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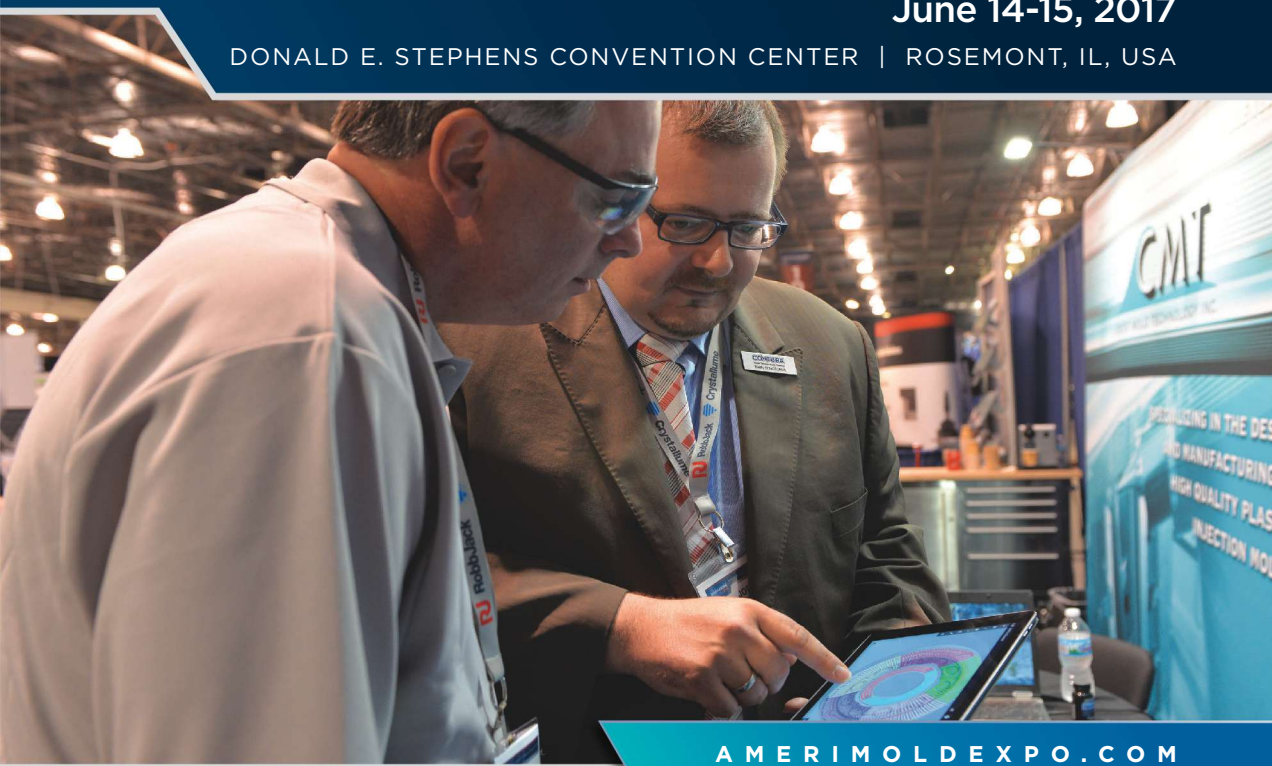

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Preview - Page 132

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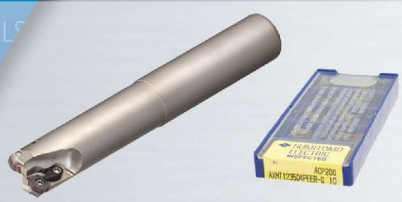

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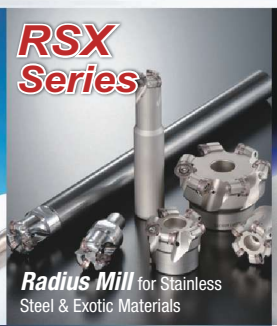

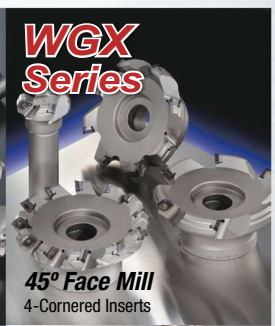

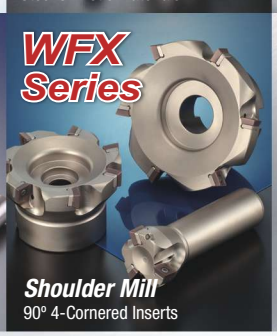

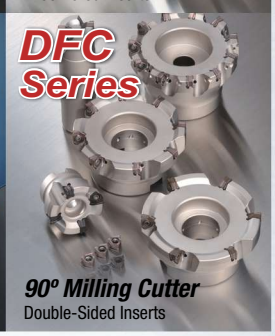

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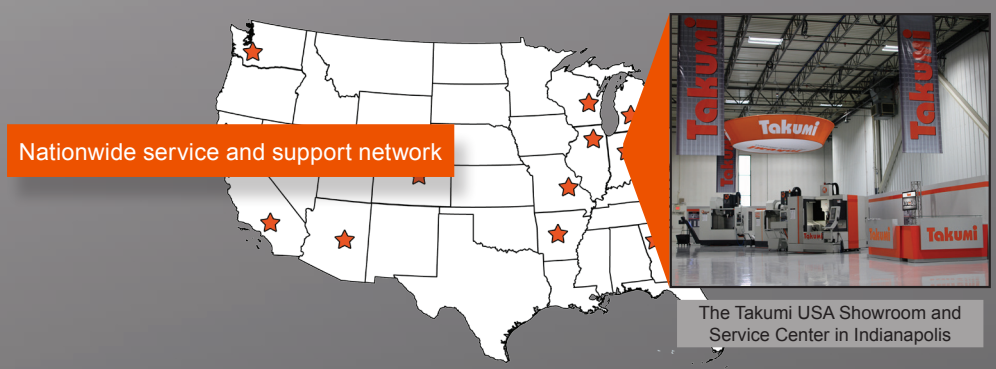

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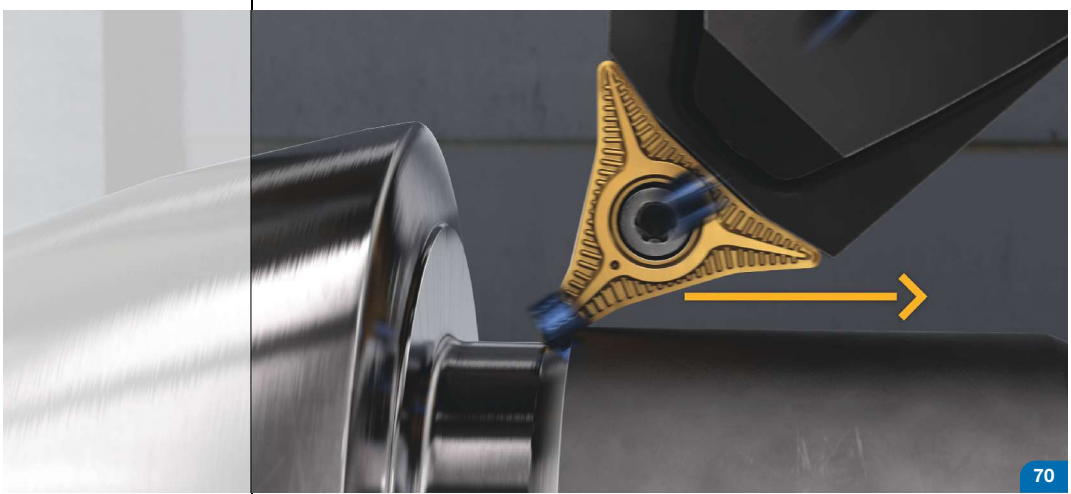

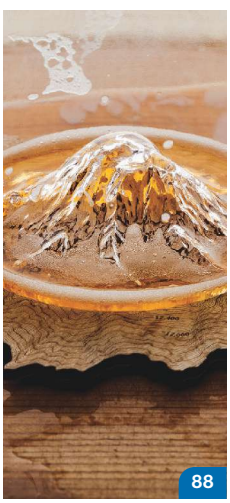

FEATURES

ABOUT THE COVER

The most striking aspect of a new concept in turning technology from Sandvik Coromant is captured in this image provided by the cutting tool manufacturer. The article starting on page 70 discusses how cutting in both directions (toward and away from the chuck) on a CNC lathe has advantages for certain types of applications. A look at this development is also worthwhile for what it shows about the interaction of the cutting tool, programming software and shopfloor discipline.

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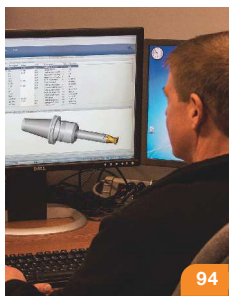

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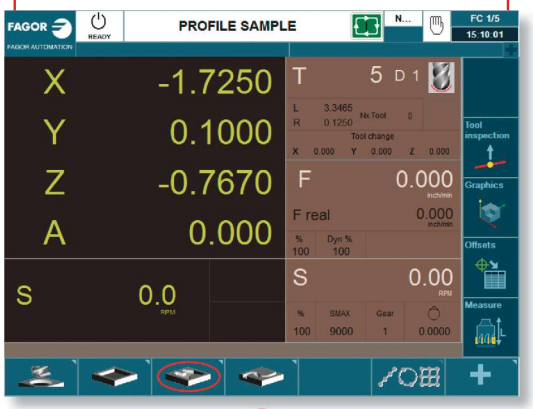

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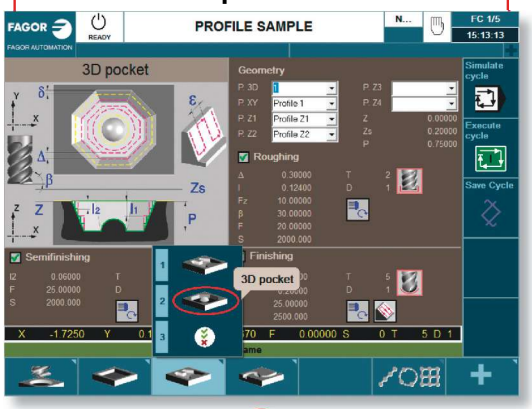

3

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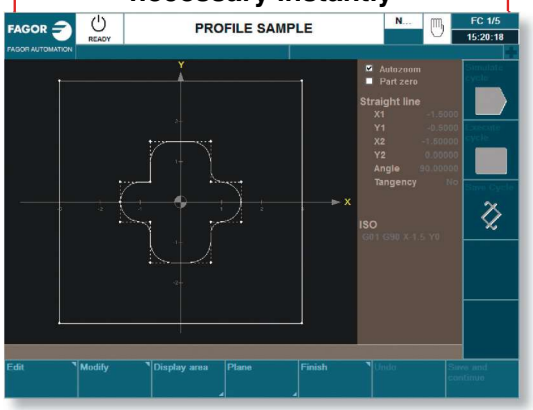

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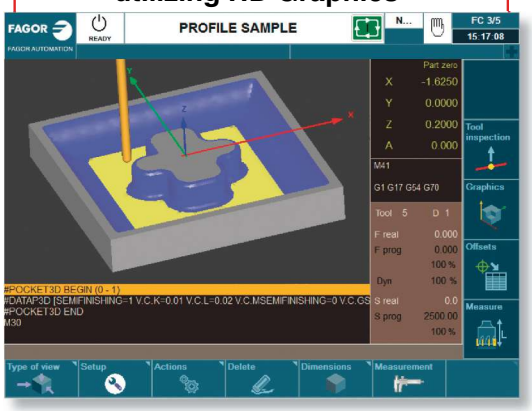

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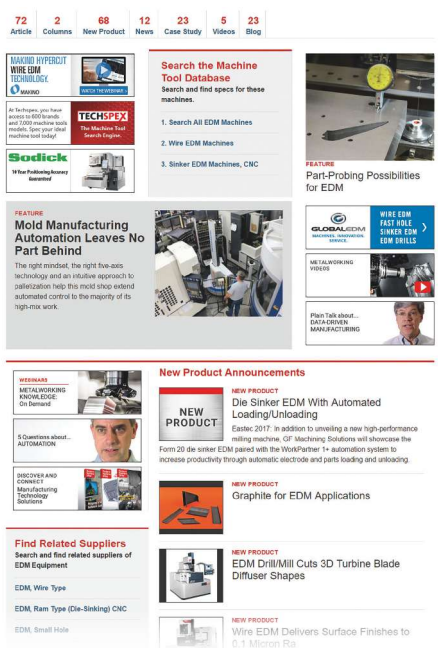

INSIGHTS FROM TECHNOLOGY EVENTS

Editorial Director Mark Albert and Associate Editor Stephanie Hendrixson recently reported on two trips they took examining technology from Hyundai Wia and FANUC, respectively.

Updates unveiled at FANUC's annual Private Show in Japan promoted higher-volume production, easier programming and better monitoring capabilities across product lines, Ms. Hendrixson reports. Read more and find a slideshow of the event at short.mmsonline.com/fanuc17.

Meanwhile, reporting from the Chicago area, Mr. Albert shares highlights on Hyundai Wia's technology center, looking at its remarkably diverse range of machine tools, from commodity VMCs to five-axis contouring machines. Read more and find his slideshow at short.mmsonline.com/hyundai.

BEYOND THE SPOTLIGHT: EDM

This issue's Modern Equipment Review, starting on page 146, focuses on EDM equipment. Although this specialized process only has a finite amount of pages we can devote to it in print, our website has an entire zone dedicated to it. After you've flipped through the product spotlight in print, head to mmsonline.com/edm to find more than 70 feature articles, 20 case studies and 60 product releases involving EDM.

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Do you manufacture a consumer product that might be a candidate for sales through Walmart? The June 28 event offers meetings with Walmart buyers as part of the company's promise to purchase $250 billion more in products made domestically. Read the full story pinned to the top of our Facebook page.

PLAIN TALK: DATA-DRIVEN MANUFACTURING

youtube.com/mmsonlinevideos

Much of the talk about the Industrial Internet of Things, Industry 4.0 and data-driven manufacturing can be confusing. For most shops, installing an Internet-enabled machine monitoring system is the obvious and practical way to take the leap toward these concepts. Find the video at the URL above.

IS IT TIME TO MOVE UP TO AN HMC?

techspex.com

The "Guide to Buying Machine Tools" Knowledge Center has been updated to include industry expert Barry Rogers' third in-depth article, this one examining what you need to know before buying a productive horizontal machining center. Read this artice along with others, which cover questions to ask before buying any machine tool as well as VMC-specific issues, by visiting short.mmsonline.com/techspex.com.

HOW TO PREDICT, PREVENT PROCESS FAILURE

bit.ly/mmstopshops

Group member Doug Wetzel of CNC machine shop Protomatic says a February MMS article on a Process Failure Mode and Effect Analysis (PFMEA) system developed by his company generated a "flood of requests" for information. He outlines the basics of what PFMEA is, various ways of implementing PFMEA, options for prioritizing risks and more. To find it, follow the URL above to our Top Shops LinkedIn group.

DON'T MISS OUT WHEN OUR EDITORS LIVE TWEET

twitter.com/mmsonline

Associate Editor Stephanie Hendrixson (@AM_StephanieH) recently live tweeted from her visit to the Rapid + TCT event:

- Reps from @DesktopMetal, @Jabil, @CaterpillarInc & @Lowes talk future of low cost metal #3dprinting at #Rapidevent.
- .@generalelectric's "Brilliant Factory" concept combines lean, digital, advanced & additive #manufacturing. Hot topics at #Rapidevent.

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Be Scared, but Be Prepared

Warnings about threats to internet-enabled networks in manufacturing plants should be taken seriously without giving in to alarmist overreactions. The risks are real, but manageable.

Machine spindles can go bad. Cutting tools can suffer catastrophic breakage. A chip conveyor can jam. System failures such as these are ordinary and expected risks that every machine shop faces. Steps to minimize these failures are worthwhile, because they can cause downtime that might hurt profits and potentially harm customer relations.

Now we face the risk of system failures due to hackers. Manufacturers are increasingly susceptible to becoming targets of cyber attacks. Although I don't doubt this fact, it is a broad generalization that makes me as uncomfortable as saying "Every home in America could be damaged by a tornado." (Certainly true, but not every home faces the same level of risk. Consider a mobile home in Kansas compared to a stone farmhouse in Vermont.)

MARK ALBERT
EDITORIAL DIRECTOR
MALBERT@MMSONLINE.COM
"Be scared, but be prepared. That's the best tactic."

Yet I think the statement about cyber threats to manufacturers must stand. It should scare us a little, and may be a lot. More importantly, it should make us think about tactics to deal with the threat in a calm, reasonable yet urgent manner. This is the main point I want to make here. What's needed most is a balanced approach. The fear of potential loss must be offset by the promise of gains from networking machine tools and becoming part of the Industrial Internet of Things.

Right now, I think the fear of loss is the side of the equation that needs the most attention. The problem is that the cost of downtime due to a cyber attack is hard to comprehend. There have been few detailed accounts of such incidents at small to medium-sized machining facilities, although reports have recently surfaced about suppliers to the metalworking field being exposed to ransomware that encrypts a company's critical data until hackers are paid off. This is pretty close to home.

At the least, shops should consider these steps:

Build awareness. Cyber security is not a concern just for the IT folks. Everyone in an organization must be prepared to follow safe networking procedures. Constant vigilance and continual training are necessary.

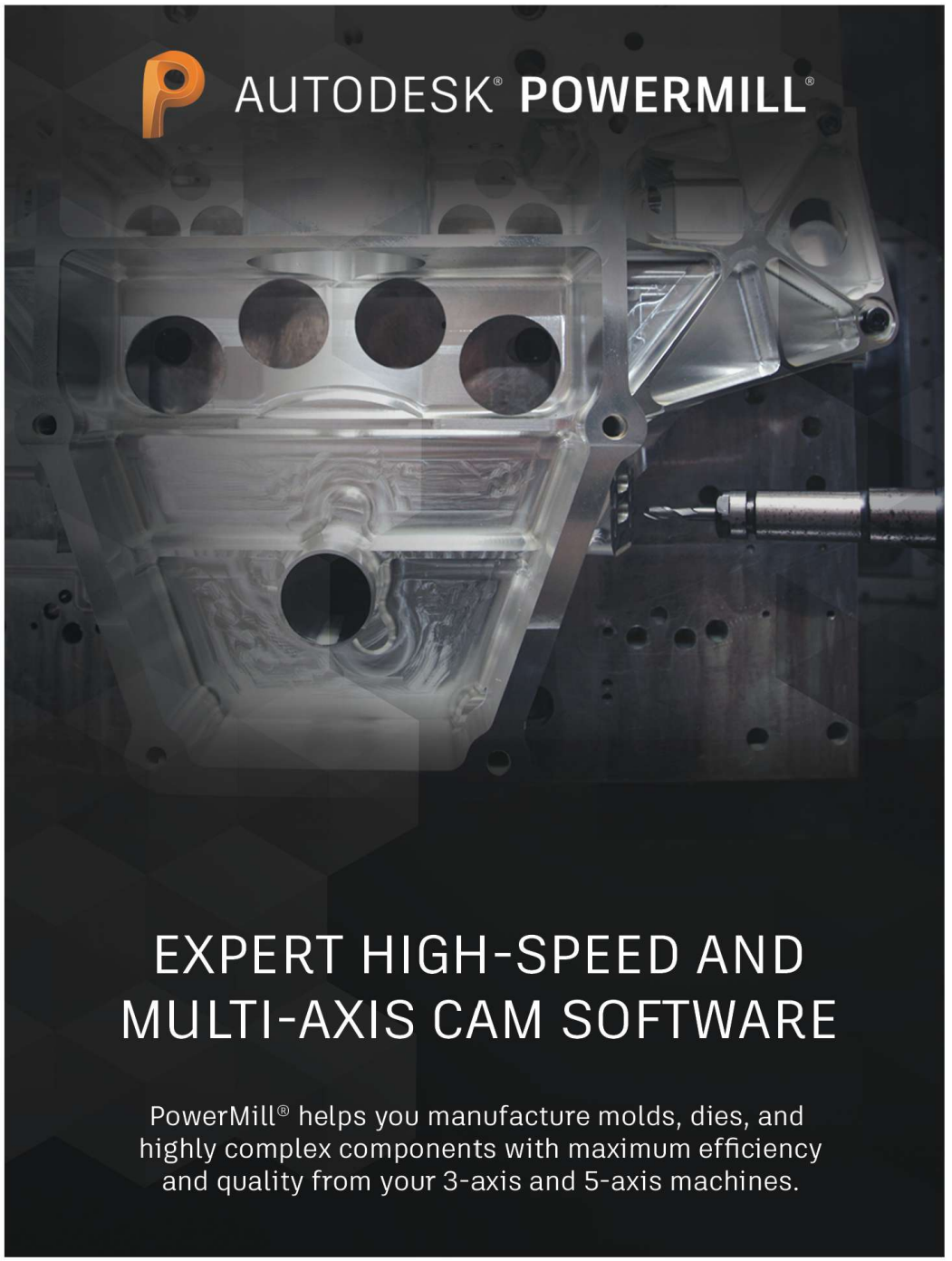
Take precautions. More and more machine tool providers are building in or making available provisions to promote the safety of connecting machines to an internet-enabled network. These options or standard features should be studied as closely as any other on the spec sheet.

Expect to be certified. It's probably only a matter of time before companies in a supply chain will be required to have certification that some sort of network security is in place. Compliance will likely require that an ongoing security protocol is in place and being followed.

Consider insurance. Like any risk, threats to the security of a company's network and data can be covered by insurers that specialize in this field. Coverage can at least partially protect a company from loss due to cyber attacks.

Stay focused. The benefits of connecting machines to a network for production monitoring, predictive maintenance and integration with enterprise resource planning are too promising to forego because fear has not been confronted.

AUTODESK.



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Theory and Practice of the Shop Visit

There is certain information that can only come from standing in the facility.

Earlier this year, I celebrated 20 years as an editor with *Modern Machine Shop*. A lot has changed in that time. North American machining facilities have become more sophisticated, changing the type of information their leaders need from us. Meanwhile, the avenues of information and the demands on our audience members' attention have expanded as well. We (the *MMS* staff) are more acutely aware than ever of the importance of delivering value in what we post and publish.

But one thing has not changed, something distinctive about *MMS* when I joined it that remains distinctive today. Namely, we retain our emphasis on what we internally call "shop visits." These are stories about an idea or technology that we research by taking a plane or car to the very facility where it is being used, so we can see it in action and talk to the people using it.

PETER ZELINSKI
EDITOR–IN-CHIEF
PZELINSKI@MMSONLINE.COM
"Explaining all the factors in play results in a story that is more shaded."

Researching a story this way entails a lot of trouble. The travel time generally exceeds the time at the site. Certainly there are other ways—we could go directly to the suppliers of the technology rather than the users; we could talk to the users by phone. We routinely do both these things.

But there are problems. The suppliers producing the technology are understandably bullish about it. Perspectives they share relate to the best-case promise. It is the users who discover what practical obstacles stand in the way. Meanwhile, though, those users also tend to be bullish. On the phone—again, understandably—the user will generalize for the sake of an efficient conversation. Only the in-person visit provides the time and context for exploring how the technology is really playing out. It offers the chance to witness a detail that doesn't seem to fit the portrayal and ask, "So what's going on there?" Genuine understanding often comes after this.

This kind of effort leads to stories that are messier and less dramatic than they might otherwise be. The 40-percent productivity improvement promised might actually be an 8-percent improvement as things have played out so far. That doesn't mean the 40 percent misrepresented the matter, and there is value in the 8 percent, but there are reasons why the user has succeeded to one extent instead of the other. Explaining or at least giving a nod to all the factors in play results in a story that is more shaded and takes more words to tell. Not to mention: The story is also prone to be less attractive on the surface, because instead of relying on catalog photos, we take real photos of where the idea or technology is really being used.

The result is a sometimes quirky magazine featuring articles that look different and read differently from what is typical of a great many other industry publications. Yet contained within those differences is detail meaningful to the audience we serve, detail that wouldn't come out any other way. So, it's my intention that shop visits and the types of articles that result will always remain part of the way we produce this magazine, and any quirkiness is a price we'll happily pay.

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A Common Problem That We Share

The challenges we face finding writing editors are similar to those you face finding skilled machinists and machine operators.

Modern machine shops and *Modern Machine Shop* face similar workforce-development challenges. Simply put, it's difficult for us (as well as our other Gardner Business Media brands) to find drop-in-place writing editors the same way it's hard for you to find drop-in-place machinists. That means we have to train them.

The editors here who travel to visit shops and then write about how those shops leverage machining technology have an odd skillset that pairs writing ability with at least a fundamental understanding of machining technology, processes and concepts. This is uncommon because, typically, engineers can't write and writers sometimes have a hard time picking up the technology.

DEREK KORN
EXECUTIVE EDITOR
DKORN@MMSONLINE.COM

"Modern machine shops and *Modern Machine Shop* face similar training challenges."

Therefore, we either have to find a manufacturing-type and teach him or her how to write effectively, or find a quality writer and teach the technology. We've had success with both scenarios as exemplified by the two editors I've worked with here the longest. Pete Zelinski and I both have mechanical engineering degrees. Mark Albert doesn't, but, among other helpful traits, he is a natural tinkerer with a genuine interest in learning about how things work.

However, we seem to have more writers approaching us for work than those with extensive knowledge about machining. The former typically have a degree in journalism or English, and already have the chops to write well. What's unknown is whether they will be able to write well about the unique topics we cover. Here are three traits I'd like to identify in such a prospect. Some of these are similar to the "soft skills" you might be looking for in candidates with no machining experience.

- Natural curiosity, specifically about how things work. It'd be great to find a tinkerer like Mark who might have taken a watch apart at one point just to see how it works. In lieu of having done things like that, successful *MMS* writers are genuinely interested in learning about how objects function, and they think what goes on in a machine shop is truly cool.
- Willingness to research and learn. Although I've been writing about manufacturing for 20 years (13 years here at *MMS*), I don't claim to be an expert on all things machining. As a result, I'm continuously researching topics ahead of shop visits so I can develop questions that will enable my stories to explain the concept with a sufficient amount of detail. It's often a process of learning, then teaching.
- Willingness to admit ignorance. Similarly, there can be times during conversations about a machining concept with shop owners or managers in which they lose me. I have no problem stopping them and asking them to explain again. Pretending as though I understand at that point does me no good and ultimately does the reader of the article I generate no good either.

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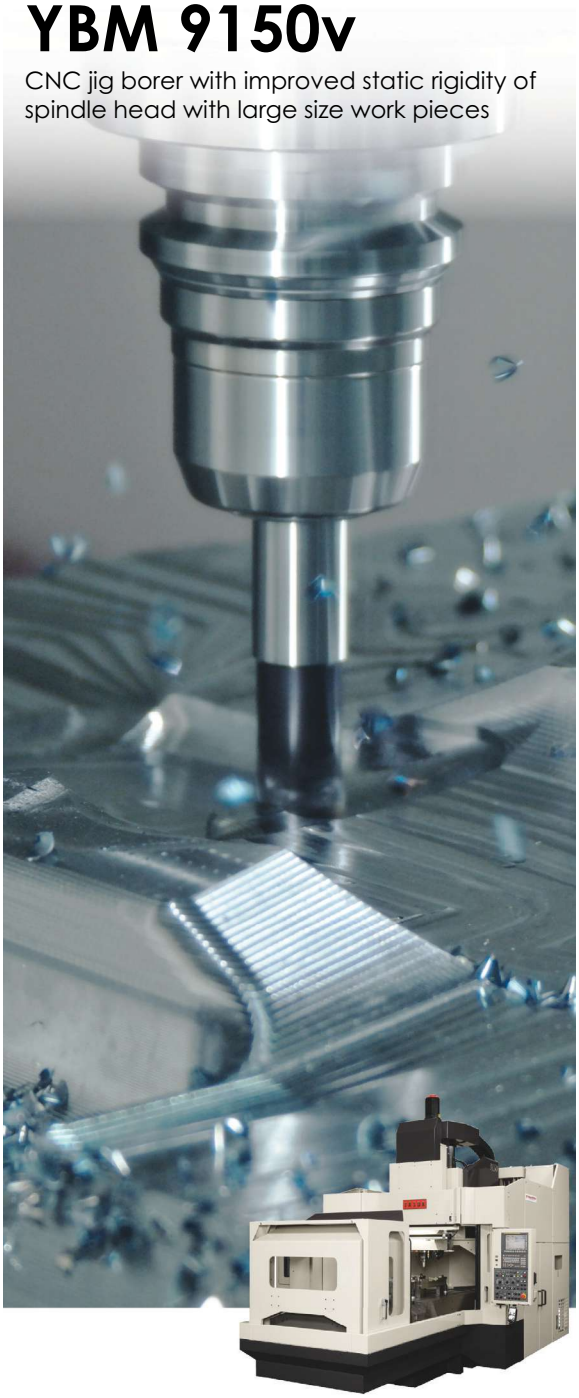

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Micro-Part Collets Make Subspindles Sing

BY MATT DANFORD

There's good reason why subspindle-equipped turning centers, particularly Swiss-type lathes, are so popular for producing small, complex parts in high volumes. However, there's also good reason for the prefix "sub." Automatic part hand-off for backworking operations isn't viable without secure gripping, and the smaller, already-machined portion of the work presented to the subspindle tends to create more challenges than the raw barstock gripped in the main spindle. As a result, subspindles can be limited when it comes to blind-hole broaching, heavy peck drilling and other processes that risk pushing a part off-kilter or damaging it.

However, the right workholding can break down these barriers, says Matt Saccomanno, CEO of Masa Tool (Oceanside, California). Founded in the wake of Mr. Saccomanno's own frustration with secondary operations and underutilization of subpsindles, Masa Tool offers the Microconic system, an alternative to traditional, extended-nose collet designs that applies force closer to the part for greater rigidity and concentricity, advantages that extend to main-spindle operations as well. Another benefit is the ability to adjust clamping pressure at the spindle nose to grip securely without damaging small, fragile workpieces. On the efficiency front, a collet in one size can be swapped for another without reaching anywhere beyond the spindle nose, and any collet can fit multiple draw-type or push-type machine collet closers. This saves time and eliminates the need for different collet series for different machines. Finally, overgrip models that expand 0.157 inch (4 mm) beyond the clamping diameter enable reaching over and gripping the part behind large-diameter areas.

Small parts can be difficult to grip securely in general, but subspindle clamping is often particularly challenging. With pressure applied directly over the part rather than farther back on the collet, the Microconic system is designed to ensure rigidity and concentricity even on pre-machined stock, regardless of thin walls, large shoulders or other challenges.

The Microconic system consists of two primary components: a cartridge that fits in the machine's standard 5C, TF20 or TF25 collet closer, and the Microconic collet itself, which fits into the cartridge. Collets accommodate workpiece diameters ranging from 0.008 inch (0.2 mm) to 0.394 inch (10 mm). Total indicator runout (TIR) is guaranteed at 0.0002 inch (5 microns) at the workpiece, absent any runout introduced by the machine structure or other elements of the setup, Mr. Saccomanno says. He adds that the cartridge can be used as a precision gage to calibrate spindle accuracy.

Installation is simple. Users place the machine in a safe state for collet changing, insert the appropriate Microconic cartridge, and thread the Microconic collet into the cartridge. "You put it in

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The Microconic system includes a variety of cartridges that accommodate the same standard and overgrip collets, potentially on any turning machine in the shop. Also pictured: brass ejection sleeves for overgrip collets, and the Micrograd face-dial wrench.

your spindle and leave it there," Mr. Saccomanno says about the three cartridge models, each of which can accept any standard or over-grip collet. This capability enables switching to a different-diameter collet for a different-diameter part and setting the correct chucking force in roughly two minutes, compared to the 15 minutes it might take to swap, say, a TF25 collet, he says.

There's no "feel" involved in tightening the collet, he says. That's a task accomplished with the company's Micrograd wrench, which features micrometer graduations of 0.001 inch (0.02 mm) to aid users in dialing in the perfect closure on either a workpiece or a gage pin of the same size. This configuration relegates the machine's own clamping mechanism to the role of an actuator that triggers the opening or closing of the collet. As such, he advises keeping the machine's own function at a medium force setting and allowing the Microconic cartridge to control the actual chucking force. Machined from a single piece of hardened steel, the cartridge preserves the dead-length operation of "push-type" collet systems (that is, the collet itself doesn't move in or out as the machine cartridge actuates the chuck).

In addition to better facilitating secure clamping without damaging thin-walled or otherwise delicate workpieces, self-contained, dial-micrometer force adjustment helps ensure setups aren't affected by temperature fluctuations that might subtly alter the machine structure between collet-closer and collet. As Mr. Saccomanno puts it, "From the first part in the morning to the last part on second shift, it grips the same. You don't have to play with it throughout the day."

He credits much of that precision to the fact that clamping force is applied directly over the workpiece, in contrast to traditional extended-nose designs that apply force farther back. He also credits the manufacturing process. Tapering collet jaws to interface with the machine is nothing unusual. However, Masa Tool employs a proprietary, five-step grinding process that leaves each jaw with a particularly precise conical shape (hence the name "Microconic") that forms a particularly tight fit. More specifically, a "slight crown" ensures that the contact point is always centered, he explains, citing the pattern of wear marks on well-used collets as evidence. "Traditionally, you'll see wear closer to the slots rather than in the center, between the slots," he says. "There's no uncertainty about whether (a Microconic collet) will touch on the left or the right side first. That's where you'll get some variation in traditional designs."

Gripping wasn't the company's only focus when designing the Micronic system. Reliable part ejection is also critical, Mr. Saccomanno says, particularly with overgrip collets that offer such a wide gripping range. That's why overgrip models ship with a Microject, a brass ejection guide sleeve that can be machined to mirror the

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outer profile of the workpiece. Once threaded into the over-grip collet, the sleeve prevents parts from falling inside the chuck or getting stuck rather than ejecting into the parts catcher. The sleeve also provides a tight seal that improves the ability of through-spindle coolant or shop air to aid in part ejection.

Mr. Saccomanno also recommends using programmed cycle stops while validating a production setup to ensure part ejection is reliable. Nonetheless, combined with the precision and gripping security common to all Microconic collets, capability for extreme overgripping can enable "doing things on the subspindle that you never would have dreamed of before," he says.

Masa Tool, call 760-732-1422 or visit masatool.com.

Identifying and Overcoming Skill Vulnerabilities in Staffing

BY PETER ZELINSKI

Reducing head count due to economic challenges is a response that often leads to longer-term challenges. This is particularly true in machining facilities, where skilled employees oversee sophisticated machines. If the facility is left with too few of the key people who are able to run the shop's most complex equipment, then having just one or two of those critical employees resign or become sick could leave costly equipment sitting idle.

After a necessary downsize, a machining facility in Texas recently took stock of its own staffing to see how vulnerable it was to this danger. The

Here is the plant's cross-training chart as of the beginning of this year. The chart has machine tool types across the top and employee names (blurred) down the lefthand side. The percentage shown at the intersection of each employee and machine indicates the employee's proficiency with that machine.

Machine Shop - Cross Training Matrix

Machine	Toshiba #1	Toshiba #2	HM 8000	Daewoo AG2SHT30C	Kafo	Okuma	Puma 800	Puma 700	Puma 400	Puma 300 LM	Puma 300L	Femco HL-65	O.M.LTD. NEO2REX	O.M.LTD. NEO16EX	Femco WVL-42 Out of Service	Manual Lathe SMX G	SAW	Dual Machine Certified	Safety Rating
Machine	4	4	3	6	6	1	5	4	4	3	5	5	2	3	3	1	2	2	13
[redacted]	0%	0%	0%	0%	0%	0%	100%	100%	100%	75%	100%	100%	0%	0%	0%	0%	0%	0%	100%
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Beginning of Year	4	4	3	6	6	1	5	4	4	3	5	5	2	3	3	1	3	2	14
Middle of Year																			
End of Year																			
Desirable Machinist Goal	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3

Percent Cross Trained	40.08%			
# of Training Points	247	Sum of Trained	97	
2017 Trend Tracker				Percent Cross Trained
Jan	Jun	Dec		
31.94%				35.5%
36.11%				48.7%
5.56%				26.3%
43.06%				14.5%
33.33%				51.3%
22.22%				26.3%
29.17%				36.8%
61.11%				75.0%
37.50%				51.3%
48.61%				51.3%
25.00%				30.3%
26.00%				31.6%
30.56%				31.6%
0.00%	0.00%			10.5%

Key

0% = No Experience
25% = Some Experience
50% = Moderately Experienced
75% = Fairly Capable
100% = Capable
RT = Requested Trainee
PT = Planned Trainee

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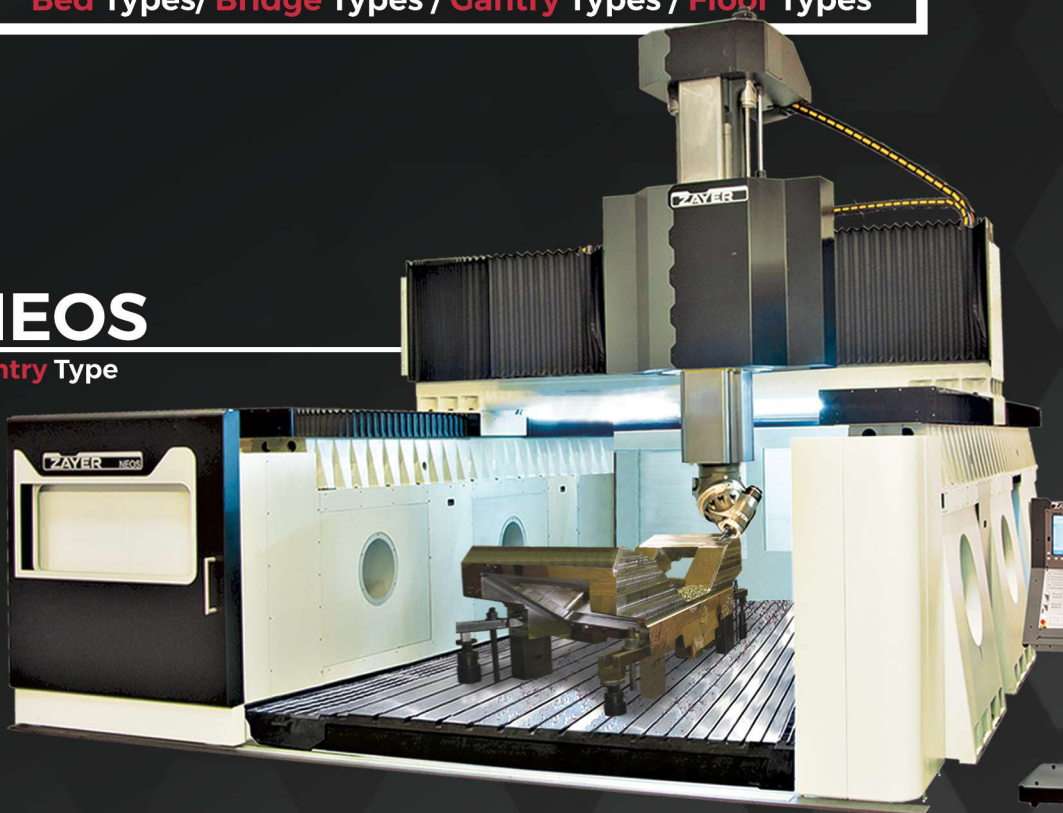

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chart resultng from this analysis turned into a tool for improving staff members' skills by advancing cross-training within the facility.

This company serves an industry segment in which both rapid expansion and downsizing are common: the oil and gas sector. Understandably, it wishes to remain unnamed (publicity for reducing head count is something no company wants). The CNC machining capabilities involved in making its broad product line cover a range of machines—milling, turning and mill-turning—in an array of sizes and more than a half-dozen brands.

The manufacturing engineering manager for this facility notes that the variety of machine tools here had not posed a personnel challenge prior to a few years ago. In 2014, however, the company's business crashed along with the oil market. He and other facility leaders had to oversee significant cuts, most notably staffing cuts. "And as soon as the layoffs were done," he says, "the first question we asked was: Which skills did we lose?" He feared certain machine tools had too few people left on staff who were proficient in running them.

That fear proved valid. The facility's strategy team took an inventory of all the machine proficiencies remaining in the staff. The team members created a chart with all the employees' names down the vertical axis and all the machine tool types across the horizontal. Then, for every pairing of employee and machine, they rated ability. They defined the increments on a scale (0-, 25-, 50-, 75- or 100-percent proficient), and scored every employee's proficiency on every machine.

They discovered they were in danger on many machines. That is, many machines had only one or two remaining staff members able to run them reliably. But in making a chart to realize this discovery, they also made an effective tool for addressing this problem.

These strategy team members openly shared their findings with employees. They began choosing employees to train on machines where the need was greatest. More significantly, they began inviting employees to increase their versatility in the shop by volunteering for their own cross-training. Employees are now able and encouraged to request the chance to be trained on any given machine, and the employee who has made the greatest advance in cross-training each year is honored at year's end. The chart proved to be the beginning and the basis for a culture of continuous employee improvement.

Of course, in the beginning, it wasn't easy, the manufacturing engineering manager says. "There was resistance," he says. "We heard, 'You can't judge us that way.'" In fact, it still isn't easy. Frequently, an employee's score on a given machine is lowered. Proficiency of 100 percent means the ability to run the machine entirely unsupported and unsupervised, such as alone in the shop on a weekend. "But someone we've given that score might prove to have trouble machining a critical feature," he says. "So we tell that person: When you've machined that same part X number of times without a non-conformance report, your score will go back up."

He says eventually he hopes to see employee compensation linked to this cross-training so employees are paid more if they know how to operate more machines. That connection to compensation does not exist today. However, employees seek their own diversification regardless. Just making the data visible has been enough to encourage that improvement. ■

Entry-Level Automation Option

BY BARBARA SCHULZ

Many machine tool builders report an increased interest in machine-tending automation solutions, which vary in sophistication and price points. Franz-Xaver Bernhard, a member of the board at Hermle AG in Gosheim, Germany, says the company has been offering both advanced pallet changers and robotic handling systems for many years. He says it

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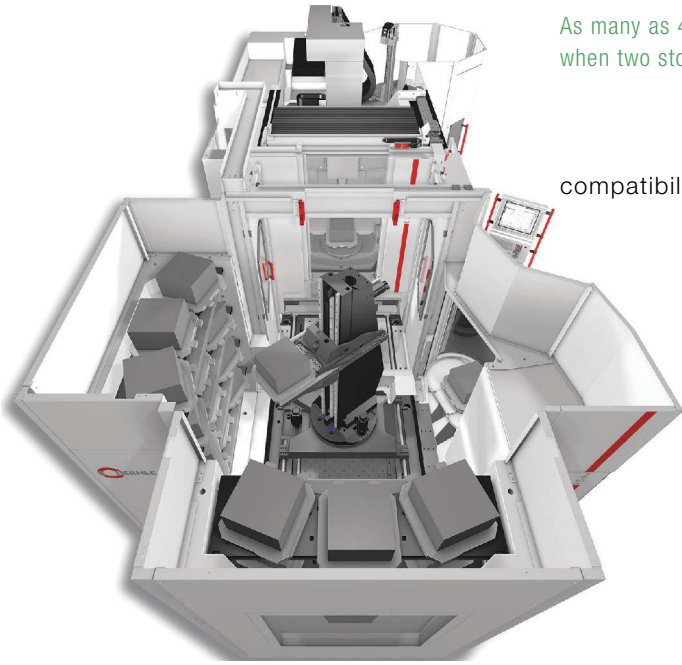

As many as 40 pallet storage spaces are possible when two storage modules are installed.

currently sells approximately 20 percent of its milling machines with automation, and the demand is increasing. However, he notes that there are many shops that don't require such high-end solutions. Some might only need automated machining from time to time and don't have the budget for an expensive robotic system.

It is for shops like these that the company designed the HS Flex handling system, which features several components delivered as a complete unit. Only the workpiece-storage modules are installed and adjusted at the user's facility. As a result, the entire installation can be completed in a very short time, Mr. Bernhard says.

In contrast to the company's robot systems, the HS Flex features a single gripper (the HS Flex Duo can be used to connect two Hermle machines, basically serving as two single, but connected, systems). It is designed for workpieces weighing as much as 990 pounds and is suitable for Hermle's high-performance C 12, C 22, C 32 and C 42 machines, as well as its more affordable entry-level C 250 and C 400 five-axis machines. (At this point, the system can only be connected to current machine models due to a lack of compatibility with older CNCs, software and interfaces, however, Hermle says it is working to make the system compatible with older machine models as well.)

The HS Flex is made exclusively for Hermle machines, which have stable machining beds made from mineral castings. The bed design only allows for front-mounted automation systems, but Hermle has created a flat mineral casting bed from which the three axes of the handling unit are operated to provide ergonomic access for the operator.

The system's dual-door design, which has already proven its functional benefits in Hermle's robot systems, provides a twofold function: It prevents operator access during tool change, and it provides access to the working-view position and working area during machining, while also preventing access to the handling unit.

The rotary, lifting and linear axes of the handling unit enable precise movement of heavy workpieces among the setup station, storage modules and the machining center's working area. It is designed for pallets as large as 19.7 by 15.7 inches. To minimize the sources of potential errors, the maximum workpiece height is queried beforehand at the setup station, thereby preventing workpieces with dimensions beyond those specified from being fed in.

The system is available with one or two storage modules, which are structured as a rack, offering customization potential of the pallet/workpiece arrangement. As many as four rack shelves can be ordered with as many as 20 pallet storage spaces per module, for a total of 40 possible pallet storage spaces when two storage modules are installed. A specially developed storage generator tests both the permitted weights and dimensions, enabling the storage arrangement to be defined quickly and easily, Mr. Bernhard says. ■

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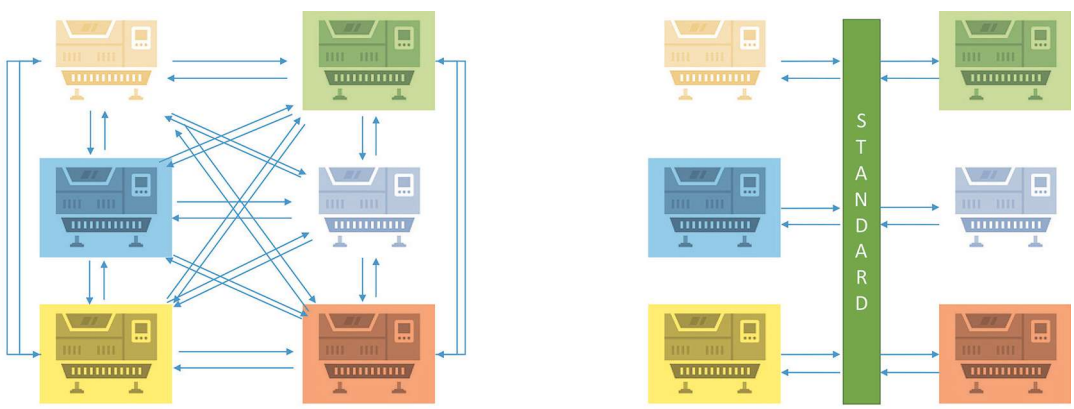
Standards Close the Loop

Artificial intelligence is an up-and-coming application enabled by the Industrial Internet of Things. More specifically, the notion of self-aware machines or systems that can learn from their own environment and adapt on the fly is gaining wider acceptance as a feasible and desirable possibility. However, the seemingly mundane world of communication standards and protocols is playing a key part in this technology development, because it promises to fill gaps in the critical infrastructure that are still missing.

To begin, it's important to grasp the value of self-aware machines by looking at some real-world cases. Machine tools already have, in fact, some capability for self-awareness. They operate as a collection of systems, subsystems, components and sensors that are linked together and centrally controlled. For example, a feature such as backlash compensation takes advantage of input from one component to calculate an adjustment that is fed back to the control of the component to eliminate an unwanted result. Likewise, the technology to make a real-time feedback loop for cutting tools is also in development. Vibration sensors feed data to a toolholder that can automatically make slight adjustments to avoid undesirable harmonics, which in turn reduces chatter, improves surface finish and increases insert life.

In theory, these current applications of self-aware equipment could soon be joined by much larger feedback loops. A part or assembly on the factory floor could carry metadata about itself and the equipment, designs and people that created it. The manufacturing enterprise software and radio transmitter components required for these feedback loops exist today, but gaps in connectivity are preventing solutions from functioning as intended. Communication standards are missing or incomplete, thus making the one-to-one connections and translations between components excessively complex.

Upstream from production, manufacturing engineers and the software companies that serve them are trying to figure out how to reduce design



MTConnect is a model for understanding the value of a standard that enables dissimilar data sources to communicate in a network without the complexity of unique data translators or proprietary interfaces.

CONTRIBUTOR **RUSSELL WADDELL, MTConnect Institute (info@mtconnect.org)**

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changes and rework. Input from machine tools, inspection data and other sources will eventually be available at the design phase to guide decisions, just as cutting tool libraries have now become an integral part of CAM software.

Similarly, finished parts will carry information about their service life with them. This will benefit operations to rework, repair or maintain them. This practice is the norm for many aerospace parts now, with sophisticated part genealogies required for FAA compliance. Promoting this trend is the continued decline in the cost of data acquisition and storage. However, developing the standards for defining data and its framework is still a hurdle to overcome. These standards are needed to link and relate different types of data from disparate components.

To assist in this transition, the MTConnect standard is changing in two major ways. First, it is expanding its sets of definitions to cover types of equipment not previously addressed. For example, the standard has been implemented for additive manufacturing and for lasers. In both cases, extensions to certain existing data items could be used for this purpose. These extended definitions are being brought into the official release of the standard through the Technical Advisory Group and its working groups. Second, MTConnect is establishing links to other standards and data models that already exist or are in development. Data on personnel, for example, are already well-defined outside of MTConnect. Data definitions for entities such as "operator" or "user" will allow MTConnect data to be associated in a useful way to data about performance, attendance, training issues and other "people factors."

Many industries must work together to realize a future for self-aware manufacturing systems and artificial intelligence. Standards may seem tedious or esoteric, yet they are the glue that joins all the pieces together and helps technology move forward in a coherent and unified manner.

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Do Your Customers Promote *You*?

Getting the *right* information about how satisfied your customers are with your services is the first step toward getting them to recommend you to others.

Few would argue that satisfying customers is a "must" if a company hopes to grow and prosper. Most companies even have some established means for measuring how satisfied customers are with their products and/or services, and they take these measures seriously. Too often, however, these internally developed measures do not provide a true picture of how satisfied customers really are. In fact, I would argue that many of the measures used by companies tend to skew results to be artificially favorable. This can lead to customer service complacency based on a mentality of "we haven't heard otherwise, so things must be OK."

In his best-selling books "The Ultimate Question: Driving Good Profits and True Growth" (Harvard Business School Press 2006) and "The Ultimate Question 2.0" (revised and expanded in 2011), Fred Reichheld argues that customer satisfaction is best measured by one simple question, the ultimate question for any business: "Would you recommend this business to a friend?" Mr. Reichheld then uses responses to this question to introduce the concept of the Net Promoter Score, which he believes to be the only important measure of customer experience with a company. This rather strict interpretation of customer satisfaction uses a scale of zero to 10, with a score of "0" representing someone extremely unlikely to recommend a business, brand, product or service, and a score of "10" representing someone extremely likely to offer a recommendation. Respondents to this Ultimate Question fall into three categories:

- **Promoters** (score of 9-10) are loyal enthusiasts who will keep buying and refer others.
- **Passives** (score of 7-8) are satisfied but unenthusiastic customers who are vulnerable to competitive offerings.
- **Detractors** (score of 0-6) are unhappy customers who can damage a company through negative comments to other potential customers.

Subtracting the percentage of Detractors from the percentage of Promoters generates the Net Promoter Score, which can range from a low of -100 (if every customer is a Detractor) to a high of 100 (if every customer is a Promoter). In a more likely scenario, if 60 percent of your customers are Promoters and 10 percent are Detractors, your Net Promoter Score is 50, which is not high enough for your company to be considered truly customer-focused. It also indicates that 30 percent of your customers are conflicted (passive), or possibly even uncaring, about your business.

What makes this measure interesting is its rather harsh categorization of respondents. Many companies might think that a response to the Ultimate Question of "8," and possibly even "7," is pretty good, but Mr. Reichheld views those scores as simply neutral. Likewise, 64 percent of the possible responses (0 through 6) are categorized as unhappy customers who can do serious damage to your business without you even realizing it. This can be a wake-up call to many who have traditionally viewed middle-of-the-road

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responses such as 4, 5 and 6 as neutral and nothing to be too concerned about.

They say the first step to bringing about change is recognizing the need for it. If we continue to believe our customers' satisfaction with our business is better than it really is, we will not do the things that are needed to raise that level of customer satisfaction. Whether you use Mr. Reichheld's Ultimate Question and Net Promoter Score approach, or find something comparably "tough" to gage customer perceptions of your business, it is important to be open-minded when reviewing the results. If you can keep an open mind, perhaps you will find that your 95 percent on-time delivery performance, of which you are so proud, is viewed as "just OK" by your customers. You may also find that your two- to three-week lead time, which seems to be the norm for your industry, is preventing you from getting any business from prospective customers or more business from your existing customers. Furthermore, you may learn that shipping the wrong products (or the right products in the wrong quantities) to your customers has a greater impact on future buying decisions than you ever thought possible. In short, if you pay attention to what your customers are saying, you may find that your perception of what constitutes good customer service is out of line with your customers' expectations. The sooner you understand this, the sooner you can do what is necessary to minimize these differences.

If we continue to believe our customers' satisfaction with our business is better than it really is, we will not do the things that are needed to raise that level of customer satisfaction.

If knowledge is power, then gaining the right knowledge about your customer service performance is the first step toward making the improvements needed to encourage your customers to promote you.

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Better Than Borderline

Even when there are no actual part defects that create scrap or rework, addressing borderline quality is important to reducing waste in any machine shop.

Our company recognizes that a key to our success as a supplier of precision medical and aerospace components is the ability to provide machinists with accurate and timely metrology data. Our low- and medium-volume production orders require many setups and measuring of various part geometries. In order for us to compete with lower-cost competitors, our machinists must operate multiple machine tools at once. This means the machinist must concurrently inspect different parts and control tool changes and offsets on multiple machines. A lean metrology approach requires the use of advanced measurement instruments located nearby, along with sophisticated statistical process control (SPC) and connectivity. Establishing and maintaining robust processes not only reduces scrap and rework, but also lessens many other more subtle but costly wastes.

Our "lean champions," like other lean practitioners, teach the various types of waste within organizations: defects, overproduction, waiting, not utilizing employee talent, transportation, inventory, motion and excess processing, to name a few. I submit that there are two additional wastes that need to be addressed: "overdesign" and "borderline quality." Here, I will focus on borderline quality.

BQ does not refer to defects, nor to the secondary or tertiary effects generated by defects. BQ drives other non-value-added wastes, such as overprocessing and motion, but it also is a waste in and of itself, similar to the relationship between overproduction and inventory.

Many machining operations involve dozens of dimensions that must be measured, adjusted and held to a print or process tolerance. Not all of those component dimensions are considered critical to quality (CTQ), but because a feature is not CTQ does not mean that it does not have to be held within the tolerance band. Any feature not within tolerance may result in scrap or rework. It also may result in a failure for the end customer.

ROOT CAUSES OF BQ	EFFECTS
Overdesign/improper GD&T	Slow down feeds and speeds
Machine inaccuracy	Add extra passes on cutting tools
Workholding location, rigidity, repeatability	Add stops in the CNC program for additional inspections
Inspection methodology	Continuously enter tool offsets
Hard materials/excessive tool wear	Change tools more frequently
Extended toolholders and tool deflection	Over-inspect parts during and after the cycle
Variability from previous operations	Do not run machine during breaks or between shifts

It is not practical to sacrifice an expensive part to scrap while dialing in tooling and fixturing during a setup. If a component has three distinct machining operations, you would lose three pieces or more to scrap. It also is not desirable to sacrifice components during the run portion of the operation due to tool wear.

When the machinist is producing components that are close to being out of tolerance or were previously out of tolerance, his behavior and productivity significantly change. He must perform non-value-added activities, thereby adding considerable time to the job. He cannot run a second machine nor get ready for his next job. Although there is no defect to record, productivity and

This Month's Columnist:
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throughput are reduced by as much as 50 percent.

How do you identify borderline quality when there are no actual defects that create scrap or rework? Use productivity metrics that record the low output, and make sure operations management is aware of the issue. Our company tracks cell output through gemba boards, OEE practices, or various utilization and efficiency measurements, depending on the type of machining.

How do you fix BQ? This is likely the toughest challenge facing today's modern machining shops. The first step is to ensure you have an inspection method that is repeatable and contains the means necessary to diagnose and improve the process. We continue to increase capital spent on metrology along with the number of kaizen events focused on optimizing quality at the source. The intent is to always recognize the BQ scenario when a machining operation is originally created. Resolving the problem is normally a joint effort by the CNC programmer, machinists, manufacturing engineer and inspector, who must overcome these problems, validate the program, document the setup and tooling, nail down the in-process inspection to correlate outputs and inputs, create toolchange frequencies, and so on. This team generally needs accurate machine tools, effective software and quality accessories, as well as precision-inspection methodologies and motivated technical talent at all levels, including night shifts.

Much of the simpler, higher-volume manufacturing has moved to low-cost regions. This means shops like ours are competing for complex, lower-volume components and processing new parts daily. This requires creating new programs and operations at least several times a week. Problem-solving and robust processes with high process capability need to be core competencies.

In addition to serving as V.P. of global lean manufacturing at Tecomet (**tecomet.com**), Patrick Tarvin is the author of the book "Leadership and Management of Machining."

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SANDVIK COROMANT SIGNS STRATEGIC RESEARCH AGREEMENT WITH PARC, A XEROX COMPANY

Sandvik Coromant has signed a strategic research agreement with Parc, a Xerox company. Parc will provide Sandvik Coromant with a footprint in Silicon Valley and expert resources for research and development in the field of digital manufacturing.

Under the agreement, Parc will allocate resources to conduct R&D on digital manufacturing technologies for Sandvik Coromant. Sandvik Coromant will also acquire all Intellectual Property (IP) and technology related to Parc's software for high-level process planning and automated manufacturing cost estimation for subtractive manufacturing.

"This partnership is a natural step and in line with Sandvik Coromant's long-term strategy to develop attractive solutions in the field of digital manufacturing and Industry 4.0," says

From left to right: Saigopal Nelaturi (Area Manager, Computation for Automation in Systems Engineering) of Parc; Janni Weber (Senior Project Manager) of Sandvik Coromant; Mats Bergstrom (Managing Director, Global Business Operations and Program Manager for Digital Design and Manufacturing) of Parc; Magnus Ekbäck (Vice President and Head of Business Development and Digital Machining) of Sandvik Coromant; Tolga Kurtoglu (CEO) of Parc; Markus Larsson (Vice President of Global Business Operations) of Parc; Mats Allard (Project Manager Virtual Machining) of Sandvik Coromant; and Michael Waltrip (Senior Director, Intellectual Property Management and Commercialization) of Parc.

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Magnus Ekbäck, vice president and head of business development and digital machining for Sandvik Coromant.

"Manufacturing is entering a dynamic new phase as the cyber and physical worlds converge, and the complex and diverse industry needs significant innovation to truly progress," says Parc CEO Tolga Kurtoglu. "The missing piece for complete design automation and manufacturing of complex products has been the integrated coupling of design and manufacturing, which we have been developing at Parc for many years. We're pleased to partner with Sandvik Coromant to see these innovations come to life on the global stage."

Parc has been developing technologies for government agencies and commercial clients in the field of digital manufacturing for almost a decade. Its digital manufacturing suite of technologies helps designers and manufacturers understand real-world manufacturing process constraints during digital product design and identifies potential limitations of a supply chain early in the design phase, ultimately minimizing time-to-market and improving overall product quality.

Sandvik Coromant, call 201-794-5000 or visit sandvik.coromant.com.

KAPP NILES LAUNCHES NEW GEAR METROLOGY DIVISION

Kapp Niles has announced the expansion of its product portfolio by adding high-end metrology products. The newly-founded division Kapp Niles Metrology GmbH, based in Aschaffenburg, Germany, leverages the experience and technology of R&P Metrology GmbH, whose employees and management have joined the new company.

The new division

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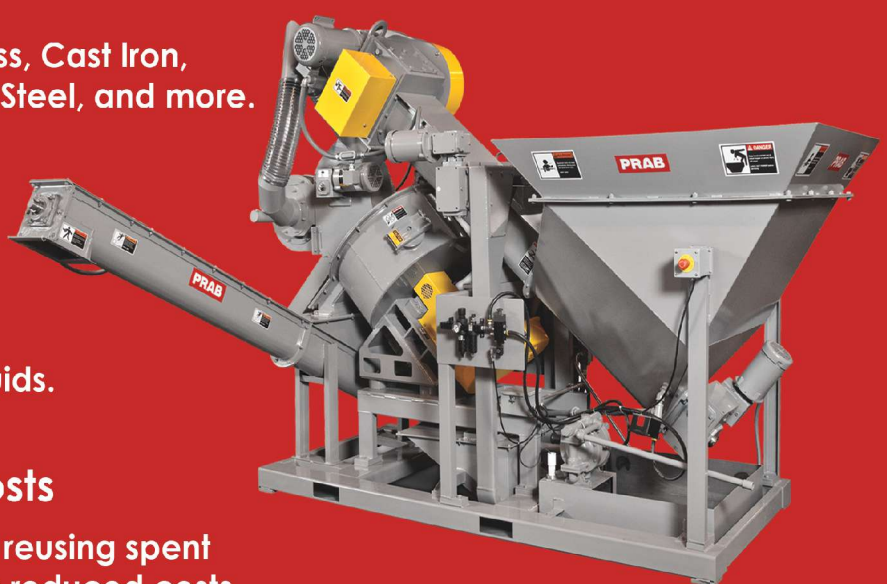

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designs and builds customized, large, four- and five-axis analyzers built to VDI/VDE class I. A derivative of the technology is a transportable three-axis device for analyzing gears in the shop on cutting machines or even in a gear box.

An expansion into the metrology sector complements the Kapp Niles product portfolio for gear and profile grinding. The new division will also provide sales and support in Europe and Asia for the smaller gear analyzers and products of Penta Gear Metrology of Dayton, Ohio, which joined Kapp Technologies in 2015.

Kapp Technologies, call 303-447-1130 or visit kapp-usa.com.

TECHNIKS INDUSTRIES ACQUIRES PARLEC'S TOOLING BUSINESS

Techniks Industries (Indianapolis, Indiana), a tooling provider for the metalworking and woodworking industries, has acquired the tooling assets of Parlec Inc. (Fairport, New York). The acquisition expands Techniks' product offering of aftermarket machine tool accessories and enhances its manufacturing and distribution capabilities to distributors and OEMs located throughout North America.

Parlec says it will retain its presetter business under the Omega Tool Measuring Machines brand. The Parlec tooling division will continue to operate as an independent company, branded Parlec LLC under the Techniks Industries umbrella. Parlec says that in January 2016, its executive team decided to view the company as two separate businesses, one focused on tooling, the other on presetting. The market strategies for these two businesses differed and their market growth was found to be compromised as a result.

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"With a global network that spans throughout North America, Europe, and Asia, Parlec's reach opens the world to Techniks Industries and Techniks Industries to the world," says Vernon Cameron, president and CEO of Techniks Industries.

Parlec Inc., call 585-425-4400 or visit parlec.com.
Techniks Inc., call 800-597-3921 or visit techniksusa.com.

ABB, IBM PARTNER TO COMBINE AUTOMATION, AI FOR MANUFACTURING

ABB and IBM have announced a strategic collaboration that brings together ABB's digital offering, ABB Ability, with IBM Watson's cognitive capabilities in an attempt to serve customers in utilities, industry, transport and infrastructure. The first two joint industry solutions powered by ABB Ability and Watson are intended to bring real-time cognitive insights to the factory floor and smart grids.

ABB and IBM say they will leverage Watson's artificial intelligence to help find defects via real-time production images captured by an ABB system and then analyzed using IBM Watson IoT for Manufacturing. Manual inspection can be a slow and error-prone process. By bringing the power of Watson's real-time cognitive insights directly to the shop floor in combination with ABB's industrial automation technology, companies will be better equipped to increase throughput while improving accuracy and consistency, the company says.The solution will alert the manufacturer to critical faults—some not visible to the human eye—in the quality of assembly. This will enable quick intervention from quality control experts. Easier identification of defects impacts all goods on the

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AME LAUNCHES ENGINEERING TRAINING DEPARTMENT

Allied Machine & Engineering (AME) has opened its new engineering training department, which provides comprehensive, hands-on education programs for new employees, end users and distributors from around the world. The training department instructs new associates in the proper use and application of the company's tooling in all phases of holemaking in metal. Trainees participate in a three-month technical and hands-on training program focusing on how the tools work and where to apply them in various applications.

The 3,000-square-foot facility, located in Dover, Ohio, includes two vertical machining centers and one horizontal machining center to showcase AME's tools. Each machining center features a dedicated camera with a live feed directly to 60-inch monitors, giving participants a view of tools in action. Demonstrations are available featuring AME's tools running in a variety of materials including low-carbon steel, alloy steel, high-strength alloy, 304 and 17-4 stainless steel, structural steel plates, 6061 aluminum, and iron. Training demonstrations include active participation, with attendees helping to select speeds and feeds.

For end users and the distributors who support them, the company offers an intense two-and-a-half-day technical educational seminar (TES) featuring classroom and metal-

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Brenk Brothers

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cutting demonstrations. These seminars, limited to groups of 15 to 30 attendees, are designed to keep participants abreast of the latest industry trends and technology.

For those unable to travel to the training facility, the training department sponsors open house events at machine tool distributors' facilities, as well as on-site training programs for engineers and machinists. Customizable training programs are available for groups of all sizes.

Allied Machine & Engineering Corp., call 800-321-5537 or visit alliedmachine.com.

AMT ELECTS 2017-2018 OFFICERS, DIRECTORS

AMT – The Association For Manufacturing Technology has elected its 2017-2018 officers and directors. Ronald S. Karaisz II will serve as chairman. He is president of Kar Enterprises Inc., Hydromat of Michigan LLC and Novi Precision Products Inc., all located in Brighton, Michigan. He follows Chairman Richard L. Simons, president and CEO of Hardinge Inc. (Elmira, New York).

The board elected Steven R. Stokey, executive vice president and owner of Allied Machine & Engineering Corp. (Dover, Ohio), to serve as first vice chairman. Christopher A. Bailey, president and COO of Etna Products Inc. (Chagrin Falls, Ohio), will serve as second vice chairman and treasurer. Brian J. Papke, chairman at Mazak Corp. (Florence, Kentucky), was elected secretary.

Newly elected to a three-year term as a member of the board is Michael J. Cicco, president and CEO of FANUC America Corp. (Rochester Hills, Michigan).

AMT - The Association For Manufacturing Technology, call 800-524-0475 or visit amtonline.org.

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June 7-8 | **Upper Midwest Design-2-Part Show**
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d2p.com

June 13-16 | **HxGN Live**
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hxgnlive.com

September 11-14 | **Composites and Advanced Materials Expo (CAMX)**
Orlando, Florida
thecamx.org

September 13-14 | **D17 Distribution Summit**
St. Louis, Missouri
amtonline.org

September 18-23 | **EMO Hannover**
Hannover, Germany
emo-hannover.de

October 10-12 | **Additive Manufacturing Conference**
Knoxville, Tennessee
additiveconference.com

October 11-12 | **Midwest Design-2-Part Show**
Indianapolis, Indiana
d2p.com

October 11-13 | **Global Forecasting & Marketing Conference**
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amtonline.com

October 24-26 | **Parts2Clean**
Stuttgart, Germany
parts2clean.de

October 24-26 | **South-Tec**
Greenville, South Carolina
southteconline.com

October 26-30 | **PMPA Annual Meeting**
Napa, California
pmpa.org

The Benefits of Variable Gaging

Although more expensive, gages are a better solution than measuring instruments for higher-volume production runs and tighter tolerances.

Measuring instruments such as scales, calipers and micrometers are used throughout a variety of manufacturing processes because they are inexpensive and versatile. These measuring tools have built-in reference scales to which they compare a part, and then the measurement is presented as a numerical result. Hand tools generally have a long measurement range and, in most cases, provide adequate resolution and performance. If you are just looking for a quick indication of part size, they do a great job. On the other hand, they also require the operator to have the proper skills and make the proper alignments to get reliable results. Thus, their accuracy, performance and measurement speed can be limiting.

Here, gaging equipment starts to shine. Gages compare the part to an external standard (not a built-in scale) and tell the user whether the part is smaller or larger than this master. While the measuring range of a gage cannot hold a candle to that of a measuring tool, gages tend to require less operator involvement, can work significantly faster and tend to be more accurate with higher resolution than measuring tools. Gages also tend to cost a lot more than measuring tools (although, with a little care and maintenance, they can last for decades).

GEORGE SCHUETZ
DIRECTOR OF PRECISION GAGES
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Variable gages are those that provide actual measurement deviations. In this way, they provide the data a shop needs to make decisions about process trends, to diagnose manufacturing issues and to learn a little about the form of a part. While fixed gages such as go/no-go devices also can provide good or bad classification, they still indicate how much smaller or larger a part is than the master being used.

There are two distinct types of variable gages: adjustable-variable and fixed-variable. The first type can be adjusted over a range and set to a new master size. Adjustable snap gages, inner/outer diameter gages and bench stands fall into this adjustable-variable gage group. These gages tend to be faster than hand tools and are fairly easy to use. They are also less susceptible to operator influence and provide significant improvement in the measuring process in a shop environment.

The other type of variable gage can be referred to as the fixed-variable variety. These gages are the ultimate in shopfloor measuring. They are by far the most accurate and require virtually no special user skills.

The term fixed-variable is not an oxymoron but rather a good description for how the gages are constructed. They include air plugs and rings, or mechanical bore plugs made to measure a specific size. Once the bore tooling is inserted, the built-in clearance aligns the plug to the bore. The clearance is so small that it is virtually impossible for the user to influence the reading.

It is easy to see how fixed-variable gages can be the fastest and still the most accurate. It's also easy to see, with each gage dedicated to one size and each requiring its own dedicated setting

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standard, that this type of gage is going to be the most expensive solution as well. But if you have a tight tolerance, and need to measure thousands of parts quickly and with excellent performance, a fixed-variable gage should be your gage of choice.

Now, if measuring tools are good, variable gages are better, and fixed-variable gages are best, what is the best of the best: fixed-size air tooling or fixed mechanical bore gages? Performance-wise, air gages probably have a slight advantage, since they, in effect, have no moving parts. There are no physical contacts passing their motion through transfer rods to the indicating device. And air gaging offers more versatility as well. The tiny air jets can be used for unique multiple-diameter applications or to generate basic form indications. There are limits on range and surface finish, however.

Mechanical plug gages, on the other hand, offer a bit more portability, because they are not tied to a display unit with an air hose. They also tend to require less initial investment since they do not require a constant supply of clean air in their operation.

Fixed-variable gaging, such as with custom air tooling, is by far the easiest, fastest and most accurate method for qualifying parts.

Either way, gages are a better solution than measuring tools for higher-volume production runs and increasingly tighter tolerances. Choosing the right type depends on a combination of performance, ease of use and overall cost.

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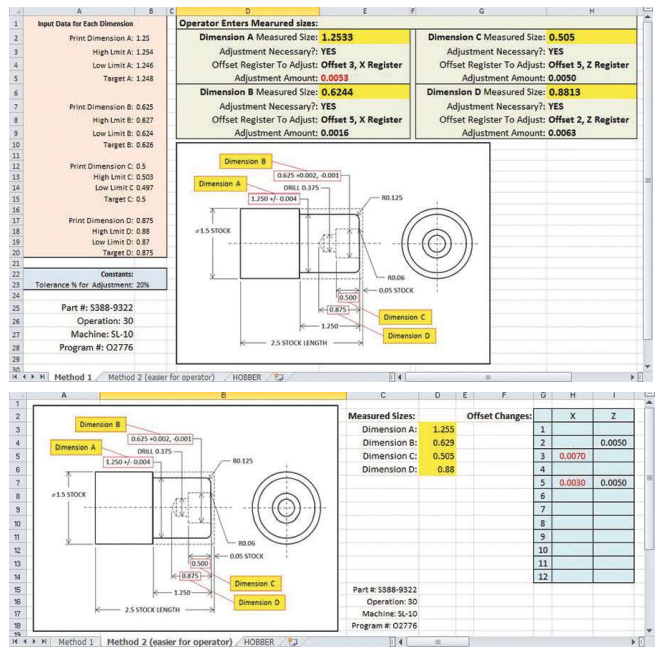
Mobile Spreadsheets for Sizing Adjustments

This is one area in which operators often struggle, so provide a reference tool to make the job easier.



You expect a lot from your CNC operators. Anything you can do to simplify operations or processes will surely improve their productivity. One area in which many operators struggle (especially entry-level operators) is making sizing adjustments. Based on your control plan and during sampling inspections, they must:

1. Measure workpiece attributes and determine whether they fall within tolerance ranges. If they do fall within range and are not approaching tolerance limits, no further action is needed. If they do not, adjustments must be made.

2. If an adjustment is necessary, determine the amount and polarity of the adjustment needed to bring the attribute back to its operator-determined target value. The target value is often, but not always, the mean tolerance value.

3. Determine which offset number and register must be adjusted. This requires knowing which cutting tool machined the workpiece attribute.

4. Enter the adjustment polarity and amount in the appropriate offset register.

While these are very common tasks, even experienced operators sometimes struggle to determine appropriate target values and figure out which offset register must be changed, especially with unbalanced tolerances. Entry-level operators are very prone to making mistakes in these areas.

We have addressed this topic in past columns, and here I offer yet another suggestion that should be of interest to shops that have many repeated jobs and/or medium to large lot sizes: Create a spreadsheet that will run on a mobile device. Operators will use the spreadsheet during sampling inspections to determine whether sizing adjustments are necessary, and if they are, the spreadsheet will show how to make them. The images above show an example and can be accessed at

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cncci.com/jun17.xlsm. This spreadsheet has been kept simple for illustrative purposes but demonstrates what is possible.

In this spreadsheet, the "Input Data" provide tolerance information about each critical workpiece attribute, including tolerance limits and target values. Under "Constants," we specify 20 percent as the cutoff point at which an adjustment must be made (this is a changeable value). This indicates that when a workpiece attribute grows or shrinks (due to tool wear) to within 20 percent of a tolerance limit, an adjustment must be made. Finally, the drawing relates each critical workpiece attribute to the required operator entries (Dimension A, Dimension B and so on).

The operator does not need to see the input data or constants. So, to save screen space, they can be hidden, possibly on a different worksheet page, as shown in the bottom image. In fact, you can hide everything except what the operator needs to know and dramatically simplify the spreadsheet for him or her.

The operator will use the spreadsheet on a mobile device at the inspection bench when taking sampling measurements. Based on the control plan, he or she will measure specified workpiece attributes and fill in the spreadsheet with each measured value. In our simple example, measured workpiece attributes are placed in the four yellow fields. Based on these entries, the spreadsheet will relate whether an adjustment is necessary, and if so, the adjustment amount and its polarity. Positive adjustments are shown in black, negative in red. The spreadsheet also specifies the offset register used to make the adjustment. When finished inspecting, the operator will take the mobile device back to the machine and use the spreadsheet results to make any required offset adjustments.

Spreadsheets you create for your shop will surely be more complex than our simple example, and you will, of course, need a different spreadsheet for each job. Once you have created one that works to your liking, use it as a template to create the others.

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Trade-offs with AM

Current design tools and process workflow are inadequate to meet our needs.

In a previous column, I described how students at Pennsylvania State University designed and produced a lightweight automotive component with intricate geometry using additive manufacturing. The part was built from titanium (Ti-6Al-4V, or Ti64, as it is often referred) on a laser-based powder-bed fusion system in a vertical orientation. The image to the right shows the part on the build plate inside the machine after fabrication is complete.

What I did not mention about building the part in this orientation was how long it took and at what cost: about 54 hours and about $2,000 in Ti64 powder feedstock. Not bad, one might say, for such a complex part, but consider this: Of the 54 hours it took to manufacture the part, about 30 hours was spent building the supports, while only about 24 hours (44 percent of the build time) was needed to build the part itself. Worse, of the $2,000 in powder, about $1,500 worth was used in the supports; the part itself only required about $500 worth of powder (25 percent of the material cost). This is not so good when you consider that those support structures had to be cut, ground, chiseled and filed away in order for the desired final geometry to be achieved. As a result, more than 75 percent of the powder and 56 percent of the build time went into making scrap. And this doesn't even take into account the amount of time and effort that was needed to remove all of those support structures, which also added to the production cost. Again, not so good.

The obvious question is why did we build the part this way? The answer is not simple and reflects the limitations of our current design/process workflow and the trade-offs that need to be made when choosing additive manufacturing. First, four different software packages and analysis tools were needed to design that part: CAD software to create the solid geometry, a finite element analysis (FEA) package to analyze the structure, a topology optimization algorithm to help lightweight the component and, finally, software for the build layout and orientation. None of these software packages communicates well with another, and changes made in one are not reflected or updated in the others. So, if we set up the build layout and realize the complexity of the geometry requires too many support structures, we then have to go back and iterate among CAD, FEA and the topology optimization algorithm.

Building this single automotive component, including its support structures, took about 54 hours, and required about $2,000 in titanium powder.

Additionally, build orientation drives build time and powder usage, and these must be traded off with how many parts can fit on a build plate. Multiple parts in different orientations will lead to different heating (and cooling) rates during the build, and this will affect microstructure, which will affect mechanical properties, which will affect the strength of the part, which will affect how it is

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designed, which means even more iteration. The design tools necessary to analyze all of this and resolve the trade-offs do not even exist yet.

A couple of further points are worth noting related to the cost. First, anyone who has worked with AM knows that $2,000 in Ti64 powder for a build of the size in our example significantly underestimates the cost of the powder feedstock that is really needed. In powder-bed fusion, the entire build volume has to be filled. As a result, you need a cube of Ti64 powder measuring roughly 10 by 10 by 10 inches to make this part, plus some extra to make sure you don't short the build. The cost for this amount of (virgin) Ti64 powder will run you close to $100,000, much of which can be recycled. Second, supports are generally over-specified. The last thing you want is to have the part warp up from inadequate supports, jam the recoater and cause a build failure. Failures like that get expensive real quick. All the more reason we need better software tools and design/process workflow to make sure we get it right the first time.

In powder-bed fusion, you need enough powder feedstock to fill the entire build volume, not just enough to make the part and its supports.

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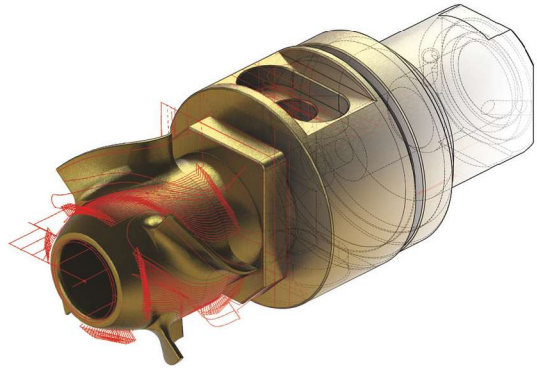

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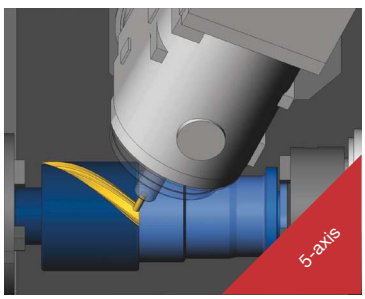

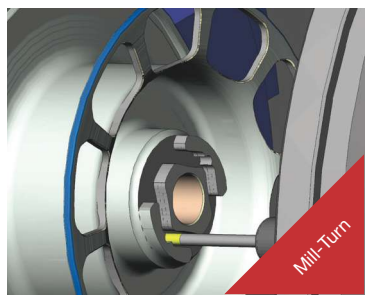

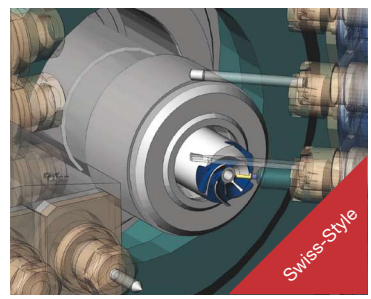

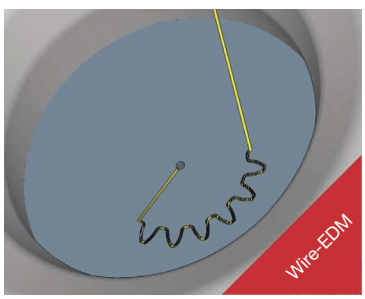

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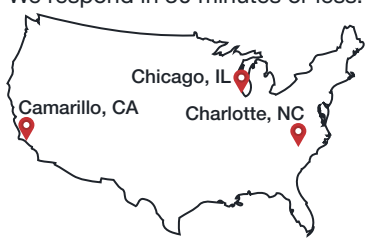

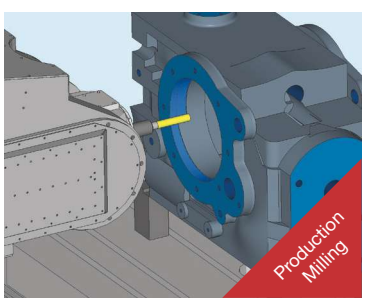

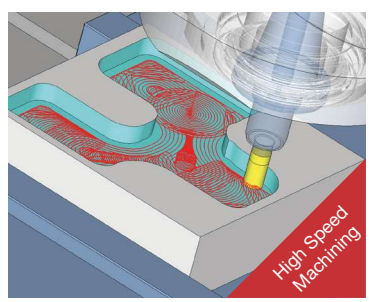

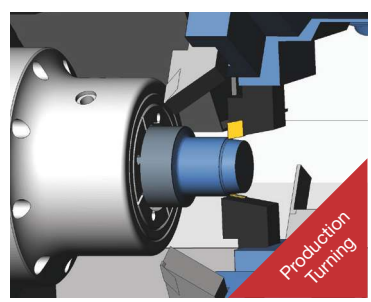

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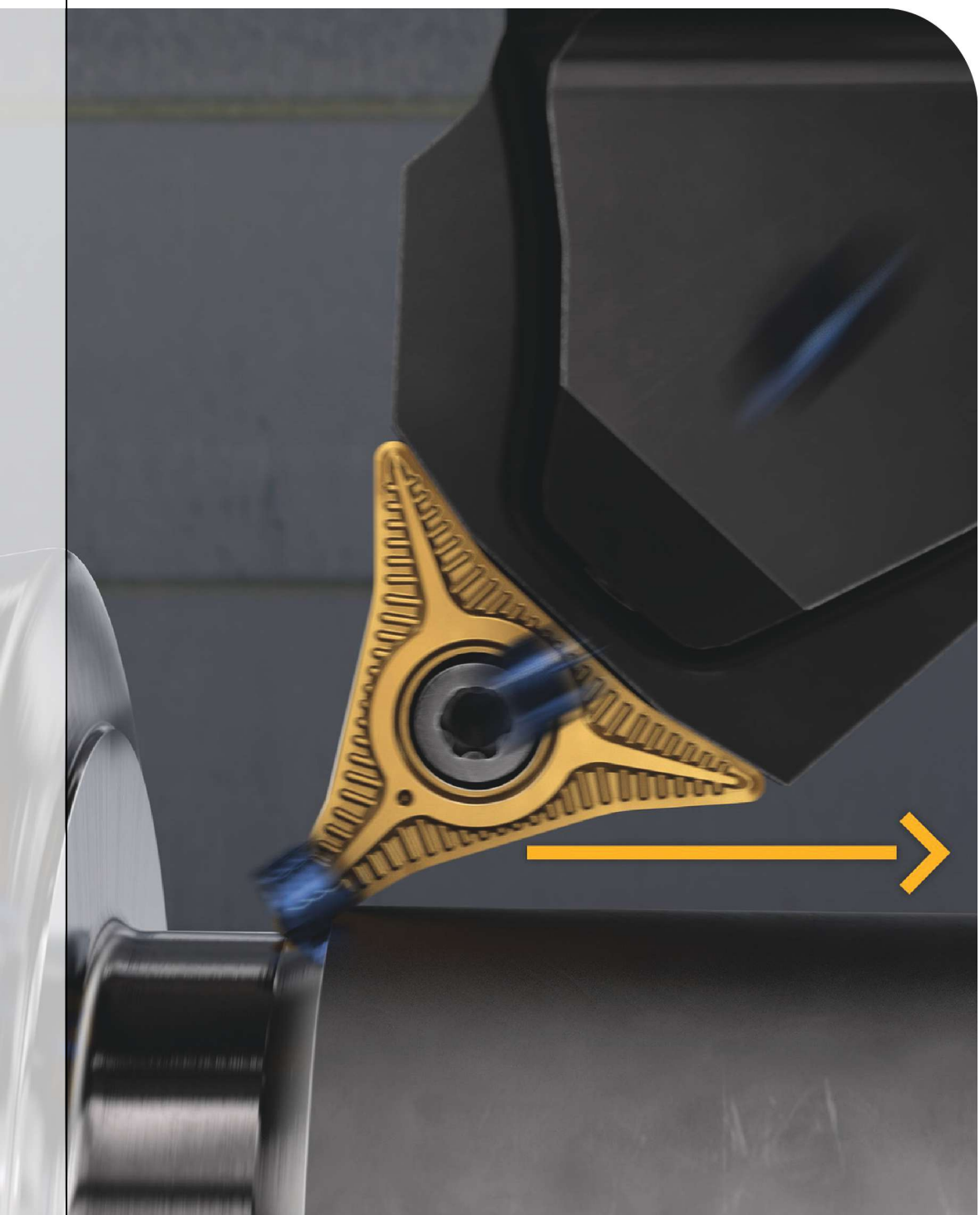


Turning Takes a New Direction

A methodology for cutting in both directions on a CNC lathe promises to make turning a much more productive operation in certain applications. New types of inserts driven by new CAM tool paths are key enablers of this development, but implementing the whole multifaceted system *as a system* is essential.

BY MARK ALBERT

Without a prior explanation, an observer of a live turning demonstration might declare that the tool in the demo lathe is cutting in the wrong direction, exactly opposite of the usual practice. Likewise, the viewer watching a video of this demo might strongly suspect that the recording was being played in reverse. That would account for what seems to be the "backward" motion of the turning tool. A rendering of the tool motion in these demos, as shown on the facing page, indicates that the direction of the cutting tool is actually following the yellow arrow. This direction is clearly the opposite of a normal or traditional turning operation. What is going on here?

Sandvik Coromant, the inventor of this process, calls this new turning concept PrimeTurning, which uses dedicated CoroTurn Prime tooling. In fact, the two current styles of inserts for PrimeTurning (one for light machining and one for heavy machining) are designed to cut in a direction that is opposite of the usual approach. In addition to moving toward the chuck in the Z axis as they cut, these tools can also "go in reverse" and move away from the chuck as they cut. Likewise, when needed, these tools can cut "up from" or "down to" the part centerline in the X axis for facing or shoulder cutting. Each insert is capable of roughing, finishing or profiling by cutting in either direction when there is an advantage.

A new method of turning enables an insert to cut away from the shoulder of a workpiece. Because the insert can travel toward the tailstock of the lathe instead of toward the chuck, there is no possibility of chips jamming in the corner as may occur in conventional turning. (All images from Sandvik Coromant, except as noted.)

For the right applications, the company claims that the results are astonishing: as much as an 80-percent boost in productivity. As much as twice the tool life for the inserts. Significantly smoother surface finishes.

How can cutting in the "wrong" direction be so right for certain operations in these applications? A detailed answer to this question is worthwhile, because it involves a number of insights into the nature of the basic turning process itself. Based on these insights, the concept of PrimeTurning seems to upend normal practice, and do so on several levels.

Apparently, a turning capability like this has never been possible before. The geometry of the light-machining and heavy-machining insert styles appears to be entirely new. Both styles are highly specialized; the multi-angled nose of the

heavy-machining insert is particularly different in a striking way. In addition, new capabilities in CAM software had to be developed to streamline programming of the unprecedented tool paths and dynamic feed rates required for this turning process. (Mastercam has been working in tandem with Sandvik to create the needed algorithms so the cutting concepts can be readily applied by end users.) The way coolant is delivered to the cutting zone is also new. (As one might imagine, chip formation and heat transfer occur in unexpected patterns, so coolant plays a critical role in the process.) Other details such as modified toolholders and strict setup requirements must also be attended to for this process to obtain its maximum benefit.

This is a lot to take in. Of course, Sandvik Coromant recognizes that the market for PrimeTurning will require considerable "re-education" to understand and implement the radical aspects of the process correctly. However, the company has been conducting numerous tests in the field with a range of selected customers around the world. Reports from these test users indicate that, once they get the hang of the process and establish the discipline it calls for, they will be clamoring for more access to these tools, the company says.

Cory Koch, an application engineer at Hartwig Inc., a machinery dealer in Houston, Texas, and one of the first machining facilities to take a close look at PrimeTurning, says, "These tools will change the way our customers process their parts, allowing better tool life, much higher material-removal rates and the ability to maintain tighter tolerances. The tools are so versatile in their design that you must think outside of the box to imagine what is possible."

WHEN TOOL DESIGNERS ARE TURNED LOOSE

The origin of PrimeTurning and the corresponding CoroTurn Prime inserts goes back several years to events in Sandvik Coromant's development center in Sweden. The company attributes the pioneering efforts to Adam Johansson, a young engineer who joined its R&D department in 2012, and Ronnie Löf, a 20-year veteran in cutting tool engineering there. One account of their collaboration begins with a note that typical descriptions of turning involve a non-rotary tool removing material as it travels from the end of a rotating component towards the chuck. Conventional wisdom confirms that, in this method, the smaller the lead angle between the cutting edge and the feed direction, the greater the opportunity to increase the feed rate and gain higher productivity. The problem is, a small lead angle prevents the cutting edge from reaching the start of a shoulder, and it also creates long, curved chips that are difficult to control. This relationship between lead angle and limited productivity seemed an unalterable "given" for turning operations.

However, when the two engineers started discussing the lead angle/reach dilemma in late 2012, they approached it with a shared curiosity and the courage to challenge accepted truths, or so the story is told. They recall that before long, a small, far-fetched seed started to cultivate, and the discussions became more intense. Their idea was simply to turn backward, from the chuck to the end of the component. This would immediately solve the challenge of reaching the shoulder with a small lead angle.

"The metalcutting industry has been removing metal from end to shoulder for centuries. Every turning expert can line up impressive amounts of arguments to why the opposite is completely unrealistic," Mr. Johansson says. He cites chip control as the main counter argument, as the small lead angle still creates long, curved chips, regardless of the turning direction. Mr. Johansson and Mr. Löf set out to solve the issue together with two other equally open-minded designers, Joe Truong and Krister Wikblad. Their research seemed to promise success. When product manager Håkan Ericksson became involved in 2015, the team intensified its discussions with colleagues, key customers and other stakeholders and began testing the concept on a larger scale.

These tests, which the company says included extensive trials and experiments in its own labs as well as applications in end-user plants, raised and then helped resolve numerous technical issues. When PrimeTurning was officially announced to the industry in April 2017, Sandvik Coromant had a clearly defined concept and a complete

methodology to present, along with practical guidelines for when and where this development had the most to offer. The main benefits, according to the company, are these:

- Aggressive cutting parameters for increased output of components and reduced cost per component.
- Consistent tool wear that leads to improved machine utilization, fewer tool changes and reduced costs.
- Chip control and long tool life that give more predictability in long-running jobs, which means fewer production holdups.
- Reduced temperature at the cutting edge, which improves tool life.

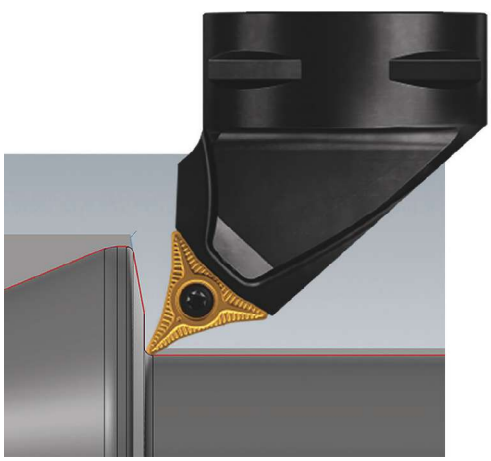
TURNING ATTENTION TO INSERT DETAILS

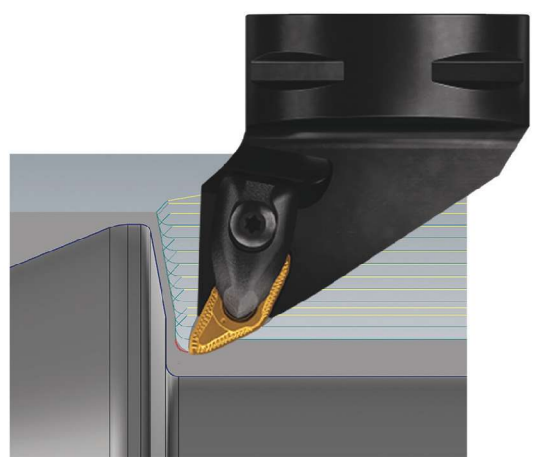
As noted, two styles of inserts are currently offered for the PrimeTurning methodology. These are designated CoroTurn Prime A and B, as shown side by side in the illustration below. The A-type insert features three 35-degree corners and is designed for light roughing, finishing and profiling, while the B-type insert is designed specifically for heavy roughing and has what the company characterizes as two, ultra-strong corners. Nine sizes of the A type are available; six sizes of the B type. These are all non-ISO inserts, meaning simply that their geometry does not fit any of the general insert shapes defined and codable by the international standard for classifying metalcutting insert types.

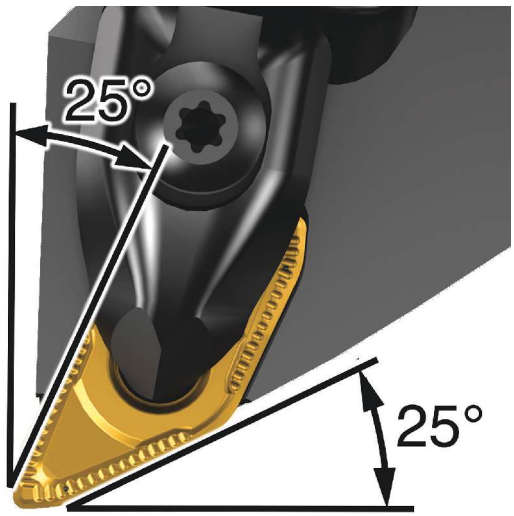
It is also important to note that both types are described as "all-directional turning solutions." In other words, either type can cut conventionally from the part end toward the chuck as on a shaft secured by a tailstock. Either type can also cut conventionally on a shoulder or a face, moving from the periphery of the part toward (down to) the center. What's new is that either type can also cut in the opposite direction, that is, entering the part at the chuck and removing material as it travels toward the end of the shaft while the nose of the insert is still facing the chuck. (In fact, holding this orientation is what makes the operation appear backward or to be going in reverse). Likewise, for a shoulder, the face of a flange or similar "vertical" feature, either type can cut up and away from the part center. The nose of the insert still faces the chuck in the same orientation as it does when going down in conventional turning, but this does not look as startlingly strange as the horizontal/longitudinal backward cutting mode.

Because the CoroTurn Prime inserts can cut in all directions, switching from roughing to finishing, for example, does not require a tool change. Instead, the direction of the cut changes. And because the cutting direction can change, the tool does not have to retract from the workpiece surface and return to its starting point in the air

Two types of CoroTurn Prime inserts are offered. The A type (left) is designed for light machining, whereas the B type is designed for rough machining. Both inserts are suitable for all-directional turning.







The distinctive shape of the roughing insert helps increase metal removal rates while providing a wiper effect for a smoother surface finish when cutting. Both types of inserts feature angles that are appropriate for conventional and backward turning.

to begin another pass. Under certain conditions, inserts can literally cut back and forth or up and down in consecutive passes. (Keep in mind, of course, that cutting parameters must change each time to suit the new cutting direction.)

What's happening when a CoroTurn Prime insert is cutting backward is easiest to grasp with the B-type insert. By entering the workpiece at the chuck and removing material as it travels toward the tailstock, it is possible to apply a small entering angle (30 degrees for the A type; 25 for the B) and a high lead angle. This approach spreads cutting forces and frictional heat over a larger area of the insert's cutting surface than is possible cutting conventionally. It also creates thinner, wider chips that do not concentrate rubbing contact (and resultant heat) on the nose radius at the insert's tip. The thin, wide chips can be controlled by the bumpy ridges of the chipbreaker texture, thus avoiding swarf in the form of long strands of tightly curled material.

These favorable cutting conditions, the company says, enable the application to benefit from an advantageous trade-off between more aggressive cutting parameters for productivity and prolonged, more predictable tool life. In other words, an operation can remove more material faster or have the insert last longer. In addition, whereas conventional cutting toward a shoulder can cause the insert to jam chips into the corner where the workpiece diameter changes, with PrimeTurning, cutting action occurs in a direction away from the shoulder. Chip jamming cannot happen as a result.

In the illustration on this page, you might notice that the B-type insert features an irregularly angled profile such that on each side of the insert the cutting edge has a wide angle past the nose, but then trails away at a narrower angle toward the center of the insert. This gives the tip of the insert a kind of distinctive shovel shape. This design is said to maximize the strength of the cutting edges, as well as create a wiper effect where the nose radius begins to broaden.

In roughing cuts, when removing material quickly is the primary goal, this wiper effect gives the remaining stock a smooth surface, thus making finishing cuts more efficient. A better surface finish in roughing and more efficiency in finishing is a double boost to productivity for the PrimeTurning methodology, the company says. When cutting conventionally, the radius at the nose of the insert enables it to perform much like a standard turning insert, though with conventional results as well.

The A-type insert, which is designed for light- and medium-duty roughing, finishing, and fine profiling, represents a miniature version of the same tip and cutting edge geometry that is more easily seen on the larger B-type insert. The benefits of a smaller entering angle, high lead angle and manageable chip shape are enjoyed equally well for the A-type insert.

However, successfully applying the CoroTurn Prime inserts of both types is dependent on certain critical nuances in the cutting strategy of the CNC tool path. A discussion of these nuances rounds out a basic explanation of what these insert styles are capable of.

PROGRAMMING IS NOT A TURNOFF

In recent years, CAM software developers have come up with streamlined techniques for programming highly efficient milling routines for pocketing

and profiling. As Sandvik Coromant developers realized early in the testing of this new turning concept, programming the required moves for all-directional turning would be a challenge. They also recognized that optimizing this new process with advanced CAM capability was an opportunity for benefits not unlike recent programming advances such as constant-chip-load techniques for milling.

"Until now, turning utilities and CAM packages did not provide for the directional changes called for in PrimeTurning," Mr. Ericksson says. "This process also requires provisions for entry and lead angles, as well as creating tool paths to gently arc into the workpiece and then ramp up to the appropriately higher speeds, feeds and depth of cuts that give PrimeTurning its potential."

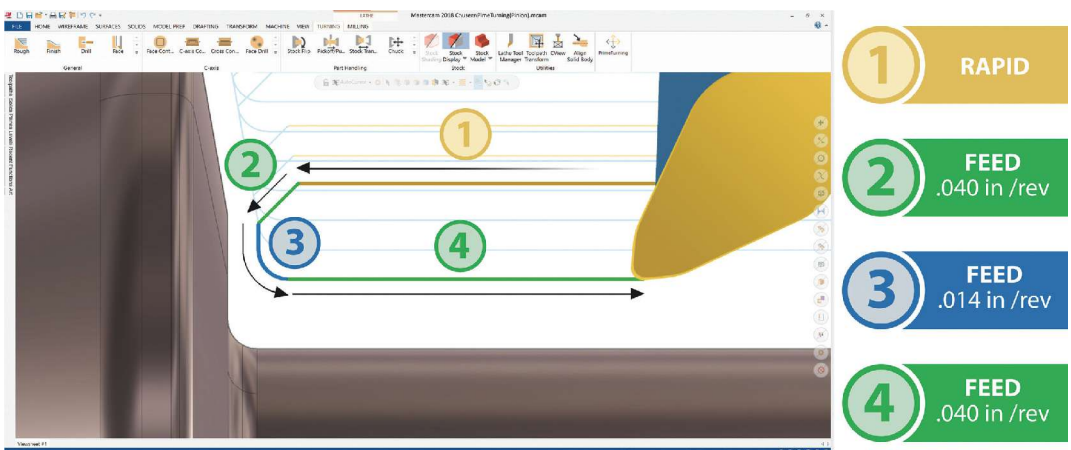
In 2016, Sandvik Coromant invited CNC Software, developers of Mastercam CAD/CAM software, to be a partner in the development of programming software to accommodate PrimeTurning requirements. According to Mastercam Product Director Dave Boucher, his company's experience with the software's Dynamic Turning and Dynamic Motion features, which involve counter-intuitive cutter motions, was expected to be useful in the novel thinking that PrimeTurning called for.

To be fair, Sandvik Coromant will make the technology for this process available to all interested CAD/CAM developers and is offering its own PrimeTurning Code Generator. This is a dedicated software utility that supports the process by generating generic ISO code compatible with CNC machines that accept this input format. It is available as a cloud-based application through an annual subscription. That said, Mastercam's new set of turning strategies to support this process is available now as part of the 2018 release of Mastercam. (By agreement, Mastercam has an exclusive right to use this technology until November 1, 2017.) Because these strategies are likely to indicate how other CAM software developers will follow, looking at Mastercam's insights and approach are handy here.

For example, automated capability is essential. When the user opens the PrimeTurning Properties window, tabbed pages solicit entry of all required values, selections and options for the tool path to be generated. For example, choice of strategy is based on the shape of the part. For shaft-like parts, the programmer would likely choose "horizontal." To turn a flange, "vertical" would be appropriate. Each strategy selection brings up the corresponding diagram of cutter moves, along with boxes for entering values for the associated variables. Using this input, the software automatically does all the calculations and toolpath generation necessary for applying this turning methodology.

For example, when the CoroTurn Prime insert

To some extent, the potential of this turning technology is unlocked by precisely controlled motion commanded by the CNC program. Mastercam's support for this method automates this essential programming capability. Sandvik Coromant also offers a generic code generator.



feeds into the part at the chuck, its entry must include a reduced feed rate and a slight arc in the tool path where it engages the workpiece at the correct depth to cut longitudinally (backward, that is, toward the tailstock). This enables the insert to engage the material gently, and then ramp up to full speeds and feeds. The precise motion is apparent in the image from Mastercam on the previous page.

All of the Mastercam strategies follow the rules established by Sandvik Coromant for the PrimeTurning process. Starting values for the variables related to each insert type and cutting strategy are pre-populated with recommendations from the cutting tool manufacturer. These values are suitable for workpiece materials most likely to be candidates for the PrimeTurning methodology. These include ISO P steels, ISO M stainless steels and ISO S heat-resistant superalloys. These rules also enable the software to recognize when the selected strategy and entered values call for conventional turning routines in the "normal direction" where appropriate instead of the PrimeTurning approach.

"The whole intent of Mastercam's support for PrimeTurning is to streamline the application of the methodology and assist users to obtain the 50- to 80-percent gain in metal-removal rates and doubled tool life that is the potential for this process," Mr. Boucher says.

END USERS TAKE A TURN

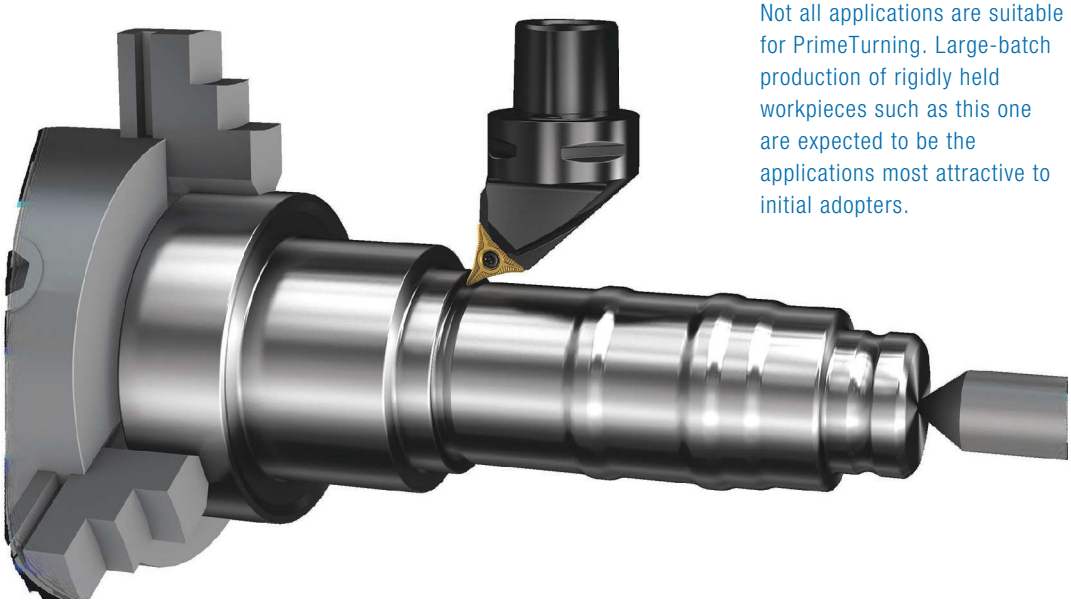
Sandvik Coromant has been forthright in saying that PrimeTurning is "not for everyone." Although the company sees a wide expansion of applications in the future, the current methodology and dedicated insert types will be most attractive to a particular class of users. The table below summarizes the conditions that will compel such potential users to apply this methodology.

"Large-batch manufacturers are most likely to see the greatest cost-per-part savings, especially if turning is a production bottleneck," Mr. Ericksson says. "The method requires stable components and a rigid setup due to the increased radial forces. This means that conventional turning may still be appropriate for vibration-prone portions of slender components." He adds that PrimeTurning is best-suited for short and compact workpieces and shafts for which a tailstock is available. It is a good choice for mass production as well as for components that require frequent setups and tool changes. He also expects it to be applied initially to expensive or high-value workpieces.

Mr. Ericksson stresses that users must be committed to the PrimeTurning methodology as a multifaceted system that should be implemented

PRODUCTION REQUIREMENTS	PROCESS CONSIDERATIONS	BUSINESS CONSIDERATIONS
• Stable fixturing of the workpiece.	• Large batch sizes (more than 100 pieces).	• Highly competent shopfloor workforce.
• Short, compact workpiece shape.	• Turning is a constraint on productivity.	• All employees are open to change.
• Lathe with sufficient torque and rigidity.	• High-value workpieces.	• Disciplined shop culture.
• Up-to-date CNC unit.	• Setup time is substantial.	• Company is driven by technology.
• Clear specs for dimensional accuracy and surface quality.	• Capability for unattended operation.	• Willingness to invest in technology.

This table summarizes the production requirements, process considerations and business considerations most likely to attract end users to PrimeTurning technology.



Not all applications are suitable for PrimeTurning. Large-batch production of rigidly held workpieces such as this one are expected to be the applications most attractive to initial adopters.

in its entirety. Otherwise, the full benefits are less likely be to be achieved, he says. “The profile of a PrimeTurning user is emerging as a shop that is highly competent in existing applications, is open to change and new ideas, has a culture of shopfloor discipline in place, and is willing to invest in technology.”

This last point deserves an added note. CoroTurn Prime inserts are premium-priced offerings, although anticipated returns make them an exceptional value, Mr. Ericksson believes. In addition to these dedicated inserts, special toolholders are also required. At the moment, the company offers 52 variants of toolholder styles that accept A- or B-style inserts, including Coromant Capto, CoroTurn QS and square-shank styles. Holders for A-type inserts have a TR-style locking interface for stability. Holders for B-type inserts have a shim-protected tip seat for added strength.

Toolholders for CoroTurn Prime inserts have multiple orifices to direct internally-fed coolant to cutting edges. These high-pressure streams are intended to help control heat and aid in chip evacuation, the company says. Coolant application is especially important for the A-type insert, because the tip at each corner is not as massive as the B-type, so its ability to absorb heat and resist wear is somewhat lower. For this reason, A-type insert holders have one coolant jet aimed at the top of the insert as well as two from the sides.

A user’s investment in this total methodology can be justified by the results, Mr. Ericksson says. For example, he points out that the overall productivity gains from adopting this turning concept may enable a production shop to defer an investment in a new machine tool if an increase in capacity is anticipated.

HAS METALWORKING TURNED A CORNER?

It can be argued that, in recent years, productivity gains in turning operations on CNC lathes have not seen the same level of advancement as that experienced in milling operations on CNC machining centers. This seems attributable to the fact that turning primarily involves a “single-point” process. In most cases, only one cutting edge on the turning tool is removing material from a single workpiece in the lathe at a time, whereas milling usually involves cutting tools with multiple edges, such as multi-flute round tools or milling heads with multiple inserts. Machining centers have also benefited from options for rapid pallet changes and multiple part setups on pedestal fixtures in horizontal machines. Combining turning with other machining processes on turn-mill

or multitasking machines has been a significant source of overall part-making efficiency, but metal removal rates in the turning portions of a part program for such equipment have remained relatively unchanged.

Mr. Ericksson believes that PrimeTurning is a significant departure from the status quo in metal removal rates for turning. "The initial reaction from users testing this technology indicates that the prospect of a 50-percent gain in productivity will be a game-changer for most turning operations. Adopting this approach is not without its challenges, but the motivation to do so is compelling," he says.

More important, however, is what he predicts will be a spate of new developments in turning technology. "PrimeTurning brings to the foreground a synergy among tooling capability, machining capability, programming capability and even workforce capability," he says. He adds that, once machine designers, cutting tool manufacturers, software developers and end-user application engineers begin opening their minds to the new possibilities, surprising innovations are likely to follow.

He notes that the digitally connected environment that is rapidly emerging in shops and plants around the world due to the rise of the Industrial Internet of Things and initiatives such as Industry 4.0 will accelerate and magnify the effect of these changes. In the meantime, he says that Sandvik Coromant has a timetable of projects to expand the PrimeTurning concept with additional CoroTurn Prime inserts. "We believe our current offerings only scratch the surface of all-directional turning possibilities," he says.

Global patents on the PrimeTurning concept and technology are expected to be finalized in mid-2018.

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Machining and Fabrication Are Different

But in this shop, ISO certification and ERP implementation have helped bring machining and fabrication together. Another important factor: management recognition of the differences in the natures of these types of work.

BY PETER ZELINSKI

When I spoke with Chad and Lindsey Carr recently about ISO 9001 certification, they had not yet seen much from it. No commercial impact, that is. Their shop, Engineered Fabrication, pursued and won the certification last year. So far, it has not brought any new business or opened any doors that weren't already open to this Watkinsville, Georgia, contract manufacturer.

And Chad, the owner and president, is entirely fine with that.

New business is what any active company generally wants, of course. He hopes and expects the ISO certification to help in this. But he had no current customers that were pushing him to get certified in this way, and he was aware of no prospective customers denying him business because of the lack of this certification. Instead, he pursued it as way of establishing an externally enforced standard that the shop would adhere to

(Facing Page) This photo captures a routine occurrence for Engineered Fabrication's machine shop. Take a close look and you'll see the jobs in work at this machine include (A) batch production of job-shop parts (lower right of photo) as well as (B) machining of two fabricated weldments (seen at about the middle of the photo near the left edge).

(Above) Fabrication work consists largely of welding. The physical nature of this work has led to differences in the way the company structures employee work weeks.

The company's fabrication work consists of building custom structures and machine components. Here are various examples.

and improve upon. Plus, he pursued it because the shop was ready.

"I felt like we were already doing the sorts of things, holding to the sort of process consistency, that ISO requires," Mr. Carr says. But that was only a feeling. "If we did ISO, it would prove we were the shop I felt we were, and it would also make us better."

Operations Analyst Lindsey Carr (his daughter) oversaw the ISO effort. Defining and documenting the shop's processes and establishing the documentation procedures that would allow the shop to be certified was essentially a full-time job of hers for about six months. Fortunately, prior to this, she had already done some of the necessary foundational work. In 2013, she led

Meanwhile, the company's machining area produces job-shop-type work in addition to supporting fabrication. Current owner Chad Carr led the company's diversification into machining alongside its traditional custom fabrication work.

the shop's effort to install and transition to an enterprise resource planning (ERP) system, Exact JobBoss, for management of the shop's work and resources. Because of the implementation of this software and the habits it requires, the shop's staff of 29 employees had already become accustomed to tracking critical performance data. The ISO effort felt a lot like a continuation of the ERP effort, she says.

And in this shop, both of those efforts required her, and required Mr. Carr as well, to face and work with one of the defining characteristics of this particular manufacturing business that separates it from many other shops. Namely, Engineered Fabrication combines both CNC machining for repetitive part making and custom one-off fabrication within the same company. It devotes roughly equivalent staffing and resources to both. On many jobs, it employs the two capabilities in tandem. The challenge in all of this is that machining and fabrication are characterized by different mindsets and follow different rhythms, requiring management to think about them in different ways.

WELDMENT WORKPIECES

Mr. Carr helped to bring about the increased importance of CNC machining in the company. He joined in 2010 as an employee, the general manager. The company's business then was serving OEM customers with tailor-made fabrications—fixtures, machine components, dedicated carts and other custom industrial structures—that are built largely by welding metal components. The in-house milling and turning capability at that time simply made custom parts to support this fabrication. As GM, Mr. Carr added more CNC machine tools, and sought to expand and balance the company's business by pursuing job-shop-type piece-machining work as a complement to the fabrication. Then, in 2013, he purchased the company from its then-retiring founder.

Today, fabrication and machining are located

Lindsey Carr, seen here discussing a traveler with fabrication team member Sam Bernard, led the shop's implementation of ERP and then its pursuit of ISO 9001 certification.

in different parts of the company's facility, but this is largely because waterjet and welding are such different beasts from small-part lathe and machining center work that they command their own space. Even so, the two parts of the business synergize more than they are separate, and this is seen most clearly during a walk through the CNC machining part of the shop. Seemingly at every machine tool, the jobs that are in work include accumulations of shiny, repetitive parts being arranged in order to complete a shipment to a customer, along with weldments in sets of just one or two requiring machining in order to be completed.

Mr. Carr explains that those weldments make their way through the CNC area because practically every fabrication job is ultimately a machining job as well. A weldment frequently needs precision machining for critical features such as mating surfaces. Indeed, this speaks to the particular level of skill required of the company's machining personnel. A weldment clamped for machining is liable to warp back to its inherent shape upon unclamping, violating tolerances. Engineered Fabrication's machinists therefore know how to use shims effectively to clamp a weldment in its free state so that it can be secured for machining without distortion. Because of the need for this kind of skill, the company has always needed machining capability of its own. Expanding into job-shop machining was a way to (A) make use of this capability when it wasn't needed for weldments and (B) expand the range of services the company could offer to its current customers, many of whom were looking not just for fabrications, but also for a trusted supplier to whom they could outsource some of their piece-machining work.

Still, having the two capabilities in the same company does mean having essentially two different cultures under the same roof, because the two different groups of skilled team members come with somewhat different needs. Perhaps the most basic detail in which the difference has expressed itself relates to the number of hours per day an employee should work.

FOUR TENS?

Mr. Carr spent much of his career in CNC machining before coming to this company. Partly because of this, he is generally a believer in employee work weeks in which each team member works four 10-hour days. And this work-week structure is popular among employees (some of them), because it gives them longer weekends. From Mr. Carr's perspective, the chance to stagger employees' patterns of working four days (so that each employee alternates between a two-day weekend and a four-day weekend) lets him keep the shop staffed through 50 hours per week without this staffing incurring overtime. In pursuit of all of these preferences—his own and some of the employees'—he once tried to move the entire shop to this timing.

And doing so was mistake, he says.

It was a mistake, he came to realize, because it did not suit fabrication employees as well as it suits machining employees. In retrospect, the reason why is not hard to see, given the difference in their work. On a machine tool—particularly a CNC machine tool, but even on the shop's large boring mill—the machine itself does the work. The employee oversees the work, inspects it and is in motion in large part to prepare for the next job. By contrast, in fabrication, much of the work is welding. This is more active and demand-

ing work that can become tiring if the day stretches from eight hours to 10.

"You have to take care of your people," Mr. Carr stresses. There was a lesson to be learned in this experience, and he learned it. The company reverted to a more typical workday and stuck with it for a time. Now, more recently, Mr. Carr has decided to go further in acknowledging that there are real and significant differences between these two different teams. The shop is shifting to a more complex plan in which the machine shop does work four 10s, while the fabrication shop continues to work five 8s.

Lindsey Carr faced and appreciated the differences between the two teams when she worked to install and transition the shop's procedures to ERP. In this effort, however, the production floor in either group was not the biggest area of challenge. Given where Engineered Fabrication was at that time, the challenge with implementing ERP was in the office, not in the shop, because of the need to transition from an office process that wasn't then computerized. On the floor, the employees generally recognized the benefits that would come from better management of the shop's data and better tracking of the shop's work. They acclimated to the new steps that ERP required. Yet one difference she did note between fabrication and machining is that the machining team seemed to become more quickly established at policing itself about clocking in accurately for different jobs. That is, members of this group were quick to step forward to admit when they had forgotten to clock into a job, meaning the record would need to be manually corrected. That self-policing helped them, because data for one job would be used to establish the reference by which another job was planned. Too few hours clocked for a given run of parts could result in far too little time allotted for another job like it.

A bigger difference came when Ms. Carr engaged on the ISO 9001 efforts. The documentation requirements of this certification had the effect of pushing even more accountability, and even more policing, to the shop floor. ISO created the need for a sign-off on the shop floor at the point of the job being completed. In fabrication, this raised an obvious and significant question:

Almost any fabrication job is also a machining job. Large weldments are machined on the shop's boring mill. Weldment machining is a skill of staff members of this shop. Weldments such as the two seen below need to be clamped carefully to prevent distortion during machining.

Who would do the signing?

The act of placing a signature includes a certain commitment, she notes. Inherent to the signing is a judgment about the completeness and quality of the work, potentially including a judgment about others' contributions to that work.

"Just a signature changes things," she says.

EVERYONE ACCOUNTABLE

Here as well, it was the differences in the natures of the work that produced the difference in the response to this requirement. A machinist making one piece after another is essentially working alone, and this person is already, in a sense, signing off. Frequently, every piece in a machining run is gaged, and in each case, all of the measured dimensions either do or do not conform to specification.

Custom fabrication is different from this. Rather than a single moment of gaging, the structure being produced might undergo many modifications and controls throughout its construction, aimed at making it effective for the ultimate purpose it will serve. And rather than one person working on many pieces, frequently it is many people working on the same big part. Given all of this, is it fair to have one person sign off, declaring his accountability for the efforts of the others and declaring himself as the one to approve what they have done? Particularly when the quality requirements often are not as precisely defined as they are for a machined workpiece?

To the Carrs, the reasonable answer seemed to be: No, quite likely this isn't fair. The result is another instance of different procedures for different parts of the shop. In fabrication, it is an allowance and a requirement of the ISO procedures the shop authored for itself that all the employees involved in a fabrication project sign off on the job. Essentially, they decide together that the work is complete.

A pending change to the shop's ISO procedures will also affect the fabrication area, Mr. Carr says, giving these team members even more autonomy.

Engineered Fabrication Inc., call 706-769-6757 or visit engfab.com.

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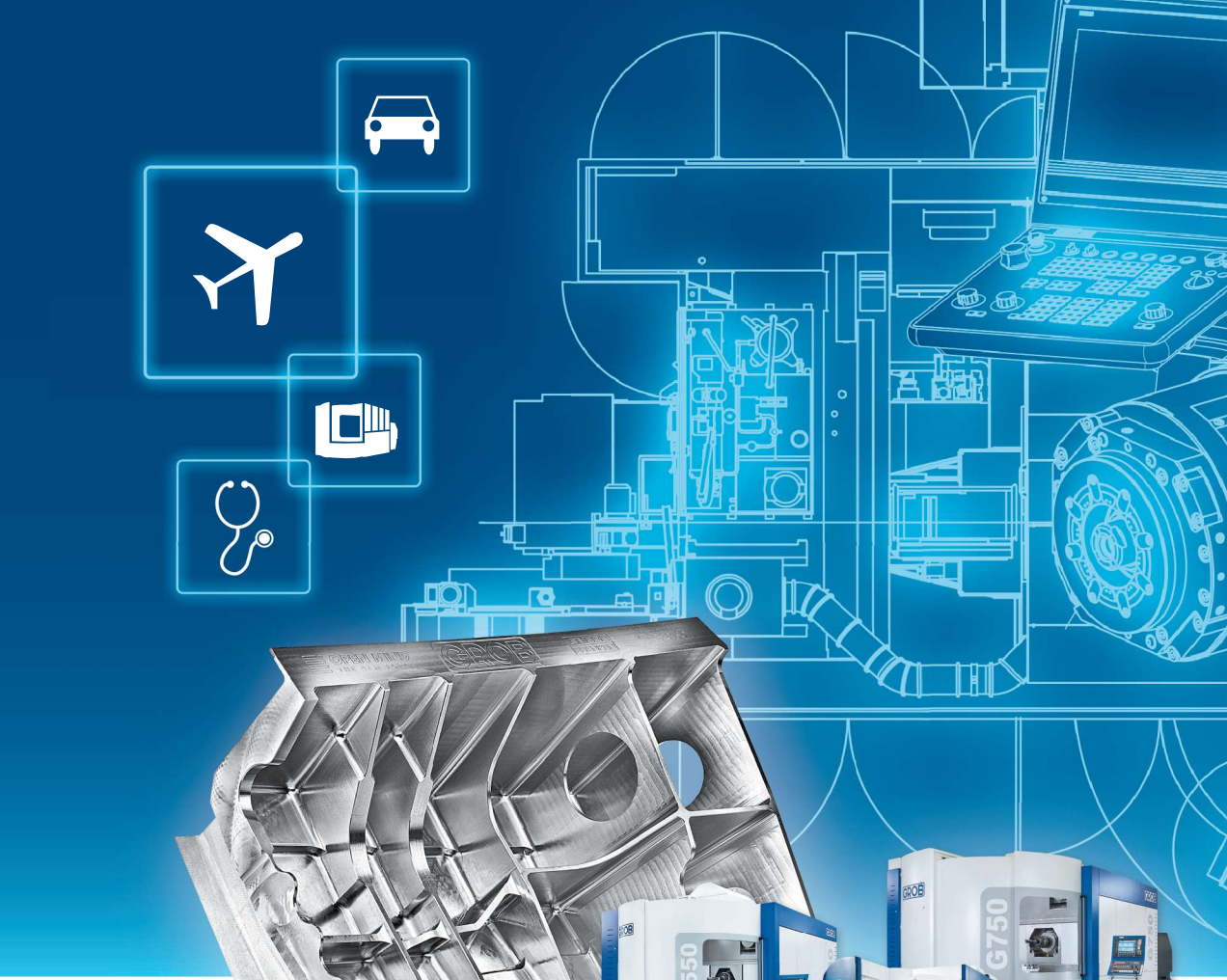
One inefficiency he believes he has observed in the shop's procedures as they now stand relates to changing the sequence of operations performed on a given fabrication job. Such a change is commonplace; certain welds and certain subcomponent machining could be done in any order, so the fabrication team looks for opportunities to seize on open stations to advance the job through the shop more quickly. Right now, however, this involves rewriting the router, a time-consuming step. In a future version of the ISO procedures, fabrication employees might be more free to change sequencing without this rewriting, a freedom the machining employees generally do not need.

ISO provides a framework to build on in this way, says Mr. Carr. Defining the process is the first step to seeing where to improve the process, and where added flexibility might lead to nimbleness rather than uncertainty, efficiency rather than waste.

And procedural differences such as the one being contemplated, far from separating the different teams from one another, actually help to tie the organization together. Different people in this company might have different skills and roles, but one detailed set of ISO procedures defines how they all fit in and how they all work together. Thanks to these procedures, ideally there is nothing to adjudicate between the two groups, and no room for personality differences or differences in the culture to tip the process one way or another. There are no judgement calls that need to be made, because the ISO effort has forced everyone to think through the important questions in advance.

"The end goal of all of this, and the real benefit of ISO certification, is a process that runs smoothly on its own because everyone agrees how it should run," Mr. Carr says. That is, the benefit is a process that doesn't absolutely require him—or Ms. Carr, or anyone else who might be in an oversight role. The team members on the shop floor, in both areas of the shop, already have the skill, talent and desire to do the work well. ISO just provides the structure. "If we do this right," he says, "then the process should perform the same way, every day, whether anyone is here to lead it or not."



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Making Mountains out of Mold Steel

When graphite molds wouldn't cut it for a manufacturer of hand-blown drinking glasses, this shop machined more durable stainless steel molds to create the famous mountainous shapes that emerge from the bottom of its customer's nifty drinkware.

BY DEREK KORN

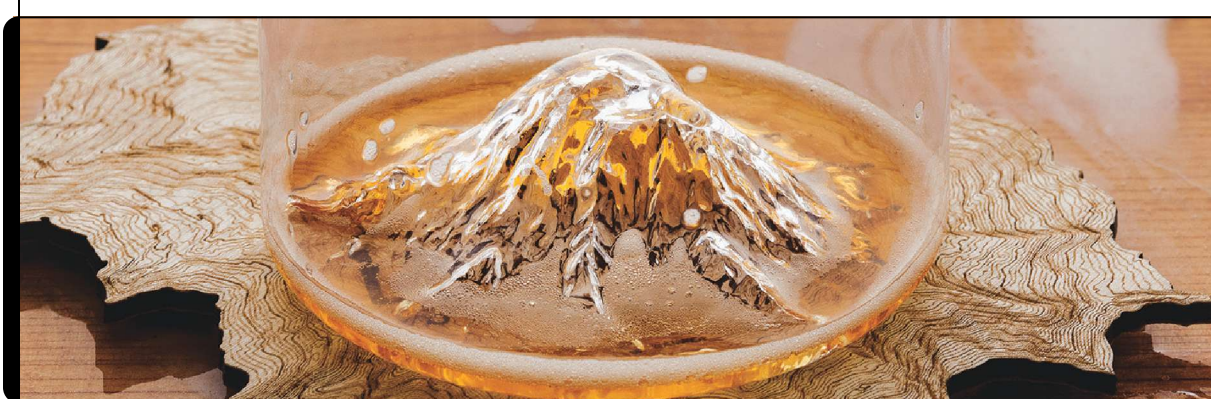
Bottoms up.

That is to say, the uniqueness of the glass pints and tumblers hand-blown by artisans for North Drinkware grows upwards from the base of those glasses as accurate representations of iconic U.S. mountains. The photos on these two pages show what I mean.

A couple of years ago, Nic Ramirez, along with husband and wife team Matt and Leigh Capozzi, started a highly successful Kickstarter campaign near Portland, Oregon, to fund a side project they named North Drinkware. In short, their idea was to partner with nearby Elements Glass to manufacture hand-blown beverage glasses that had the shape of Mount Hood, Oregon's highest peak at 11,250 feet, molded into their bases. The team felt this would offer local craft beer drinkers a unique connection to their scenic area in the Pacific Northwest.

To start, North Drinkware used United States Geological Survey (USGS) 3D data of Mount Hood to develop a CAD model of the mountain. It then 3D-printed that model to create and refine plaster prototype molds, ultimately hiring Portland's C and L Custom Tooling to machine the first production mold from graphite. After that, North Drinkware started its "Oregon Pint" Kickstarter

A good deal of intricate machining work capped by finishing with a 0.030-inch ball end mill goes into manufacturing the stainless-steel molds for this hand-blown North Drinkware glass that features an accurate representation of northern Oregon's Mount Hood. (Photos courtesy North Drinkware.)



Mold roughing starts with a 0.5-inch flat-bottom end mill. Eventually, these are finish-machined with a 0.030-inch ball end mill. The shop machines flats on two sides of bottom of the cylindrical molds for the vise to grip.

campaign to support the fledgling company's growth efforts and vision for creating glasses featuring other famous U.S. mountains. In fact, this campaign with a $15,000 goal closed at $531,581 with funding provided by 5,620 backers, signifying significant interest in the idea.

However, the first glass-production molds led to production problems. The first problem was finding a shop to machine the molds. North Drinkware approached C and L first, knowing that the shop, which specializes in injection mold tooling design and machining, was successfully branching out into mold machining for local custom glass manufacturers. Unfortunately, Glen Sparkman, C and L's co-owner with wife Donna, says their three-person shop was simply too busy at that time to take on the job. North Drinkware tried another shop, but that one wasn't able to generate the crisp mountain details the company was looking for, so it waited until C and L's schedule opened up a bit.

Eventually, C and L produced the type of detailed graphite molds that North Drinkware needed to begin production. Over time, however, those molds, which are heated to 600°F during the molding process, began to break down. Essentially, the molten glass would stick to the molds and pull away bits of graphite when the blown glass was removed from them.

Therefore, the decision was made to switch to stainless steel, an alloy commonly used for production-glass molding applications. This material ultimately held up longer, only requiring periodic repolishing. That said, compared with graphite, it was much trickier to machine the intricate mountain details. "Graphite wasn't too difficult when using a 0.030-inch-diameter ball end mill for finishing, but it became a different story when moving to stainless steel," Mr. Sparkman says.

Although one might think the process for machining these types of features with such small tools might involve machines with very high spindle speeds, C and L uses a VMC with a maximum spindle speed of 8,000 rpm. As Mr. Sparkman described during my recent visit, the process he developed for these finely detailed molds is not appropriate for the typical high-volume job in which minimizing cycle times is key, but it is necessary for one-off/low-volume jobs such as machining these stainless-steel molds. In fact, he's since applied this process to create three other mountain mold designs for North Drinkware, with another design currently in the works.

ALL ABOUT THE DETAILS

The molds are created from two pieces: a cylinder that C and L turns on its Femco lathe to create the outer shape of the blown glass, with a taper where it meets the separate base component that includes the mountain shape. Although Mr. Sparkman is provided with a CAD model of the mountain, he typically uses repair tools in Solidworks to patch areas where model data is missing and to create the mold design. From that, he uses Surfcam to create tool paths that are designed not to bury small-diameter tools in corners to prevent tool breakage.

The base mold components are machined on the shop's Chevalier 2040 VMC. Mr. Sparkman

says he purchased this boxway machine with 8,000-rpm spindle for its flexibility to accommodate anything from graphite to tool steel. He admits that, while a more specialized, high-rpm machine might be more appropriate for producing the fine details the mountain molds have, he believes it makes more sense for his shop to have a versatile machine that can run a variety of jobs rather than a more costly high-speed machine that might sit idle waiting for the right work. Plus, even though the process for machining the mountain molds can be rather long, he can run longer programs unattended overnight.

A base mold component starts from a length of round bar with flats milled at the bottom so it can be secured on the VMC with a conventional vise. Mr. Sparkman says he uses Niagara Cutter tools for these jobs, some featuring titanium aluminum nitride (TiAlN) coatings and others using titanium carbo-nitride (TiCN), because they perform well, have minimal runout and are reasonably priced.

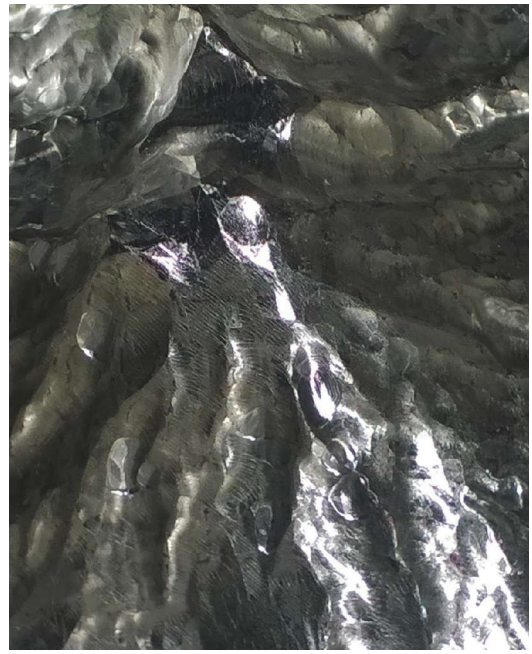
Dennis Noland, senior design and R&D engineer at Niagara Cutter, says the thinness of the coatings (in the range of 3 to 5 microns) is especially important for micro-tools like the ones C and L uses. (He defines micro-tools as tools having a diameter smaller than 0.100-inch.) That's because there's not as much rounding on the cutting edges, and the tool surface finish is smoother because there are fewer droplets left behind from the coating process.

In addition, Mr. Noland notes that stepovers for such small-diameter tools should be no more than 8 to 10 percent of the tool diameter, especially when a very smooth workpiece surface finish is required.

What follows is the series of milling operations Mr. Sparkman commonly uses for these stainless production molds. He starts with two-axis, roughing contour and cuts around the mountain shape, and this is followed by a three-axis Z-roughing operation. Next is a Surfcam three-axis Auto Rough tool path followed by a three-axis Planar tool path, which cuts multiple surfaces at one time in a straight-line path, generating a 0.001-inch-tall scallop height. Machining is completed using successively smaller ball end mills (the last being a 0.030-inch-diameter tool) and the 3-Axis Steep/Shallow tool path, which provides constant 3D offset based upon surface angle and overlap specifications to produce an equal scallop height of 0.0002 inch.

In addition to proper tooling and toolpath selection, Mr. Sparkman says coolant type plays a key role, too. The shop uses Ometa's Hycut two-component water-soluble metalworking fluid, which is based on synthetic ester oils that are said

C and L primarily uses tools from Niagara Cutter. The shop ground the shank of this $^{1}/_{16}$-inch ball end mill to enable it to machine a 0.5-degree draft on the side of California Half Dome mountain mold.



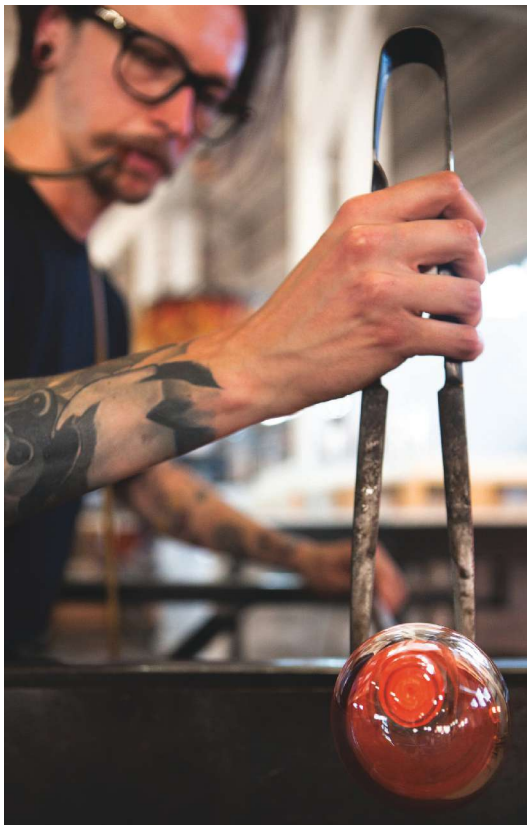
This offers a sense of the crisp details C and L machines into these stainless molds. This base mold component bolts to a hollow cylindrical component to form the complete mold.

to offer high lubricating performance and reduced tool wear. (This product has also been certified by the USDA under its BioPrefered program.) The company's Hycut CF 21 cutting oil is combined with Additive BF and added to the machine's sump. This offers the ability to mix the two components in any number of different ratios to dial in the correct amount of lubricity depending on the application. (The mixture used for the stainless steel molds is highly lubricious to more effectively machine the "gummy" stainless steel material.) The two-component concept also yields a longer shelf life for the oil and additive compared to pre-mixed coolant, because the components are stored separately and blended together only as needed.

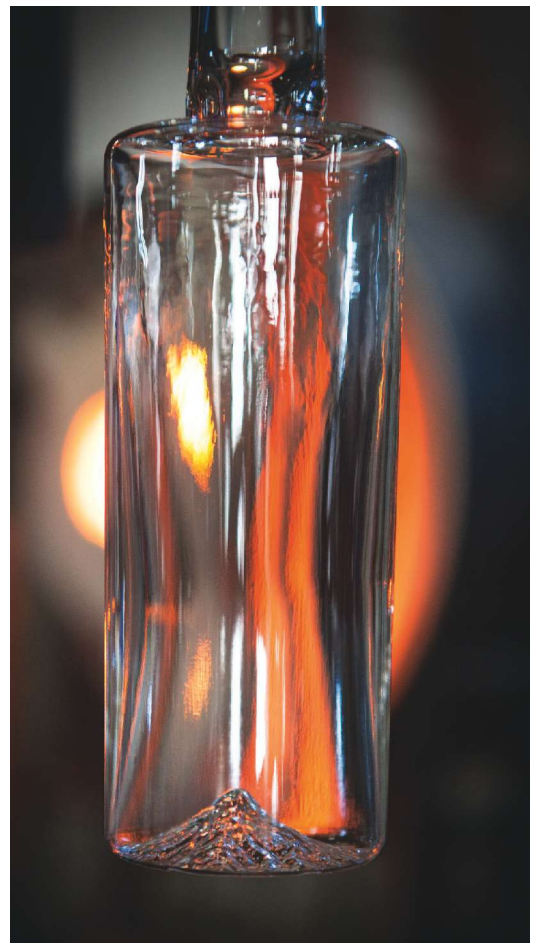
MORE MOUNTAINS ON THE HORIZON

After machining, Mr. Sparkman hand-polishes the mold's mountain features. To date, C and L has created molds for four different North Drinkware mountain designs (Mount Hood, Washington's Mount Rainier, Vermont's Camel's Hump and Half Dome in Yosemite National Park). For very popular glass products that are produced in greater volumes, it has machined duplicate molds. Plus, the molds do become slightly corroded due to the high operational temperature range, so they require C and L to repolish them every few months.

The deft, manual work that goes into hand-blowing these North Drinkware glasses, and the detailed molds that are machined to produce them, are impressive. Mr. Sparkman says his shop is currently working on a mold for a new product for the glass manufacturer, but we'll have to wait to find out what mountain that might depict. However, because C and L has already established an effective process for machining the molds, North Drinkware will be able to get to market faster. Ultimately, this is the goal of every machine shop.



It takes artisans two days and more than 15 steps to create one hand-blown North Drinkware glass. The company currently offers four mountain designs (three featuring West Coast mountains and one featuring an East Coast mountain), but it is currently working on a fifth design. (Photos courtesy North Drinkware.)



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James Faulkerson's passion, Top Fuel Hydroplane ("Hydro" for short) drag boat racing, provided him with a purpose to invent something new. In 1996, he built a drag boat with a modified outrigger design that provided increased stability and went hand in hand with his new twin-propeller drive system. While the boat had its problems, Mr. Faulkerson knew he was on to something.

In August 2016, his company, Advanced Design Technologies LLC of Las Vegas, Nevada, assisted

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EDITOR **EMILY PROBST, eprobst@mmsonline.com**

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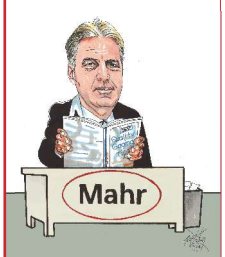

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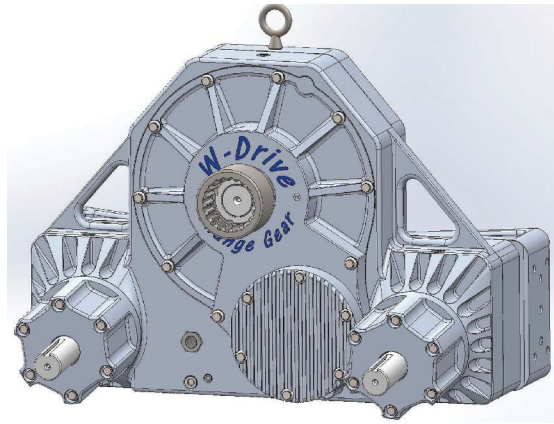
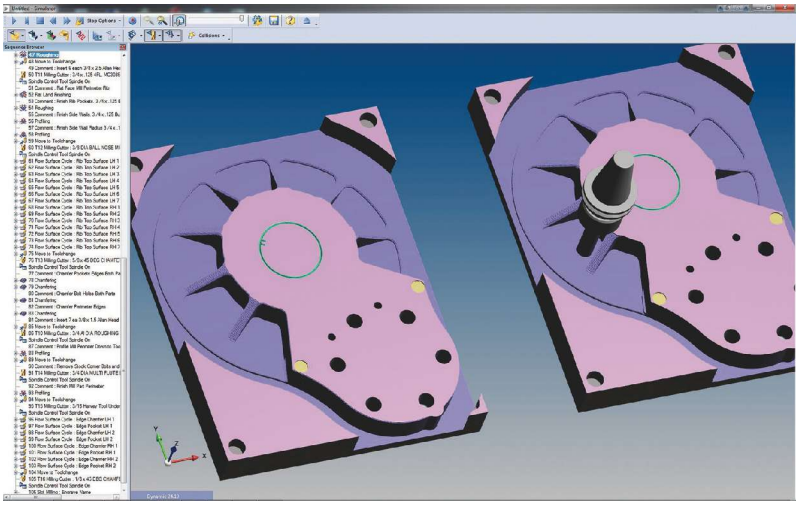


The 2017 version of the W-Drive is rendered above. This power-splitting marine transmission includes a single-engine input shaft with two counter-rotating propeller output shafts. The six gears for input and output overdrive and power distribution for the two propeller output shafts were once outsourced, but after a faulty gear disintegrated, on a boat traveling close to 200 mph, Mr. Faulkerson decided to make everything himself.

Tommy Thompson Racing's Nitrochondriac team in setting a new elapsed-time record for Top Fuel drag boat racing. As a consultant and parts supplier for the team, Mr. Faulkerson provided a set of experimental W-Drive gears, which he engineered and manufactured with the help of Surfcam by Vero Software (Thousand Oaks, California), along with other custom parts.

The W-Drive is a power-splitting marine transmission that includes a single-engine input shaft with two counter-rotating propeller output shafts. It includes six gears for input and output overdrive and power distribution for the two propeller output shafts. "For each revolution of the input shaft, there is a set of change gears that can be selected to obtain the desired number of revolutions of the output shafts," Mr. Faulkerson explains. "A key feature is the counter-rotating propeller output shafts that act to cancel out the propeller torque, creating a balanced propulsion drive system. The W-Drive is a completely new approach to drag-boat propulsion."

Initially, Mr. Faulkerson manufactured all drive components, except for the gears, using manual mills, lathes and other manufacturing equipment.



Both of these parts can be roughed in only one cycle using comprehensive roughing. Simply stated, the Surfcam roughing-milling cycle can rough blank material to stock to within a specified tolerance of the finished part.

He subcontracted the gear manufacturing until the late 1990s, when a faulty gear disintegrated and blew a large hole in the bottom of a boat traveling at close to 200 mph, he says. "I decided that I was no longer going to use subcontractors, because I always seem to experience problems. At that point, I decided to make everything myself."

He began his new venture by acquiring a Haas VF-3 mill and SL-20 lathe. In 2002, he purchased the Surfcam Traditional CAM system to program

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his CNC machinery, later transitioning to Surfcam 2015 and redesigning most of his drive components and parts. He now runs Surfcam 2017 R1, which offers 14 milling cycles with specific applications that range from hole- to pencil-milling, as well as four toolpath-projecting milling cycles. The milling cycles used most often at ADT are the face-mill, hole, roughing, profiling, flat-land-finishing and chamfering cycles. There also are a few unique milling cycles, such as the flow-surface and parallel-lace cycles, that simplify the complex milling of non-uniform 3D shapes and surfaces.

As he manages a job from design to production, Mr. Faulkerson uses the Solidworks CAD system by Dassault Systèmes to create custom parts. He then imports the design into Surfcam, which reads the native Solidworks part file without the need for translation. This seamless interoperability between CAM and CAD systems ensures that design data will completely retain its integrity after importation, Mr. Faulkerson says. He also appreciates the flexibility of the Surfcam tool path, which is designed to ensure that parts are ideally programmed and collision-free via the Surfcam simulator.

A highlight of the CAM system is its roughing-milling cycle, which enables programmers to select and define entry points for each region to be machined. Programmers can also start the roughing cycle from pre-drilled holes and set a preference for ramp or helical approaches. The cycle has been optimized for high-speed machining, including tangential links between passes and optimized retract moves.

Other cycle features include associative depth parameters, which ensure that

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programming is uniform; intermediate slices, which reduce the size of the steps left by the roughing cycle; and flat-land detection, which machines to the specified Z offset from the top of islands and the base of pockets. In addition, the roughing-milling cycle offers a "check-fixtures" option for collision checking against fixtures, a corner-type option to clean up the last pass' stepover at each machined Z level to control the behavior of the cycle on sharp corners, and more.

"The Surfcam tool path has the ability to conform to unusual 3D shapes, and Surfcam can cut those shapes efficiently," Mr. Faulkerson says. "A few of the tool paths are astonishing in machining the rear case on the W-Drive."

He credits three cycles—comprehensive roughing, parallel-lace and flow-surface cycles—with helping him increase overall efficiency and toolpath quality.

"Simply stated, comprehensive roughing is an application of the Surfcam roughing-milling cycle that, in one cycle, can rough blank material stock to within a specified tolerance of the finished part," Mr. Faulkerson says. "Defining the tool path again is a simple matter of specifying speeds and feeds; providing an overall tolerance; specifying intermediate slices information (overall lowest depth); and a few other details, and that is it. I was simply amazed at the ease of initially roughing a complex part with a single Surfcam roughing cycle. All I had to do was select an appropriate milling cutter; set feeds, speeds and depth of cut; and select the 3D model; and it rough-machined the entire part."

The Surfcam parallel-lace milling cycle performs milling operations on several surfaces at the same time. Parallel lace includes built-in gouge protection, which makes it well-suited for machining multiple surfaces. Programmers can use this cycle for roughing, semi-roughing and finishing surfaces. The cycle also includes a "check-surfaces" option, which enables users

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to specify surfaces that they do not want machined (gouge protection), and allows for the restriction of a generated tool path. Also, users have the option to exclude flat areas to optimize tool-path generation.

"Parallel lace is very powerful in its ability to machine complex 3D-model faces with adjoining edges of planer or radial chamfers," Mr. Faulkerson says. "The tool path will 'crawl' along the 3D-model face in a tangential lacing pattern in addition to simultaneously cutting adjoining edges that contain radial or planer chamfers all in one programmed cycle action. This cycle is used in the cutting of an angular 3D-lofted-model face of the rear case of the W-Drive transmission."

With one programmed parallel-lace milling cycle, the pocket's top wall faces and associated edge radii are cut, saving considerable time and simplifying the programming of this milling operation. Mr. Faulkerson says he used Surfcam's flow surface milling cycle extensively to manufacture the W-Drive alloy encasement parts. The cycle follows the flow of a surface, which is ideal for machining fillets and 3D surfaces. It offers improved surface finish, helical support to reduce link moves, and multiple face and surface support. The tool path is controlled by two types of surfaces that can be selected: "drive" surfaces that produce the basic tool path, and "check" surfaces that are not to be machined or are gouge-protected.

"The beauty of the flow surface is that you can have any shape of a surface between two line curves or surfaces that are bounded by other adjoining surfaces and it will simply machine them," Mr. Faulkerson says. "You have the ability to control the tool path like never before."

Vero Software, call 866-334-3226 or visit surfcam.com.

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Tool Management System Eliminates Information Silos

The Wagstaff family built a successful business designing and manufacturing systems and equipment needed to produce primary aluminum ingot and billet using direct-chill-casting methods from their 133,000-square-foot facility in Spokane, Washington. Like many companies that originate in a garage, or in this case a pump house, Wagstaff Inc. has faced various challenges as it has grown, particularly, those of "lost information." Integrating a tool management system from TDM Systems (Schaumburg, Illinois) has helped capture the company's tribal knowledge, saving both time and money.

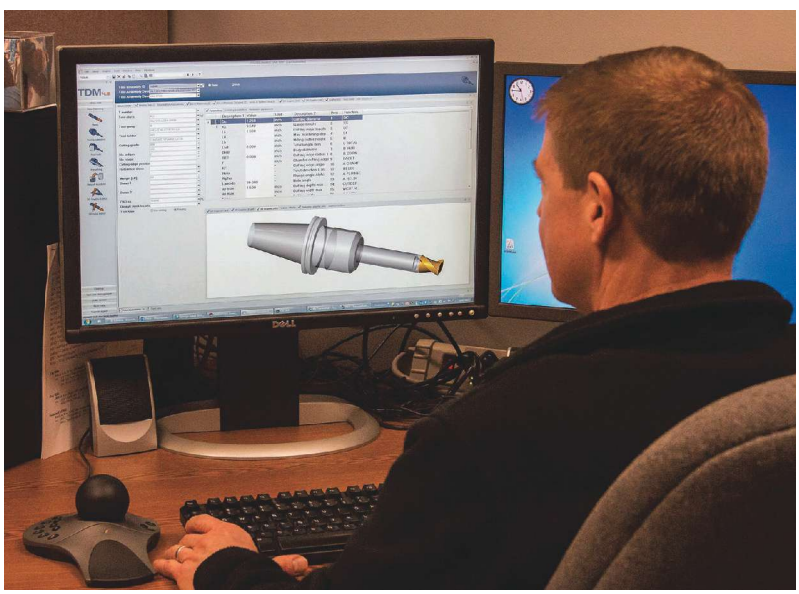
Around 2004, Wagstaff began to look critically at the cost of lost information, says Jeff Smutny, manufacturing engineering manager. Product line information was stored in process documents, the CAM system and Excel spreadsheets. Tracking and leveraging the information on new jobs was difficult and not very efficient, he says. And the information wasn't necessarily being shared amongst different users, says Russ Rasmussen, manufacturing engineering technician. For instance, product information wasn't always adequately communicated between NC programming and the shop floor, he says, and without a central database, native information would commonly change, be cloned or mutate. There was no way to know if current, correct information was being used, which made it a challenge for workers to perform vital operations like simulating part programs.

WAGSTAFF INC.

PROBLEM Tooling information wasn't digitally traceable or searchable

SOLUTION Tool Lifecycle Management from TDM Systems

RESULTS Reduced lost time and money



Russ Rasmussen, manufacturing engineering technician, uses the Tool Lifecycle Management program from TDM Systems.

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This pintle bearing for a navigation lock on the Columbia River is being machined on one of Wagstaff's five-axis CNC mills for a U.S. Army Corps of Engineers facility. Wagstaff's Spokane facility measures 133,000 square feet and houses R&D, fabrication, machining, assembly, testing and shipping operations, along with 30 CNC machines.

That situation began to change in 2005 when Mr. Smutny, as a guest of Walter and Wagstaff's local Walter distributor, visited the cutting tool company's headquarters in Germany. He saw that Walter was using TDM System's Tool Lifecycle Management system in its own shop, and he was impressed by its scope and capabilities.

"TDM's Tool Lifecycle Management system ensures that tool data is available where and when it is needed," explains Dan Speidel, TDM's director of sales. It links CAM, presetting and crib systems, and CNCs, but it can also extend upstream to systems at the planning and execution level, such

as in production planning, enterprise resource planning and manufacturing execution systems. To extend so widely, a tool management system must be open and able to supply numerous import and export interfaces, he says. It must also integrate data from various sources, such as manufacturer catalogs or 3D models created in house, into a centralized database.

The Tool Lifecycle Management system collects production data and transfers it to other systems. It impacts the entire process, from tool selection to production planning to seamless transfer and use on the shop floor, Mr. Speidel says. Information from the individual process steps continuously flows back to a centralized database, creating a growing mass of data that is accessible throughout the networked system.

"Wagstaff had the typical standalone silos of information that we see in so many companies," Mr. Speidel says. "The old process was to get a job and turn it over to manufacturing engineering to design and plan the process, then turn it over to NC programming. Once the NC program was defined, they would walk the program to the tool crib and look for the tooling. They would look in their stash, and the machine operator would often need to look through his stash." Of course, everyone has their own preference for tooling, he adds. This was neither consistent nor efficient.

Since the shop had numerous tooling racks in a variety of locations and there was no way to digitally search for the tools, the central tool crib primarily sharpened tools and tried to maintain

Wagstaff no longer stores product line information, like that of this large steel hydraulic cylinder weldment, throughout the facility. Instead, the company uses a central, searchable database.

stock levels, Mr. Rasmussen says.

Determined to become more organized, the company decided to capitalize on its wealth of tribal knowledge. The first step was to define approximately 4,000 tool assemblies and many more components within the Tool Lifecycle Management system. Instead of relying on a CAM system's generic tool models, this system uses actual graphics to take the guesswork and uncertainty out of tool creation, leading to efficient and repeatable accuracy, Mr. Speidel says. The system also provides basic tool information and potential applications to help Wagstaff quickly decide which tools are best-suited for each process step and which combinations are most efficient.

The tool management system stores geometry and cutting data for each tool assembly, and makes 3D tool graphics available for NC and simulation analyses. It also saves tool lists from the NC programs for future use. In addition, its recording of cutting data, machining conditions and best practices helps optimize tool use in future applications.

TDM Systems Inc., call 847-605-1269 or visit tdmsystems.com.

"Features like these are what make TDM such a benefit on repeat jobs, but it comes into play on new jobs as well," Mr. Smutny says. "For instance, it might be a different product or application, but maybe the material is the same, so the programmers already know about the behavior of the cutting tools and tool assemblies with this material. Overall, we've saved a lot of time and realized increases in accuracy."

The Tool Lifecycle Management system is designed to bring benefits to tool presetting as well, and Wagstaff eventually purchased a presetter to complement its system. TDM says it works with presetter manufacturers to facilitate two-way communication. During the measuring procedure, these systems can access the nominal data for each tool assembly stored in the TDM system and transfer the measured data back to TDM to continually fine-tune the system. This data transfer is carried out via direct numerical control (DNC) or tool chips. The tools and NC programs simultaneously get to the correct machine, together with the current preset tool data and with graphics, photos and/or captions.

Access to accurate data can reduce programming and job setup time by 25 percent. For instance, instead of needing as many as seven people in the tool crib, Wagstaff now runs the area with just three, Mr. Rasmussen says. Although the company has grown since it implemented TDM, the programming crew is staffed at roughly the same level as in 2004, Mr. Smutny adds. They now spend more time preparing revenue-producing jobs and less time searching for information.

"Now we know what we need to stock in terms of cutting tools, extensions, holders, collets, you name it. That's definitely streamlined the purchasing function, in addition to reduction of inventory," Mr. Rasmussen says. Full knowledge of Wagstaff's tools and their capabilities has enabled the company to reduce its purchases in some areas.

Although buy-in to the new system wasn't automatic, it is well-accepted by Wagstaff's staff today, Mr. Rasmussen says. "People don't like to adopt new things, so there's always some degree of hesitancy. However, one of our programmers recently mentioned to me that he didn't know how he did his job without TDM. It's become a vital part of our successful operation."

CAD/CAM Helps Shop Achieve Tight Tolerances for Medical Components

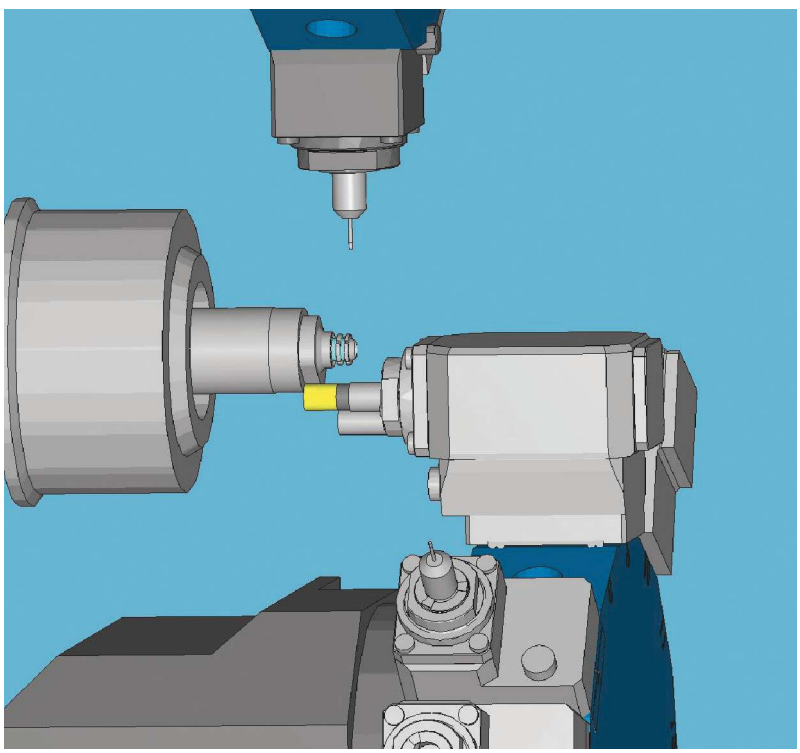
VALLEY MACHINE

PROBLEM Manual programming of turn-mills was time consuming, required multiple edits

SOLUTION Esprit CAD/CAM software from DP Technology

RESULTS Available postprocessors eliminated code editing, sped production of complex medical parts

Valley Machine specializes in suppling precision-machined components as well assemblies for customers in the medical, semiconductor, photonics, optics and aerospace industries. To best support this variety of industries, the North Plains, Oregon, machine shop uses a range of equipment, including vertical machining centers; horizontal machining centers; conventional turning centers; two Miyano BNJ42S twin-turret, twin-spindle turn-mills; and an Index C200 three-turret, twin-spindle lathe.



One of the key features of Esprit software that enables posting edit-free code is its simulation capabilities. Here, the software is simulating machining of a medical interconnect.

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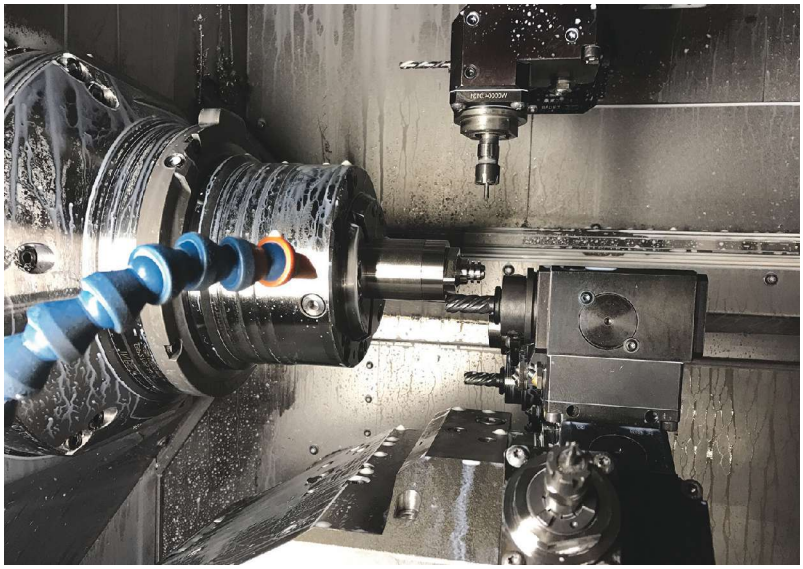


By using Esprit to re-sequence cutting operations, Valley Machine was able to move the machining of this medical interconnect to an Index C200 lathe, improving production time by 30 percent.

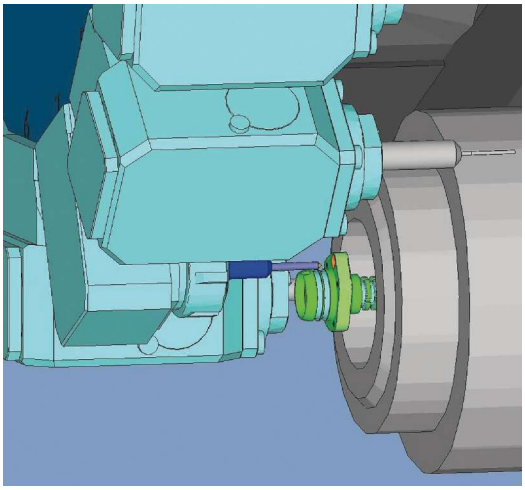
Previously, the manually written numerical control (NC) code for turning centers often required significant editing before it would enable those machines to produce good parts, eating away at the programmer's available time while leaving the machine idle.

To remedy this, Valley Machine decided to implement CAD/CAM software for its standard turning centers and more complex turn-mill machines. After evaluating numerous packages, the shop chose Esprit CAD/CAM software from DP Technology Corp. (Camarillo, California), in part because of its standard postprocessors, which could generate code that required no editing for the shop's machines, therefore eliminating the time and cost involved in proving out the code.

The primary feature for generating edit-free code is the software's multi-channel synching ability, which is said to effectively enable coordinated motion of multiple turrets and spindles on the turn-mills. Another important capability is simulation, which enables programmers to view the complete machining operation offline—including simulated parts, tools and machining—prior to post processing.

After purchasing the new software and attending a week-long training program, Valley Machine immediately began modifying jobs that it had previously run, and it began programming new orders on its two Miyano BNJ42S machines. For these machines, Esprit helped reduce the cycle times required to produce complex parts by moving operations from one spindle to another so that both spindles were continuously working.

Once the shop was confident Esprit could handle its complex programming needs, it began to optimize the machining capabilities of its new Index C200 to effectively machine an important component for one of its medical customers. This project involved producing 2,000 medical interconnects made from 303 stainless steel. Previously, the shop faced many challenges in trying to manufacture these medical interconnects. For instance, in addition to problematic handwritten programs, the machine on which these parts were originally manufactured could not hold the required tolerances. Instead, the



Esprit helped reduce the cycle times required to produce complex parts by moving some operations from the main spindle to the subspindle so machining can be performed on both spindles simultaneously.

company had to machine the parts on a twin-spindle lathe and then move them to a VMC to machine the face holes and other profiles, which cost valuable production time and money. The company reduced the time required to produce these parts by 30 percent by moving them to the Index C200 machine and using Esprit to quickly resequence cutting operations.

Now, the company can hold tolerances within a few ten-thousandths of an inch by resequencing operations to avoid the potential for deflection that could cause machining errors. In addition, the shop can use the software to produce solid, edit-free lathe programs that help reduce both setup and cycle times, while also improving part quality.

Today, Valley Machine enjoys quicker machine setup times in Esprit with postprocessors that consistently generate accurate NC code, saving valuable machining time and increasing productivity. The shop says it can now efficiently machine any part on its complex turn-mills with the software. Jeremiah Archer, lead programmer at Valley Machine, notes that it is also easy to make changes and try new machining strategies when a part is programmed in Esprit, because the software's realistic, full-machine simulation enables visualization of each operation. Valley Machine continues to expand its technology and capabilities, and it is gaining additional opportunities to machine more complex parts in new markets with the help of Esprit.

"The support we received prior to even purchasing the product was superior, and immediately providing the help I need is something at which the Esprit support team excels," Mr. Archer says. "There was never a hesitation when I asked to borrow a machine setup or post for evaluation."

Esprit by DP Technology Corp.,
call 800-627-8479 or visit espritcam.com.

END MILLS CUT AND POLISH 2D CONTOURS SIMULTANEOUSLY

Emuge has introduced its Cut & Form solid carbide finishing end mills, designed to perform both cutting and polishing in one operation. The tools' dual functionality is attributed to a design that incorporates three cutting edges to remove material and three burnishing edges to compact the material, producing polished mirror surfaces as fine as 0.08 micron Ra. The tool series is designed to speed throughput and cut back on manufacturing time, secondary operations and cost.

These high-performance tools are ideal for trimming 2D contours in nonferrous materials, such as aluminum and copper, and for the medical, jewelry, food and electronics industries, the company says.

Emuge Cut & Form end mills are available in stub- and standard-length designs, with cutting diameters of 6, 8, 10 and 12 mm.

Emuge Corp., call 800-323-3013 or visit emuge.com.

MILLING TOOLS PERFORM VARIOUS OPERATIONS WITH SINGLE INSERT

Pokolm's Squareworx multifunctional milling system is designed for precise machining with both 90- and 45-degree approach angles. One insert is sufficient to perform square-shouldering, slotting, facing and chamfering operations, the company says. Each insert has four useable cutting edges with a corner radius of 0.8 mm. Five different grades can machine all standard materials, ranging from roughing to finishing, the company says.

All available end mills, shell-type cutters, and threaded-shank tools possess the maximum possible number of teeth. Combined with an internal coolant supply, this design enables high feed rates, the company says. Square-shoulder and slotting cutters are available from stock in diameters between 25 and 66 mm. The 16- to 63-mm chamfering milling cutters' special geometry enables both forward and reverse chamfering operations.

Pokolm Frästechnik GmbH & Co. KG, call 49 5247 9361 0 or visit pokolm.de.

EDITOR **JEDD COLE, jcole@mmsonline.com**

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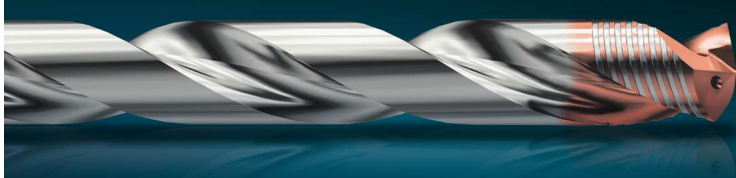

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QUICK-CHANGE DRILLING TOOL LINE GETS NEW DIAMETER RANGE

Tungaloy is adding a set of tools with diameters ranging from 6.0 to 9.9 mm to its DrillMeister line.

According to the company, DrillMeister provides simple and fast drill head indexing thanks to its self-clamping system. Tool replacement is performed by simply replacing the drill head; there is no need to remove the entire drill body from the toolholder and readjust the tool overhang, reducing tool-change time. A drill head can be mounted or removed with low torque, and the process can be done in the machine as needed. Because the clamping structure prevents deformation of the drill body, the number of heads per body is substantially increased.

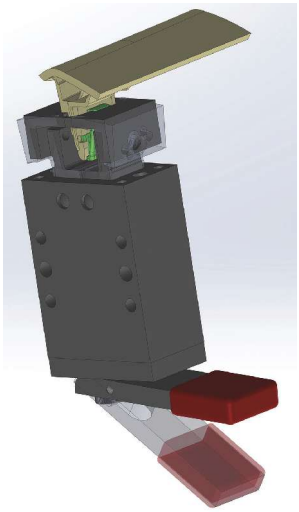
The new diameter ranges will be available with the TID-type drill bodies of 1.5×D, 3×D, 5×D and 8×D, ensuring high drilling performance for small-diameter holemaking in various materials. The flange-type drill body is designed for excellent chip evacuation with a high helical flute angle and polished flute surface. Good chip evacuation can be achieved even in holes as deep as 5×D or deeper, where chip evacuation tends to be difficult, the company says.

Tungaloy America Inc., call 800-542-3222 or visit tungaloyamerica.com.

CLIP-HOLDING, RELEASE DEVICE FOR CHECK FIXTURES

Fractal Engineering has developed the Clip Buddy, a clip-holding and release device for check fixtures. Suitable for use with W-base plastic clips, steel H-clips, and interior or exterior panels, the Clip Buddy can help to overcome the challenge of precisely holding clips in check fixtures and releasing them without damage to the clip, the company says.

The product is significantly smaller than traditional jaw blocks and requires less backside access



for actuation. Several available jaw configurations can be machined as required for particular applications. The jaws close securely and precisely to enable insertion and holding of a clip for accurate and repeatable inspection of an assembly. To release the clip, the operator actuates the lever with a short and smooth motion to open the jaws; the lever is then actuated in reverse to close the jaws to prepare for loading another part.

Fractal Engineering LLC or visit fractal.engineering.

QUICK-CHANGE PALLET SYSTEM WORKS WITH VARIOUS TABLE SIZES

Schunk's Vero-S NSL quick-change workholding and positioning system is designed to speed setups with the ability to mount any workholding on top, from a standard vise to a custom fixture, for reliable and consistent change-over. For a micron-precise connection between machine table and workpiece, the clamping system makes optimal use of even smaller machine tables, the company says. The Vero-S quick-change pallet system delivers fast and precise resetting of workpieces, clamping devices and other equipment on three-, four- or five-axis machining centers.

Workpieces can be directly clamped and machined from five sides without restricting accessibility. This is done by screwing the clamping pins of the quick-change pallet system directly into the workpiece. The components are then quickly exchanged in the machine, positioned,

fixed and clamped all in one step with a repeatable accuracy of less than 0.005 mm. The clamping height of the workpieces can be adjusted with module height extensions, so the machine spindle can reach all five sides of the workpiece without any special tools.

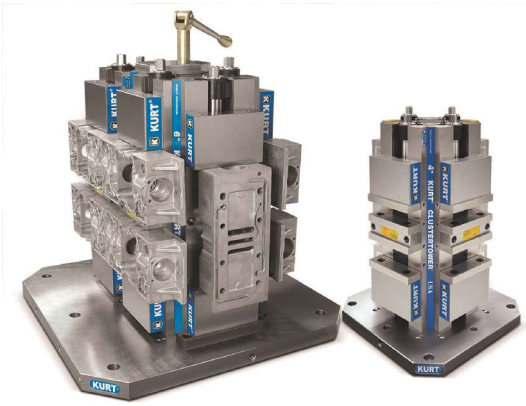
Schunk Inc., call 800-772-4865 or visit us.schunk.com.

For more cutting tool information, visit mmsonline.com/cuttingtools. For workholding information, visit mmsonline.com/workholding.

HYDRAULIC WORKHOLDING TOWERS OFFER AS MANY AS 12 CLAMPING STATIONS

Kurt Workholding offers a complete line of high-density CarvLock workholding towers for precision machining with eight or 12 clamping stations in both manual and hydraulic models. Equipped with easily changeable jaws, these towers provide maximum setup flexibility and fast change-over between jobs, the company says.

The towers are ideal for use on mid-size and larger horizontal machining centers, and options enable configuration to users' exact needs. Each tower station has either a 3" or 4" jaw opening and provides repeatable clamping to 0.0002" with a maximum clamping force of 5,870 to 7,460 lbs, depending on the model.



Self-adjusting holding blocks clamp the similar- or dissimilar-size parts. Fast manual operation is enhanced with the adjustable pre-load feature that reduces handle turns for opening and closing clamping stations. Hydraulic power speeds part clamping by eliminating the need to manually clamp the piece part.

The CarvLock towers are made of ductile iron, maximizing strength, rigidity and long-term accuracy. The elevated column is designed to make clearing chips and coolant from the clamping area fast and easy. Additional features include jaw options for specific applications, such as hard jaws, machinable aluminum and ductile iron jaws, plus aluminum fixture plates. For maximum flexibility, jaws are indexable 180 degrees.

Kurt Manufacturing - Industrial Products, call 877-226-7823 or visit kurtworkholding.com.

LIVE TOOLING FOR POPULAR SERIES OF TURNING CENTERS

Heimatec now offers live tooling for all popular

models in the Hyundai, Miyano and Nakamura turning center lines. Standard and custom styles are available for all tapers, including HSK and BT30, as well as fixed and adjustable models.

Heimatec Inc., call 847-749-0633 or visit heimatecinc.com.

MODULAR CONNECTION SYSTEM FOR DRILLING, BORING, TAPPING

Allied Machine & Engineering offers Wohlhaupter's MVS modular connection system. Part of the Multibore collection, the MVS connection is a flexible system designed primarily for drilling and boring, with application possibilities in tapping, end milling and light shell milling.

The MVS connection is a modular connection that enables the use of extended lengths or reduced diameters by using a series of components engineered for flexible adaptation. Four sizes are available to accommodate the diameter range of the boring required: MVS 50-28, 63-36, 80-36 and 100-56. Operators can easily build and change tooling components, and this flexibility enables the system to work accurately for almost any project's needs, the company says.

The MVS connection offers a mating and clamping draw force of approximately 1,900 psi provided by a three-point triangular system. The pressure points are an equal 120 degrees apart, providing high rigidity, high performance capability and a total system accuracy of 3 microns. The system holds tolerances of 0.002 micron ID to OD and a consistent 0.002 micron of parallelism between mating surfaces.

Allied Machine & Engineering Corp., call 800-321-5537 or visit alliedmachine.com.

TANGENTIAL MILLING CUTTER ENABLES INCREASED DEPTHS OF CUT

Sumitomo Electric Carbide's TSX series tangential milling cutter is designed for stable, efficient shoulder milling at high feed rates. Engineered with a tough and sharp cutting edge, the TSX provides the strength required for increasing cutting depths in applications ranging from small jobs to heavy-duty roughing.

A four-corner, ground-tolerance, tangentially mounted insert with optimized chipbreaker is said to achieve excellent edge sharpness and sidewall accuracy. The TSX is available in two precision-ground insert sizes, offering a maximum depth of cut of 8 or 12 mm (0.315" or 0.473").

Other features of the competitively priced TSX include reduced cutting force, surface roughness of less than 0.5 micron Ra, squareness of less than 0.05 mm and long-term wear resistance.

Sumitomo, call 800-950-5202 or visit sumicarbide.com.

GEOMETRY/GRADE COMBO MAKES BURR-FREE PARTS

Walter USA introduces the MS3 cutting geometry with the new WSM01 grade. The combination of the HiPIMS physical vapor deposition coating and the MS3 geometry is said to be ideal for machining ISO-S materials with difficult cutting properties such as high-temperature alloys, titanium, and cobalt-based and nickel-based alloys. Negative inserts with MS3 geometry feature smooth surfaces and sharp cutting edges to minimize buildup and ensure high-quality, burr-free surface finishes.

Walter USA LLC, call 262-347-2400 or visit walter-tools.com/us.

CAM SOFTWARE FOR DENTAL MILLING, GRINDING

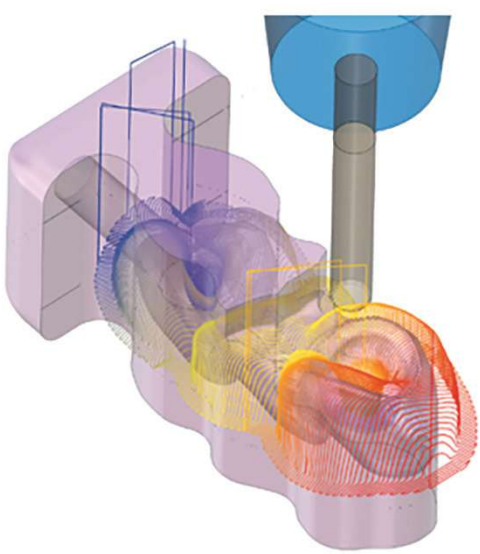
ModuleWorks' Dental Framework 2017 offers new, intelligent features for chair-side applications and complex dental indications. This dental CAM plug-and-play product performs advanced toolpath calculations and outputs the corresponding NC file for dental CNC machines. It uses verified and configurable machining templates in the form of XML scripts for efficient and flexible implementation, and it contains a complete toolset library for manufacturing a range of dental indications. The integrated CAM engine, which is used for the toolpath calculations, provides three-, four- and five-axis strategies for dental milling and grinding (chair-side) applications.

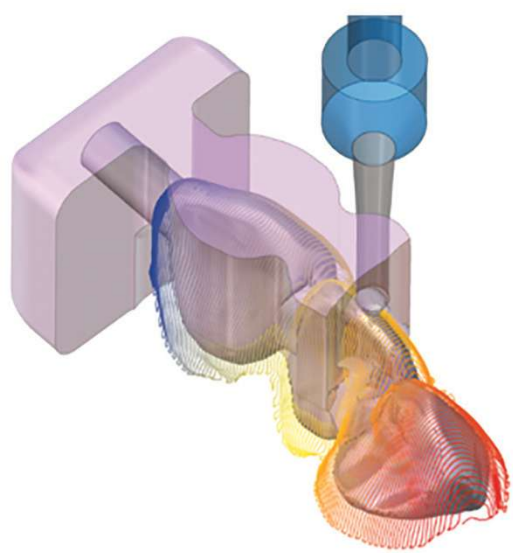
Besides adding intelligent algorithms for chair-side grinding, the core CAM features for milling applications have also been enhanced to increase the efficiency and quality of machining operations for complex dental indications, including indications with deep undercuts.

By ensuring the cutting conditions remain almost constant, the adaptive roughing strategy for grinding has significant advantages compared to conventional constant offset roughing. The constant-cusp pattern continuously analyzes the remaining stock in front and adapts the stepover to ensure tool engagement with the stock is always the appropriate for the application.

For milling, the 3D silhouette curve can be used as a reference curve for splitting the constant-cusp finishing operations from the occlusal and cavity sides. The 3+2-axis automatic undercut strategy detects the undercut areas from the top and bottom without any user input, then machines each region from the most approachable angle.

ModuleWorks GmbH, call 49 241 990004 0 or visit moduleworks.com.





EDITOR **JEDD COLE, jcole@mmsonline.com**

Modern Machine Shop

mmsonline.com

WEBINAR

FeatureCAM for SwissCAM

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Dan Pacific
Technical Specialist

FeatureCAM Ultimate automates CNC programming of milling machines, turning and turn/mill centres, Swiss lathes and wire EDMs. FeatureCAM 2018 includes a new user experience including a new ribbon interface that will improve the user experience. An icon accompanying text and dynamic help give more insight into functionality. In this webinar, we will concentrate on programming advanced Swiss -type lathes through an innovative and easy to use patented platform. This platform helps to improve machine usage, reduce cycle times and improve throughput through visual easy to use selections.

Dan comes to Autodesk through the Delcam acquisition, he has extensive knowledge on machining working previously as part of a fabrication team. Dan has extensive experience from the ground up when it comes to swiss type lathes; from grinding tooling, performing set-up's for production runs, operating and hand programing Citizen L's and Hanwha XD's before joining the PartMaker team. As an enthusiastic hobbyist in the maker movement, Dan has also machined his own wedding bands with engraving out of Titanium on a Citizen L20 type 7 using PartMaker.

DURING THIS WEBINAR, YOU WILL LEARN:

- Multispindle/multi-axis synchronization
- Simulate advanced swiss type lathes

DATE AND TIME OF WEBINAR

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MANUFACTURING DATA GATHERING, CONTEXTUALIZING SOFTWARE

System Insights has launched Vimana Enrich, a software solution designed to simplify the capture and integration of relevant data from the shop floor and business systems, and add context to the manufacturing process without increasing time and cost for programming and systems integration. It is said to enable manufacturers to leverage machine data to gain improved insight, in real time, that will support decision making and enable smart manufacturing, the company says.

The software is a stand-alone, on-premise, streaming application that consumes data from MTConnect and other data sources. It leverages a set of standard and custom-developed rules to generate events that can be consumed by Vimana Utilize or other analytics platforms for visualization and predictive analytics. Enriched data can also be integrated with other manufacturing and business systems to include ERP, maintenance and scheduling systems to enable a closed-loop process, and end-to-end supply chain and process automation.

Vimana Enrich is designed to enable manufacturers to be able to identify the true state of the manufacturing process, such as current machine activity, asset health, part production and operator status. Additionally, events and alerts can be created for insight into maintenance, scheduling, inventory, part quality and more.

System Insights, call 510-584-9029 or visit systeminsights.com.

For more information about systems and software, go to mmsonline.com/erp and mmsonline.com/cam.

MACHINE SOFTWARE SPEEDS 3D CONTOURING

Makino introduces SGI.5, the latest version of its Super Geometric Intelligence software for high-

feed-rate, tight-tolerance machining of complex, three-dimensional contoured shapes. The technology facilitates greater levels of accuracy and reductions in cycle time, the company says. Depending on specific geometry, SGI.5 can provide 20 to 60 percent faster cycle times while maintaining accuracy and surface finishes.

The software leverages the rigidity of the Makino machine structure, the kinematics of the machine drive systems and the company's latest advancements in servodrive technology. The result is high speeds, high feeds and tight accuracies when executing NC programs with microblocks with traverse movement value of 1 mm or less, the company says. This is characteristic of the complex 3D surfaces found in die/mold, medical, aerospace and other high-performance milling applications.

Makino Inc., call 513-573-7200 or visit makino.com.

CAM SIMULATION SOFTWARE SPEEDS TURNING-TO-MILLING TURNAROUND

Spring Technologies offers the latest version (2017) of its flagship software NCSIMUL Solutions and the NCSIMUL 4CAM add-on module. New probing strategies with checking and measurement of intermediary rough stocks enable automatic compensation, taking into account tool wear during machining.

Support for turning after milling enables one-click CNC machine turnaround, the company says. This feature provides automatic reprogramming for all CNC tool and machine changes, delivering flexibility and time savings for CAM programmers and workshop scheduling.

The Optitool option is built into NCSIMUL 4CAM 2017, enabling automation and optimization, especially all rapid motion, with graphic analysis for quick before/after comparison of improvements.

NCSIMUL Tool cutting tool management with 3D definitions, attachments and cutting conditions has been enriched, standardized and stored by material, machine and operation.

This version features one-click project update (phase calculation, simulation and ISO code restart, etc.) and phase export/import to exchange project information with other customer sites or external partners. This enhances inter-company collaboration with subcontractors, suppliers and customers, covering all or part of a project, enabling data exchange and securing the whole project.

Automatic performance analysis of the assembly for five-axis NC machines graphically detects machining risk zones and less-than-optimal cutting conditions.

Three new CAM programs have been added to the list of Workpackages available with NCSIMUL Solutions 2017, including Alphacam, Catia, Cimatron, Creo, Edgecam, Esprit, FeatureCAM, GibbsCAM, HyperMill Mastercam, NX, PowerMill and TopSolid'Cam.

Spring Technologies Inc., call 617-401-2197 or visit ncsimul.com.

CAM SOFTWARE OFFERS CHIP BREAK SETTINGS FOR MACHINING STRINGY METALS

CNC Software Inc.'s Mastercam 2018 offers several new features and improvements. Stock awareness has been added to select 2D tool paths. The tool motion can now use the top, bottom or both values of the stock, and all the

linking parameters can be set to adapt to changing stock values. Finish passes now have more options to choose from. Users can add or remove finish cuts based on the number of rough depth cuts specified on the Depth Cuts page. The workflow for all 3D high-speed tool paths has been streamlined and gives users fine control over exactly where to cut. Users can also assign variable stock to leave values on its walls and floors.

In turning and mill-turn operations, Chip Break is now available for face and finish tool paths when chip breaks occur. The company says this function is valuable when working with stringy materials such as aluminum or plastic, enabling users to set length and time conditions, retract and dwell options. Mill-turn machine definitions now contain tailstock and quill components. The new tailstock operation enables users to define how the machine's tailstock is used, and tailstock options differ depending on the selected machine.

The angle sweep function improves the creation of more complex wireframe functions and, when creating or editing primitives, there are now on-screen sweep and rotate controls that can snap to the AutoCursor positions of existing entities. Seam control lets users visually rotate a seam to see how geometry will respond, as well as snap to AutoCursor positions.

Additional features include a new set of turning strategies that automate toolpath generation and support for Sandvik Coromant CoroTurn Prime inserts and the PrimeTurning method.

Mastercam - CNC Software Inc., call 860-875-5006 or visit mastercam.com.

Amerimold 2017

Taking place June 14-15 at the Donald E. Stephens Convention Center in Chicago, Illinois, Amerimold 2017 brands itself as the event for mold manufacturing. Thousands of attendees, including owners, executives, engineers, and managers at OEMs and contract manufacturers come to network and stay up-to-date on industry developments from more than 200 equipment suppliers, service providers, and tool and mold makers. Featuring educational opportunities with Tech Talks and in-booth demos, the show offers a the place to visit suppliers of machine tools, mold components, materials, tooling, workholding and more. This section showcases a sampling of the many products to be displayed there.

FLEXIBLE, SELF-CONTAINED TOOLROOM LASER

ALLIANCE LASER SALES INC., BOOTH 623

Developed in partnership with Vision GmbH, Alliance Laser's MobileFlexx Toolroom Laser System is said to be highly mobile, extremely flexible, and self-contained, with all tools and materials necessary for in-shop laser welding. The welder features a fixed-size scanner laser in 150, 300 or 450 W. The company says it uses the systems daily in its own shop for repairs and service.

Alliance Laser Sales Inc., call 847-487-1945 or visit alliancelasersales.com.

CAM UPDATE EASES SIMULTANEOUS FIVE-AXIS CONVERSIONS

CGS NORTH AMERICA INC., BOOTH 705

CGS will introduce Version 13 of its CAM-Tool software for 3D machining of molds and dies.

This version includes upgrades to simultaneous five-axis conversions that change the way a stock model is created. With this new method of creation, five-axis conversions calculate faster and more accurately, the company says. This will also help when using the Delete Air Cuts function, which optimizes tool paths by referencing the stock model to remove any unnecessary air cuts.

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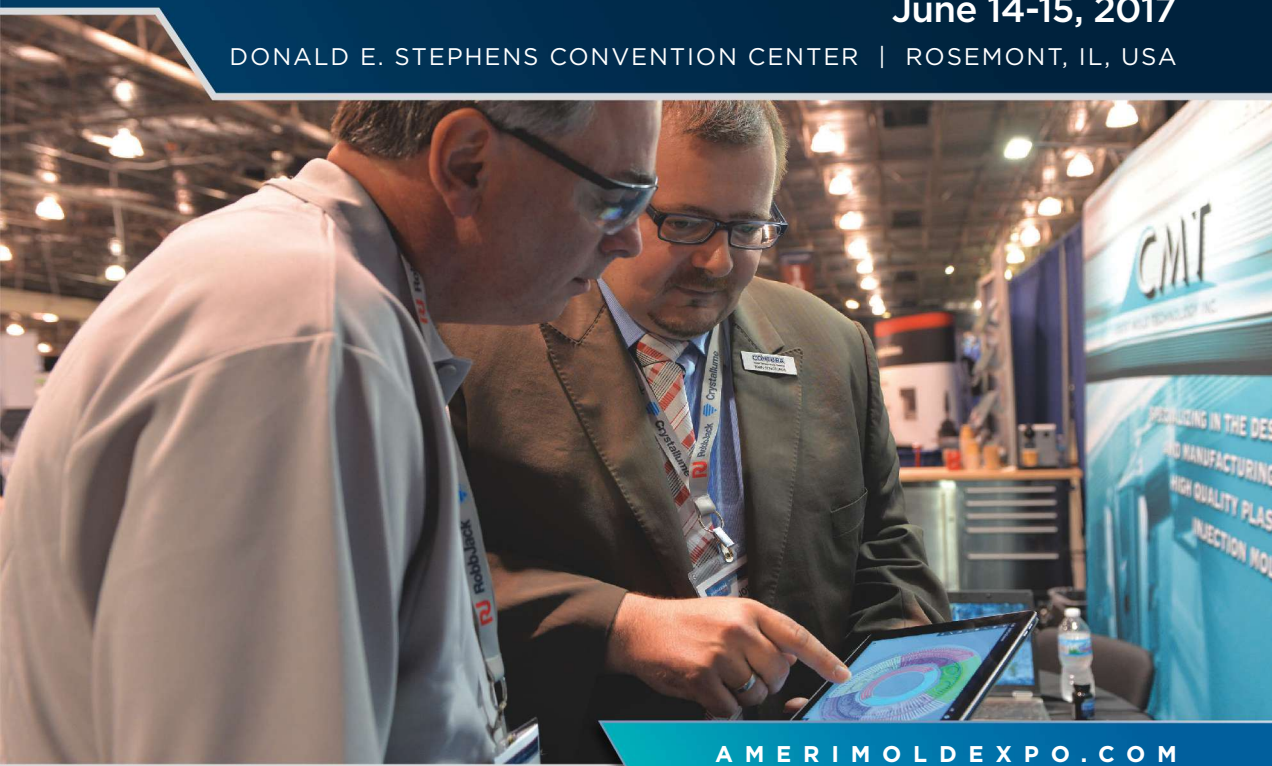

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Increased functionality in the Solid Modeler module enables CAD data to be more easily altered to cover, move or remove areas of the part that users no longer wish to machine. Machine simulation also has been upgraded to enable easier switching between machines in simultaneous five-axis simulation.

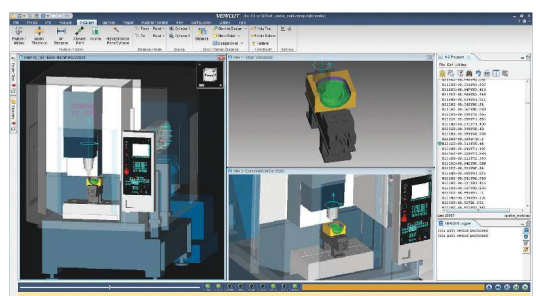
CGS North America Inc., call 844-737-6009 or visit camtool.com.

SIMULATION SOFTWARE STANDS ALONE OR INTEGRATES WITH CAM SYSTEMS

CGTECH, BOOTH 1025

CGTech will showcase the latest version of its Vericut CNC machine simulation, verification and optimization software. Like earlier versions, Version 8.0.2 can operate independently or be integrated with leading CAM systems. This full integration with the CAD/CAM and machine tool industry is an important attribute of the software, the company says. Machine simulation detects collisions and near-misses between machine tool components such as axis slides, heads, turrets, rotary tables, spindles, toolchangers, fixtures, workpieces, cutting tools and other user-defined objects. Vericut can simulate virtually every machine tool brand, the company says, including DMG MORI, Mazak, Makino, Matsuura, Hermle, Chiron, Starrag, WFL, Nakamura-Tome and more.

CGTech, call 949-753-1050 or visit cgtech.com.



ON-MACHINE PROBES AUTOMATICALLY DETECT AXIS POSITIONS

MARPOSS CORP., BOOTH 1210

Marposs will feature its WRP60P and WRP45P touch probes with multichannel radio transmission, designed for machine part measurement

on high-accuracy five-axis machining centers and milling machines. Through automatic detection of machine axes positions, the probes achieve part positioning, workpiece orientation and origin identification, as well as accurate part measurement. Piezo-electric technology provides repeatability within 0.25 micron on 3D surfaces. A special filter enables the probes to distinguish false-triggering events from actual touch events.

The probes operate with the WRI receiver and have a range of 15 m, making them well-suited for large machines. And, because the line of sight between the probe transmitter and receiver is not required, complex surfaces and deep-cavity parts can be inspected. The modular structure and extensions of the probe enable measurements to be performed at depths as great as 1 m.

Marposs Corp., call 248-370-0404 or visit marposs.com.

CARBIDE END MILLS LENGTHEN TOOL LIFE, REDUCE WEAR

ROBBJACK CORPORATION, BOOTH 923

RobbJack will highlight its DM/MDM end mills, made from a carbide material and coating combination said to last 450 percent longer than comparable tools designed for hard-metal applications. Testing in D2 steel with a hardness of 58 HRC resulted in a smooth wear land of just 0.0025", the company says.

RobbJack Corp., call 800-527-8883 or visit robbjack.com.

MACHINE MONITORING SYSTEM ENABLES REMOTE ACCESS

SMART ATTEND INC., BOOTH 717

Smart Attend will introduce its Pro device, a remote monitoring system featuring real-time analysis capabilities that can be accessed from virtually anywhere in the world. Incorporating a purpose-

AMERIMOLD 2017
June 14 - 15

built tower light, the device can communicate machine and efficiency status visually through configurable LEDs and audibly through a 100-db-capable speaker installed at the top. It also sends information through the cloud and directly to mobile devices through a web-access portal and a native iOS/Android app.

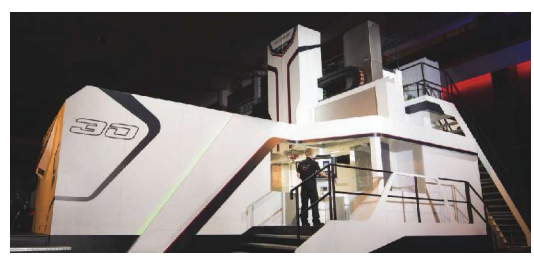
Smart Attend Inc., call 866-210-9630 or visit smartattend.com.

BRIDGE-TYPE MILLING MACHINES PERFORMS ROUGHING, FINISHING

WALDRICH COBURG, BOOTH 418

Waldrich Coburg's Taurus 25 and Taurus 30 bridge-type milling machines feature a robust cast iron structure and hydrostatic guideways to ensure a stable platform for heavy roughing cuts, while still providing high-speed, chatter-free finishing for mold and die applications.

Both five-axis machines offer 85/63 hp, 6,000 rpm and high torque to power through tough materials. Optional motorized spindles are available for finishing speeds of 20,000 rpm supported by feed rates of 1,181 ipm. Table load is 88,000 lbs, supported by two base sizes: 79" × 158" or 98" × 197". Other options and features are available.



The company also offers the hydrostatic high-rail MultiContour gantry machine, which features the same high-quality construction features as the Taurus series. This machine is equipped with a 63-hp, 6,000-rpm, two-speed spindle, as well as finishing spindles with speeds ranging to 30,000 rpm. Feed rates of 1,181 ipm and acceleration rates of 3 m/sec.^{2} provide high flexibility.

Waldrich Coburg, call 814-835-1955 or visit waldrich-coburg.com.

MILL'S "OIL SHROUD" VIRTUALLY ELIMINATES DUST IN GRAPHITE MACHINING

EDM NETWORK INC., BOOTH 1226

EDM Network will exhibit the HM43GT graphite mill, which features an optional "oil shroud" that virtually eliminates the dust common to graphite milling. EDM-compatible oil captures the graphite dust, and then it is filtered through two 30-micron cartridge filters. Vacuum compatibility is also available.

The HM43GT and two larger models, the HM65GT and HM86GT, all feature 30,000-rpm spindles with HSKE 32, 40 and 50 tapers, plus optional Blum laser diameter compensation and Fagor glass scales. In addition to graphite milling, the larger models can be equipped with 10- and 15-Kw motors to mill metals as hard as 63 HRC.

EDM Network Inc., call 888-289-3367 or visit edmnetwork.com.

VMC MACHINES HARDENED STEEL MOLDS

TOYODA AMERICAS CORP., BOOTH 411

JTEKT Toyoda Americas will demonstrate its Stealth 965 vertical machining center running a mold in hardened steel. Featuring a 900-mm (35.4") X axis, a 1,110 × 650 mm (43.3" × 25.6") table and a 900-kg (1,985-lb) load capacity, the boxway VMC is engineered to handle a range of challenging materials. Four hardened and ground Y-axis box guideways are integral to the single-piece casting, and are mated to a super-wide, inverted Y-shaped column. All metal-to-metal contact surfaces are hand-scraped for additional

rigidity. This results in better vibration-damping characteristics and a better surface finish, the company says. A 200-block look-ahead prepares an optimal route for tooling while maintaining constant machining speed, resulting in a high-quality surface finish through curves and corners.

Standard features include a temperature-controlled, 30-hp, direct-drive, 12,000-rpm spindle. Large, precision spindle bearings provide high revolution accuracy, thermal stability and extended tool life.

Toyoda Americas Corp., call 847-253-0340 or visit toyoda.com.

DIAMOND-COATED CUTTERS FOR HARD MILLING

CRYSTALLUME, BOOTH 923

Crystallume will showcase its latest tool lines,

including the Demon series for hard milling, which features an advanced coating for increased high-temperature stability while machining hardened steels. The Stealth line of end mills, also on display, is said to have the sharpest cutting edge available in a diamond-coated tool. This makes the line well-suited for machining graphite.

Crystallume, call 800-789-4322 or visit crystallume.com.

WORKPIECE CLAMPING SYSTEM FOR ONE-OFFS, SMALL-BATCH PARTS

EROWA TECHNOLOGY INC., BOOTH 1012

The clamping elements of Erowa's CleverClamp workpiece clamping system are specifically tailored to the manufacture of one-off and small-batch parts. They are said to be simple to handle and serve a variety of applications, while decreasing setup times, increasing machining times and improving productivity.

The basic rails of the system are calibrated to fit the Erowa UPC and MTS production tooling systems. They provide the flexibility to attach workpieces of varying shapes and sizes in a limited amount of space. The range of clamping elements can be quickly positioned on the serrated base rails and used either horizontally or vertically.

Erowa Technology Inc., call 800-536-4894 or visit erowa.com.

TOOL PRESETTERS MINIMIZE MACHINE IDLE TIME

HAIMER USA, BOOTH 1113

Among the products and technologies Haimer

will display are its Microset tool presetters, which are designed to streamline the tool-setting process, reducing setup time by as much as 70 percent, to minimize idle time and increase machine utilization. The line includes the Uno series, which offers high precision, speed and reliability, and the Vio series, which provides absolute reliability with high-quality components, the company says.

Also on display will be the company's Power Clamp shrink-fit machines, shrink-fit toolholders and collet chucks; Tool Dynamic balancing machines; Safe-Lock and Duo-Lock technologies; 3D sensors; and the Cool Flash coolant delivery system.

Haimer USA, call 630-833-1500 or visit haimer-usa.com.

DOUBLE-COLUMN MACHINING CENTERS DELIVER HIGH ACCURACY

TAKUMI USA, BOOTH 1015

Extremely rigid and thermally stable, the Takumi H series double-column machining centers are designed for parts that require high accuracy and quality surface finish in die/mold, aerospace and other high-speed applications. The H10 has XYZ travels of 40" × 27" × 19"; a 30-station swing-arm automatic toolchanger; and inline, direct-drive, high-speed Big Plus spindles with 30-bar (435-psi) coolant-through capability and linear scales.

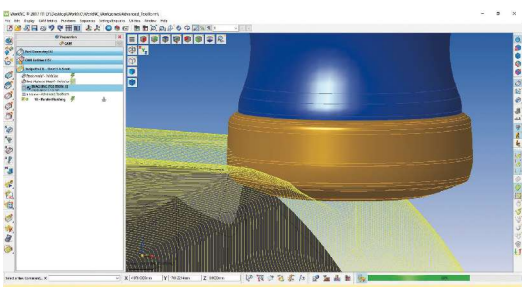
Mechanical features include ladder design of the cross rails. This configuration reportedly provides a rigid support for the saddle and head and prevents deformation in the vertical axis, thus allowing for faster speeds and more accurate 3D surfacing operations. The close proximity of the spindle to the bridge casting reduces overhang. The one-piece base design also absorbs the thrust force of the table, which prevents the column distortion found on typical C-frame machines. Roller-type rails on all axes increase rigidity and enable high table loads

compared to ball-type guides.
Takumi USA, call 844-302-3792 or visit takumiusa.com.

UPDATED CAM SOFTWARE INCLUDES PARALLEL FINISHING TOOL PATH

VERO SOFTWARE, BOOTH 1222

Vero Software will demonstrate WorkNC 2017 R1, which features a new parallel finishing tool path that the company says has achieved cycle-time reductions of as much as 80 percent. Based on Vero's new Advanced Toolform technology, parallel finishing toolpath calculations take into account the physical geometry of cutting tools, including high-feed, standard and convex tooling.

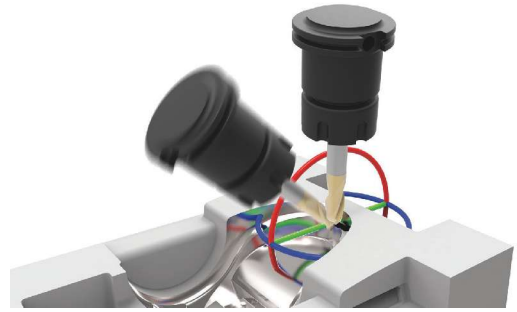


Among other updates in this version of the CAM software is a dynamic calculation queueing function, which is said to deliver significant time savings by enabling users to accomplish more tasks within a shorter timeframe. Operators can generate multiple tool paths, run postprocessors and check for eventual toolholder collisions without waiting for calculations to finish.
Vero Software, call 248-356-8800 or visit verosoftware.com.

CAM SOFTWARE SIMPLIFIES INTERFACE FOR COMPLEX PARTS

AUTODESK INC., BOOTH 305

Autodesk will demonstrate its PowerMill CAM software and its Moldflow mold simulation product. PowerMill 2018 features a new ribbon interface designed to simplify use of the software and help moldmakers create the 2D, three-axis and five-axis NC code needed to successfully machine complex parts. The software package's Dynamic Machine Control provides enhanced tools to help optimize five-axis machine motion.



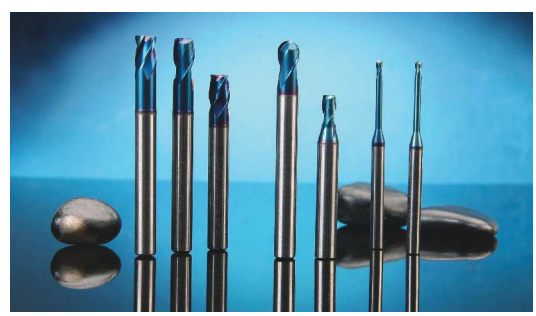
Upgraded simulation tools combine improved image quality with the ability to pan, zoom, rotate and identify collisions and near-misses involving unmachined stock.

Moldflow's plastic injection molding simulation tools are designed to help CAE analysts, designers and engineers validate and optimize plastic parts, injection molds and the injection molding process. The software supports direct data exchange with most CAD software tools, the company says.
Autodesk Inc., call 877-335-2261 or visit autodesk.com.

END MILLS CUT THROUGH HARD MATERIALS

YG-1 TOOL CO., BOOTH 823

YG-1 Tool's 4G and X5070 end mills are designed to cut through hard materials. The 4G and 4G Rougher models can handle materials as hard as 55 HRC, while the X5070 is specifically designed to process materials ranging from 50 to 70 HRC. The tools feature tailored coatings that allow cutting through hardened steel, steel forgings, castings and a variety of other materials. The X5070 also features a blue coating that helps to identify wear.
YG-1 Tool Co., call 800-765-8665 or visit yg1usa.com.



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MACHINES COMBINE DEEP-HOLE DRILLING, MILLING FOR MOLDMAKING

UNISIG DEEP HOLE DRILLING SYSTEMS, BOOTH 606

Unisig USC and USC-M deep-hole drilling and milling machines are designed to allow moldmakers to combine operations, reduce setup time, increase accuracy and eliminate mold design restrictions associated with traditional machining centers.

The reliable and compact column-type USC machines perform BTA and gundrilling operations and can generate highly accurate holes ranging to 1.5" in diameter in large workpieces on available table weight capacities ranging to 50 tons. For increased part processing capability, optional milling spindles and rotary tables are also available.

USC-M series machining centers use two independent spindles along with rotary workpiece tables and programmable headstock inclinations to perform high-accuracy, seven-axis deep-hole drilling of hole diameters ranging to 2". Advanced CNCs provide five-axis positioning, while automatic tool changing and laser presetting contribute to the machines' abilities to perform all required machining in one operation.

Unisig Deep Hole Drilling Systems, call 262-252-3802 or visit unisig.com.

MODULAR WORKHOLDING SYSTEM SPEEDS SETUP FOR FIVE-SIDED ACCESS

FCS NORTH AMERICA, BOOTH 1220

Available in manual, automatic and full-motion configurations, FCS North America's Breyl modular workholding systems offer flexibility, repeatability and precision to a tolerance within 5 microns.

The manual system is designed to provide quick setup options for unrestricted access to five workpiece surfaces in one step. It is based on a 50-mm grid and starts with a base gage, clamping body, ring and rod. The ring provides the exact centering and the rod the connection. The automatic system is designed around the direct needs of an internal workspace and provides a full range of automatic clamping for fast handling of palletization. The fully automated Motion Line System is operated by a proprietary software platform or can be integrated with an existing software system.

FCS North America, call 519-737-0372.

FIBER LASER TECHNOLOGY ENGRAVES MOLD CAVITIES

LASERSTAR TECHNOLOGIES CORP., BOOTH 1219

FiberStar laser engraving systems from LaserStar Technologies can be used to letter, mark or permanently engrave most metals and plastics, and some ceramics. They are available in Class 1 and Class 4 platforms with power levels ranging from 10 to 100 W.

According to the company, fiber laser technology offers a variety of methods for laser marking and permanent laser engraving, and can be used in many applications, including deep engraving on mold cavities.

LaserStar Technologies Corp., call 401-438-1500 or visit laserstar.net.

MACHINING CENTERS SUITABLE FOR VARIOUS COMPLEX PARTS

PROMAC NORTH AMERICA CORP., BOOTH 928

Promac produces a range of five-axis equipment designed for machining medium and large parts with complex shapes. According to the company, the rigidity of the machine structures, the power provided by the spindles and exactness of move-

ment, combined with high speed, ensures a high-quality final surface.

Promac North America Corp., call 248-817-2346.

QUALITY INSPECTION SOLUTION COMBINES SOFTWARE MODULES

VERISURF SOFTWARE INC., BOOTH 836

Verisurf Software's Quality Inspection Suite is a combination of the software's popular application modules customized for efficient quality inspection and reporting.

Verisurf CAD is capable of reading all native CAD file formats, allowing customers to work with any CAD model, whether solid, surface or wireframe. Model-based definition allows users set unique IDs, tolerances, and geometric dimensioning and tolerancing constraints in the model for any surface, feature or other critical inspection item.

Verisurf Measure provides measurement of features from precise single points to scanned point clouds. A virtual image of the measuring device is graphically displayed on screen, while smart tools automatically recognize and display features during the measuring process.

Verisurf Automate programs and operates virtually all types and brands of coordinate measuring machines using visual object-oriented programming and open standards.

Verisurf Validate provides precise CAD model translation validation by comparing the authority CAD model to the translated CAD model, enabling users to quickly identify any translation error.

Verisurf Software Inc., call 714-970-1683 or visit verisurf.com.

SIX-AXIS EDM DRILL ALSO MILLS 3D SHAPES

EDM Network offers Chmer EDM's six-axis AD5L EDM Drill/Mill, a high-speed EDM drilling machine that can also mill 3D diffuser shapes required for air cooling in jet engines and industrial gas turbine generators. The AD5L can be equipped for fully submerged operation or standard flushing. Also available are a 20-position rotary electrode changer and a guide changer to handle different electrode diameters in one setup.

The EDM's X-, Y- and Z-axis travels measure 500 × 300 × 350 mm, with an optional Z-axis travel of 600 mm also available. The X and Y axes are driven by the Chmer linear motors using Panasonic drives with precision glass scales for positioning accuracy. Submersible A-B index tables are available from MMK, Yukiwa, Parkson, Hirschmann and others. Electrode diameters range from 0.2 to 6.0 mm.

EDM Network Inc., call 888-289-3367 or visit edmnetwork.com.

WIRE EDM SERIES FEATURES TWO OPTIONS FOR SURFACE ROUGHNESS

Global EDM Inc. introduces the Excetek VGPlus series of wire EDMs. The series has a new digital power manager for improved cutting and accuracy, an HP AVR circuit for better accuracy with multiple parts, and two options on cutting surface roughness: the WGPlus SKD-11 (0.3 micron Ra) and the WGPlus tungsten carbide (0.1 micron Ra). The company says that this series is ideal for those seeking a modern wire EDM with a user-friendly control interface.

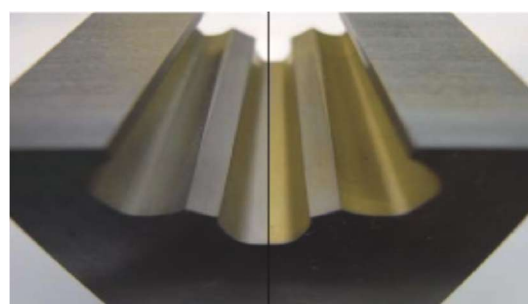
There are four models in this series. X, Y and Z axes measure 15.7" × 11.8" × 8.7" on the V400G Plus; 19.7" × 11.8" × 12.2" on the V500G Plus; 25.6" × 15.7" × 16.1" on the V650G Plus; and 31.5" × 19.7" × 13.8" on the V850G Plus.

Other features include a Windows XP-based control; rigid, heavily-ribbed, high-grade Meehanite castings; a direct-couple drive system (no belts); electrolysis-free machining with Digital Power Manager technology; and intelligent servo-controlled wire threading technology.

Global EDM Machines, call 513-701-0441 or visit globaledm.com.

BRASS COATING PROTECTS CARBIDE EDM PARTS FROM OXIDATION

Seibu's EL coating, available from KGK International, is designed to protect carbide parts, resulting in longer tool life and more parts produced. Seibu's wire EDMs require a simple M code to be added to the CNC program in order



to activate the coating process.

During wire EDM machining of carbide, the cobalt will start to break down due to oxidation caused by the dielectric fluid, even while machining is occurring, the company explains. If the cobalt is not protected after the final EDM skim pass, it is attacked by the oxygen ions. To reduce oxidation of the carbide tool, Seibu's EL coating applies a thin layer of brass wire onto the carbide during the final trim pass. This thin layer of brass protects the carbide's cobalt from the oxygen ions located in the dielectric fluid.

KGK International Corp., call 847-981-5626 or visit kgki.com.

DIE-SINKING EDM FEATURES LOW ENERGY CONSUMPTION

Available from GF Machining Solutions, the AgiesCharmilles Form 20 EDM features Intelligent Power Generator (IPG) technology that gives it low energy consumption levels (3.7 kW/hr. at full power). With every machine pulse, the 70-A generator continuously optimizes the EDM process and reduces electrode wear to provide uniform surface finishes. The machine reliably generates surface finishes of 0.1 micron Ra and radii as small as 0.0007", the company says.

Additionally, the Form 20 features the company's AC Form human-machine interface (HMI), which is designed to make the control flexible and easy to use. Combined with full spark generator technology, AC Form HMI enables operators of all experience levels to achieve good results.

GF Machining Solutions LLC, call 800-282-1336 or visit gfms.com/us.

EDM WIRE ENABLES HIGH CUTTING SPEEDS

Sodick has launched JQ (Japan Quality), a new line of EDM wire consumables consisting of uncoated brass wire that enables high cutting speeds. Produced in Japan, the wire is made by first melting down raw copper and zinc and analyzing the nascent mixture for optimal purity. Virgin wire is then drawn at a standardized size before being annealed and redrawn through special diamond dies to ensure a pristine surface.

Sodick Inc., call 847-310-9000 or visit sodick.com.

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April 2017 – 54.8

Growth slows slightly, but expansion is still the greatest it has been in three years.

With a reading of 54.8, the Gardner Business Index showed that the metalworking industry grew in April for the fourth consecutive month. While the rate of growth slowed slightly, the industry grew faster from January to April than in any month since May 2014.

New orders increased for the sixth straight month, although their rate of growth was the slowest of 2017. The same was true for the production index. The backlog index grew for the third month in a row, and at a fast rate compared with one year earlier. This trend in the backlog index shows that capacity utilization should increase this year. Employment increased for the sixth time in seven months, but the rate of increase slowed slightly in both March and April. Exports continued to contract; their rate of contraction has remained relatively flat since November 2016. Supplier deliveries continued to lengthen at their fastest rate since April 2012.

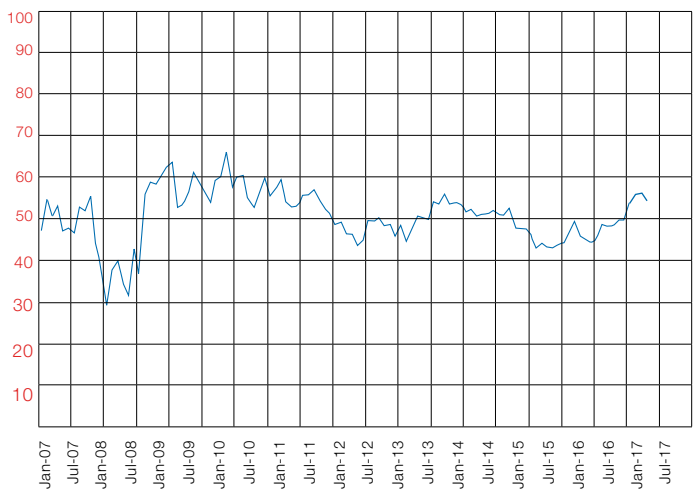
Material prices have increased at an accelerating rate each of the last two months. The rate of increase in April was the fastest since February 2012. Prices received increased for the fifth month in a row, but the rate of increase decelerated for the second month in a row. Future business expectations remained strong, but the index fell below 80 for the first time in 2017.

Power generation was the fastest growing industry in April, growing for the second time in three months and posting an index of 70.8. Twelve other industries recorded an index above 54.0 as well. Industrial motors/hydraulics/mechanical components grew at an accelerating rate for the fourth month in a row; aerospace has the longest streak of growth at six months; and job shops and oil/gas-field/mining machinery also grew. Off-road/construction machinery, military and HVAC contracted in April.

All regions grew for the third month in a row. The North Central-West grew the fastest for the third month in a row, posting an index above 58.0 in each. It was closely followed by the North Central-East. The South Central grew for the fourth month in a row, while the Southeast has had the longest stretch of growth at nine months.

Plants with more than 250 employees grew for the seventh month in a row, while facilities with 100-249 employees expanded for the fifth straight month. Companies with 50-99 employees grew for the eighth time in nine months. All three of these plant sizes recorded an index of 59.0 or greater in April. Shops with 20-49 grew for the sixth time in seven months, and shops with fewer than 20 employees expanded for fourth month in a row.

Metalworking Business Index



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