conditioner compressor bracket from a 25-year old Case tractor. A mounting hole in the 7"×6"×7" bracket had been worn oblong by an attachment bolt. Shop owner Jim Kos said drive belt tension and vibration contributed to the wear. In addition, a steel bushing nut held the bolt in the bracket, and "anytime you put steel to cast iron you're going to get wear," Kos said.

Kos began the repair by making the mounting hole round again. He clamped the bracket on two 12"-long × 1¼"-square steel blocks set on the bed of the shop's manual Giddings & Lewis horizontal mill. To ensure the repaired hole and its twin at the other side of the bracket would line up later, Kos clamped a ½"-dia., 14"-long drill in the mill spindle to use as an alignment rod. "The back hole was a good hole; that gave me my center," he said.

With the clamps loose, he "tapped it around, eyeballed it. Being that this is just a hinge bracket, a pretty low-tolerance part, if I'm off 0.010" to 0.020", it's not a big deal," Kos said. "Once we know that those two holes are lined up, then I know I can repair the front hole and the bolt will slip through."

Kos machined the worn hole with a ¾"-dia. HSS endmill, run at 195 rpm and a 0.005-ipr feed. "We used an endmill because a drill bit will follow an oblong hole," he said. Kos next applied a Deming ⅞"-dia. HSS drill, run at the same speed as the endmill. He centered the drilling pass toward the bracket's thicker part. "I only took about 0.015" or 0.020" off of that thin area," he said. Finally, Kos applied a Deming 15⁄16"-dia. drill to bring the hole to the desired size of 0.950". The drill was nominally undersize, but he said "drill bits typically go over," and that in this case, he expected the difference to be about 0.010", which is normal.

Next, preparing to make the repair sleeve, Kos measured the bracket thickness at 0.625". He chucked a 1"-dia.


Kos Machine

In its efforts to serve local farmers, western Oklahoma's Kos Machine LLC has developed cost-efficient ways to repair worn machinery components, such as this worn mounting hole on a cast iron air conditioner compressor bracket from a 25-year-old tractor. The worn hole (left) was machined round and fitted with a custom sleeve (right).

bar of 1018 steel stock in the shop's Supermax 16"×67" manual lathe. Considering the 0.950"-dia. bracket hole, he cut the sleeve about 0.005" smaller, making its diameter 0.945". He turned the sleeve with a Newcomer coated CNMG insert run at 345 rpm and 0.008 ipr. Although the finished sleeve would be 0.625" long, he machined back 1" to facilitate the later cutoff operation.

The bushing nut that fit in the sleeve had a 0.633" OD. "As far as a boring bar, we don't have tooling that small, so we went in with a 0.625"-dia. drill bit," Kos said. Before drilling the hole, he center-drilled the bar with a 5⁄16"-dia., 60° taper point HSS drill.

Again, Kos recognized that the drill would create a hole larger than its nominal size, so he drilled the sleeve with the 0.625"-dia. HSS drill chucked in the lathe's tailstock. He ran at the same speed as before, feeding by hand to a 1" depth. "We felt confident we could drill with the 0.625"-dia. tool and probably end up with a 0.630"- or 0.635"-dia. hole," he said. "Sure enough, we drilled it, and that bushing fit perfect, with a couple thousandths clearance. We didn't have to do any more touchup."

Kos used a 6" scale to measure ⅝" along the bar and establish the point to cut the sleeve from the bar stock. "It's not critical," he said. "When we need to, we use a dial indicator or whatever to make an exact part. In this case, measuring ⅝" off of a scale was enough."

A Newcomer ⅛"-wide carbide parting tool run at 690 rpm cut the part off. Kos held a small Allen wrench in the bore to catch the sleeve before it fell.

After prepping the bracket hole with a ¾"-dia., 80-grit abrasive flapper wheel, Kos coated the hole with Loctite sleeve retainer material, an anaerobic adhesive that provides as much as 3,000 psi of holding power up to 400° F. He applied the material to the sleeve as well and then inserted it into the hole, twisting it a quarter-turn to assure that all the mating surfaces were coated. He said the adhesive works with sleeves as small as 0.015" undersize, but at 0.005" undersize "the part slips in and out real easy, and it gives you a better connection."

Kos said this kind of job is common, and he averages one or two of them a week. "We call it a sleeve repair." He said he charges 2 hours of time for sleeves of this size, which is about the smallest that the shop produces. "Most of the time was spent setting up the first operation, and the rest of it was pretty easy. Building the sleeve probably took me 10 minutes," he said. For larger sleeves, up to about 3", "the time gets a little longer because the bushings get a little larger, and they are more complex to build," he added. "I've done thousands of these."

Regarding work for farmers, "We have a pretty good reputation for fixing this kind of stuff for these guys," Kos said. "It's not uncommon for us to take an obsolete part and repair it or build a new one. We feel it is a real service." Kos estimated that a bracket like the one repaired here, if available at a salvage yard, would cost $300 to $400. "We fixed it for 120 bucks," he said. "We like doing work for farmers because they are always going to be here." **CTE**

For more information about Kos Machine, call (580) 472-3832 or visit www.kosmachine.com.

Esprit 2008 has plenty of spirit

By Bill Fane

DP Technology Corp., Camarillo, Calif., claims its Esprit 2008 to be "the next generation CAM." A quick look at its capabilities, and the new features in Esprit 2008 in particular, tends to back up this claim.

To get an idea of the software's capabilities, one need only look at the table of contents of its "Getting Started" book. It covers topics such as milling along a contour, roughing and finishing, milling with the B-axis, threading, turning, drilling on the rotary axis and milling pockets, slots and holes. The book also covers wire EDMing, including 2-axis and 4-axis capabilities. If it is physically possible to CNC machine or wire EDM a part, then Esprit 2008 can probably handle it.

Given the existing capabilities of Esprit CAM software, one has to ask, "What could possibly be added in a new release?" The answer is "plenty." I have figured out how new software releases work. When the new feature list hits the magic number of 200, a new version ships, and Esprit 2008 is no exception.

Software reviewers are always looking for the catchword or phrase that sets the tone for the new release. In the case of Esprit 2008, it's "automation." Many of its new features simplify the software's operation.

In a similar vein, software reviewers are always looking for the catchword or phrase that sets the tone for the new release. In the case of Esprit 2008, it's "automation." Many of its new features simplify the software's operation while increasing its capabilities.

Let's start with turning operations. The big one here is that Esprit 2008 always displays the workpiece condition at any moment. Previous releases allowed users to set "casting" as the stock type and to start from the stock profile. Esprit 2008 can do this starting from any stock type and updates it as each operation is performed.

This makes it easier for the programmer to see what needs to be done next and for the software to calculate toolpaths. It greatly reduces air-cutting time or efforts to move too quickly through metal.

Esprit 2008 remembers the stock condition after cutoff. Subsequent operations performed start from the state of the stock after cutoff. This is particularly useful on dual-spindle machines because there is no need to program the stock definition for the second spindle.

Draft feature recognition has been enhanced for EDMing. This includes a simplified start strategy, where the starting element is automatically defined based on the location of the lead-in. The user gets to choose from one of five different start strategies.

In addition, Esprit 2008 users can now set up options that tell the software how to recognize and handle certain types of holes based on a size or range of sizes. For example, when a company builds punch-and-die sets for the metal stamping industry, holes can be automatically recognized as dowel pin holes, pierce holes or taper or die-cavity holes with land and relief. This can greatly reduce an operator's time and effort when making large progressive dies that often have numerous holes of the same size and type.

Pocket milling is a common operation. Traditionally, the definition of a "pocket" implies a cavity sunk into a flat face and with a boundary wall around the entire feature. In the real world, however, many pockets have one or more open sides; they are not completely bounded by a wall. Esprit 2008 allows specification of which sides of a feature are open. The big advantage to this is that the toolpath can enter and exit the pocket through these open sides in a simple lateral move, rather than having to move up, over and down to cross a nonexistent barrier.

Turning operations can now include B-axis contouring. The cutting tool can be rotated about the B-axis as it is cutting a profile. There are a number of strategies and options available with this functionality, but at its root, it means the tool can be rotated to maintain an optimal lead angle with the surface, even though the surface is a changing contour. Contours that usually require several different turning tools can now be cut with one smooth, continuous operation.

Esprit 2008 introduces "feature groups," which allow a user to apply any number of wire EDMing or milling operations on a series of features. These are applied in a parent-child relationship that shows up in a unique t ree structure in the "feature manager," but only the children turn up in the "operation manager" and therefore in the NC code.

With this functionality, users can

update a parent operation, and it automatically updates all the children. Also, this is a one-way associativity. A child operation can be updated by itself, without affecting its siblings or the parent. Unique changes to a single child survive updating of the parent.

Those machine shops cutting threads—internal or external—on a lathe will also be interested in the changes introduced in Esprit 2008. The threading cycle has been so completely redesigned that the "What's New" book requires 16 pages to summarize it.

All in all, Esprit 2008 is indeed powerful, functional CAM software. CTE

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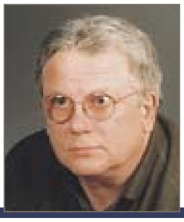

By Michael Deren

Words to work by

Poka-yoke, root cause analysis, kaizen and failure mode and effects analysis. How many times have you heard these terms? Unless you work or have worked for a medium-sized or larger company, probably never. By not knowing these terms and implementing them, your company may be missing out on becoming more efficient and profitable.

Poka-yoke is a Japanese term, pronounced "POH-kah YOH-keh," that means "error proofing." It was coined by Shigeo Shingo, a Japanese engineer.

The basic principles of poka-yoke advocate designing or developing tools, techniques and processes so that it is impossible or very difficult for people to make mistakes.

For example, a component defect is found. Evaluation determines that the component was incorrectly loaded in a fixture. The solution is to design the fixture so the component can only be loaded one way. This is error proofing of the fixture.

Root cause analysis is commonly referred to by its acronym, RCA, but it has nothing to do with the television manufacturer. Actually, it's a systematic process to find the fundamental reason for a defect or error. In the previous component defect example, it would be easy to blame the operator for loading the part incorrectly and leave it at that. But that was not the problem's root cause. RCA would show that by having a fixture designed with error proofing in mind, the operator could not incorrectly load the part.

Kaizen is another Japanese expression. It loosely translates to "continuous improvement." There are five basic principles to kaizen.

1. A reliance on teamwork where everyone's opinion is valued and considered.
2. Workers must have strong personal discipline.
3. Employees should be confident about offering suggestions for improvement, even when the process appears to be working well.
4. There is always room for improvement.
5. Groups of workers must work together to find solutions and develop innovative changes.

One of the primary goals of kaizen is to eliminate waste. Kaizen is constant. Employees should develop new ideas and submit them all the time. Continuous improvement teams then meet frequently to see if and how these ideas can be implemented. The result should allow a company to compete effectively.

Poka-yoke, root cause analysis, kaizen and failure mode and effects analysis. By not knowing these terms and implementing them, your company may be missing out on becoming more efficient and profitable.

Failure mode and effects analysis, as defined by Wikipedia, is "a procedure for analysis of potential failure modes within a system for the classification by severity or determination of the failure's effect upon the system. Effects analysis refers to studying the consequences of those failures."

Basically, FMEA covers what can go wrong with a design, process or item and what happens if it does go wrong. Each potential failure is given a numerical value. The lower the number, the less significance the failure would have, and vice versa.

An automotive computer malfunction that could cause an automobile not to start is an example. An inconvenience is the typical result. Another computer malfunction could cause the ABS not to work during a critical braking and handling maneuver. This could mean possible injury or death to the occupants and therefore would have a much higher value.

These are just a few of the terms, briefly described, that play an important role in the success of medium to large organizations. But, they can play an important role in any size facility. CTE