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- Tips for speeding up rapid prototyping
- Knee mills’ popularity on the rise
- Prevent chatter and other boring problems

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__________________________________________________________________________

Number of employees at your company.

A ☐ 1-9  B ☐ 10-19  C ☐ 20-49  D ☐ 50-99  E ☐ 100-249  F ☐ 250-499  G ☐ 500+

Your job title (check one):

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2. ☐ Engineering Manager (Supervise Engineering Personnel);
3. ☐ Engineering Department (Non-Supervisory Position);
4. ☐ Production Manager (Supervise Production Personnel);
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9. ☐ Other (please specify)
## Table of Contents

### COVER STORY

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>46</td>
<td>Machining Power</td>
<td>MTU America machines parts for large diesel engines while helping fill the skills gap.</td>
</tr>
</tbody>
</table>

### FEATURES

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>54</td>
<td>The Knee Mill: Still Standing</td>
<td>The venerable knee mill might have had its niche filled by more versatile CNC machines—but it remains popular.</td>
</tr>
<tr>
<td>66</td>
<td>Rapid Rules</td>
<td>Efficient rapid prototyping on a CNC machine tool requires the right technologies and effective organizational skills.</td>
</tr>
<tr>
<td>74</td>
<td>Boring Basics</td>
<td>When boring holes, it’s critical to choose the right tool for the job at hand.</td>
</tr>
</tbody>
</table>

### STAYING SHARP

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>Machine Technology</td>
<td>Tabletop equipment for sharpening cutting tools.</td>
</tr>
<tr>
<td>34</td>
<td>Swiss-Style Machining</td>
<td>Training options for new and experienced machinists.</td>
</tr>
<tr>
<td>38</td>
<td>Shop Operations</td>
<td>Reducing workholder setup.</td>
</tr>
<tr>
<td>42</td>
<td>Ask the Grinding Doc</td>
<td>Techniques for imparting fine finishes and achieving tight tolerances.</td>
</tr>
</tbody>
</table>

### GLOBAL GRINDING DIFFERENCES?

As an independent grinding consultant to companies around the globe, Dr. Jeffrey Badger occasionally is asked if he sees differences in grinding from one country to another. [cteplus.delivr.com/2hx35](http://cteplus.delivr.com/2hx35)

### CNC CHEF EYES CHIP THINNING

Well-intentioned machining conservatism can actually shorten tool life, according to the second episode of The CNC Chef, which addresses chip thinning. [cteplus.delivr.com/2dxyp](http://cteplus.delivr.com/2dxyp)

### SHOP KEEPS THE SPINDLE TURNING

A South Carolina machine shop purchased extra pallets to cut down on changeover time and ensure that it keeps the spindle turning as much as possible. [cteplus.delivr.com/27bd3](http://cteplus.delivr.com/27bd3)

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# Table of Contents

**DEPARTMENTS**

8  Lead Angle

10 Industry News

20 Letters to the Editor

24 Metalworking Product Review

78 Productive Times

82 People & Companies

84 Marketplace

85 Advertisers Index

88 Look-Ahead

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APRIL 2017  
Volume 69  Issue 4

Photographs of an off-highway diesel engine and shop workers courtesy of MTU America Inc., Graniteville, S.C.  
Cover design by Gina Moore.

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**APRIL 2017**  
Volume 69  Issue 4

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Koma now offers onsite installation and rotary table integration.
Many shop owners and managers bellyache about the difficulty of attracting skilled workers.

 Quit complaining and commit to a German-style, dual-training apprenticeship program so you can grow your own talent. That was one piece of advice offered by Mario Kratsch, director of the skills initiative for the German American Chamber of Commerce of the Midwest Inc., Chicago. He was speaking at an informational event about the dual vocational training program offered by GACC Midwest’s Industry Consortium for Advanced Technical Training. Hermle Machine Co. LLC, which has committed to the program, hosted the event March 2 at its Franklin, Wis., facility to highlight the program’s benefits.

 Modeled after Germany’s apprenticeship system and billed as a company-driven approach to technical training, GACC Midwest developed ICATT in 2015. The organization is seeking other Wisconsin manufacturers to join Hermle Machine so the program can successfully launch this fall.

 “We need a critical mass of 10 to 12 students in order for a technical college to say, ‘Yes, we will provide those classes,’” said Manuel Merkt, vice president of operations for the machine tool builder.

 This number is needed because the qualifying apprentices in the 3-year program attend classes as a group to earn a customized associate degree. They also work at the participating manufacturers that hired them to receive training tailored to each company’s needs. Depending on the program, an apprentice might attend school 3 days a week and work 2 days or attend classes in, say, 8-week blocks, with each followed by a multiple-week block of work.

 “The ICATT program was initially developed in Illinois due to the high demand from German companies looking for skilled employees, but more and more U.S. companies are joining to keep a competitive edge,” said Geneva Scurek, manager, skills initiative at GACC Midwest. “This is why we are now expanding the program to Wisconsin.”

 Merkt, who completed an apprenticeship in Germany, explained that ICATT follows the German approach of developing a network of young people who all have the same training for a particular field. “It’s a lot easier to go from one company to another because each company knows that this person went through this program and has the same skill set,” he said.

 Nonetheless, after apprentices complete the program, they are contractually obligated to either work for the company at least 2 more years or reimburse the company some or all of the tuition and other expenses, Merkt noted. “You can also look at it this way: We provide the apprentices with at least a 2-year employment guarantee after the apprenticeship program.”

 Based on input from the three apprentices who participated in a panel discussion at the event, a large percentage of program graduates will continue to work for a company significantly longer than the 2-year minimum because one of the benefits of ICATT is greater employee loyalty. “If you cannot create loyalty for your company to that young professional within 5 years, you have kind of failed your job,” said Merkt, who has worked at Hermle for 17 years.

 For more information, visit www.thinkicatt.com.

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CHICAGO INNOVATION CENTER TO STOKE MANUFACTURING: On March 2, mHUB, a physical-product innovation center and microfactory, celebrated its official grand opening in Chicago. The center is designed to galvanize the area’s manufacturing ecosystem by generating innovative ideas, attracting world-class talent and fostering collaboration.

To date, mHUB (the “m” stands for numerous concepts, including manufacturing, make, machines, Midwest, mentor and markets) has attracted more than $8 million in partner funding, with a variety of sponsors. These include Autodesk and founding-partner GE. The center offers Chicago manufacturers access to state-of-the-art equipment and resources to develop and

Maxwell Emcays, an mHUB member, uses a laser cutter at Chicago’s product innovation center to cut wood for one of his art projects.
bring new products to market. The 63,000-sq.-ft. facility, formerly home to the Milwaukee Iron and Metal Co., contains 10 fabrication labs, including electronics, plastic fabrication, metals, textiles and rapid prototyping.

The center is working in partnership with the Technology & Manufacturing Association to add large, production CNC machine tools and to provide National Institute for Metalworking Skills Machining Level I and II certification on-site. There are plans to add plastic injection moldmaking equipment this year, according to Haven Allen, executive director of mHUB.

mHUB has more than 100 members, representing around 35 companies, in a roughly 7:3 entrepreneur-to-established-manufacturer ratio, as well as a handful of service providers. Allen said the goal for 2017 is to grow to 250 members, adding that the center can accommodate about 1,000 members.

In conjunction with the grand opening, GE announced the opening of the first regional GE Fuse location on-site. GE Fuse is a new approach to manufacturing that reportedly accelerates product and technology development by combining open innovation with small-batch manufacturing.

Allen said, “mHUB is here to create new jobs and to create new manufacturing companies, and we are working with our regional manufacturing base to make sure that what is invented here is manufactured locally. Having manufacturers engaged in the innovation process and helping product developers think about how a product is actually

In addition to producing products, manufacturing involves taking care of business. At mHUB, Delna Sepoy tries the Keyo palm-scanner payment terminal.
Industry News

manufactured” serves that mission.

According to Allen, mHUB was conceived by World Business Chicago, an economic development firm that focuses on regional growth, job creation and workforce development. Other WBC initiatives include apprenticeship programs, a new community college training center and the 1000 Jobs program, which has placed over 1,000 nonmanufacturing people into manufacturing jobs.

“There’s a strong sense that we have to create new businesses and new products—not just wait for companies to come here—in order to really grow the manufacturing industry,” Allen said.

—Holly Martin, Science Writer

AI TO GUIDE TOOL SELECTION IN THE FUTURE: Engineers who currently ask humans for advice about cutting tool selection will one day direct their questions to advisers derived from artificial intelligence. So says MachiningCloud Inc., a single-source provider of digitized product data gathered from manufacturers of cutting tools and workholding devices.

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MachiningCloud connects cutting tool users with the latest digital product data available from tool manufacturers. Information and application knowledge is readily available to power CAM systems.

Selecting the best tool for a job from the vast universe of available products can be daunting. Users often must sift through tens, hundreds or even thousands of pages of print or digital catalogs looking for the best tool, geometry, coating...
and cutting parameters. Or, they can call and speak to an applications engineer at the cutting tool manufacturer.

“It can be done human to human very quickly,” said MachiningCloud Managing Director Chuck Mathews, adding that “there’s no software that serves that need.” MachiningCloud, Camarillo, Calif., envisions a future where tool suppliers “take the process of advising people about tools—artificial intelligence, to use a fancy word—and put it into software.”

This would allow users to pose questions to the program, and the program would reply with recommendations about tool selection, speeds and feeds, and other data relating to a specific application.

Major cutting tool suppliers employ many specialists who can answer questions. “But that’s not sustainable over the long run, for a variety of reasons,” Mathews said. “For one, it’s very expensive to maintain the staff, and number two, the new generation of workers expects [the ordering of products] to be done electronically and are not comfortable with the old-school face-to-face or telephone calls.

“And number three, it’s not very consistent. You may get a good answer if you talk to a good engineer, but if you talk to an engineer with less experience, you may not get a good answer,” said Mathews.

Assuming that artificial intelligence will play a role in how cutting tools are ordered in the future, one question sure to arise is, “Will AI also drive the order-giving side of transactions?”

To learn more about how MachiningCloud works, visit www.machiningcloud.com/get-started/how-to-videos.

—Don Nelson

**MACHINE TOOL CONSUMPTION WILL SHOW GAINS:** Economic pundits are anticipating global machine tool consumption to increase 2.1 percent in 2017, reaching a market value of $73.6 billion, said Dr. Wilfried Schäfer, executive director of VDW (German Machine Tool Builders’ Association), Frankfurt am Main, Germany. He presented information

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-Joe Adams, plant manager, Myles Tool, Sanborn, NY

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about the machine tool business at a March 9 press conference in Chicago for the EMO trade show, which takes place Sept. 18-23 in Hanover, Germany.

This compares with a fall of 1.7 percent in 2016, when global machine tool consumption was $72.2 billion, as estimated by the British research institute Oxford Economics, VDW's forecasting partner. VDW forecasts that Asian and American countries can achieve only a below-trend rise in their machine tool consumption during 2017, of 1.7 and 0.9 percent, respectively. Those levels, however, are an improvement compared to an estimated drop in 2016 of 3.6 percent for Asia and 3.8 percent for America.

Despite the uptick for the overall U.S. economy, the nation's industrial investment activity is sluggish, in part because important sectors like mining and oil and gas production are in a consolidation phase, according to Berlin-based economic development agency Germany Trade & Invest.

The automotive industry, however, is doing well. According to Oxford Economics, the industry will increase
its capital investment by 1.0 percent this year. Technologies for reducing fuel consumption and lightweight components are in demand, with the focus on machining aluminum, stacked lightweight materials and composites. Lightweighting also applies to aircraft manufacturers, who plan to invest 5.6 percent more in 2017 than in 2016.

Looking at the latest actual results, the U.S. imported more than 60 percent of its machine tools in 2015, totaling about $8 billion. With a share of 16.5 percent, Germany was the second main supplier of those machines, with Japan supplying 33.9 percent.

“The German machine tool industry is very well anchored among the major American automakers, their component suppliers, the aviation industry and the mechanical engineering sector,” Schäfer stated. “We also, however, want to encourage the numerous mid-tier and relatively small users of machine tools to find out at EMO Hannover what else the world of metalworking has to offer.”

At the press conference, David Koepp, president and CEO of Roscoe, Ill.-headquartered All World Machinery Supply, spoke about the benefits of attending EMO. He emphasized the scope of machines and other metalworking products exhibited at the trade fair. “It’s the largest that I’ve seen.”

Koepp added that attendees are able to interact with the owners and presidents of companies that manufacture production equipment and tools, as well as engineers. Attendees can generate “real business” and gather useful ideas and solutions instead of just a stack of business cards. “The engineering flair is impressive,” he said. “You get a look at where manufacturing is heading.”

Although U.S. manufacturers may question why they should spend the time and money to travel to Hanover for a trade show, Larry Turner, president and CEO of Hannover Fairs USA, Chicago, said exhibitors use EMO to launch new technologies. When the biennial event was previously in Germany, in
2013 (the show was held in Milan, Italy, in 2015), 45 percent of the exhibitors presented new innovations, according to show organizers. The 2013 show drew 1,100 U.S. attendees.

Because EMO is quite large, with 1,889 exhibitor applications for 521,250 sq. ft. of exhibit space as of press time, Turner recommends that a company send more than one person to adequately cover it.

For more information, visit www.emo-hannover.de.

—Alan Richter

IMMIGRANT ENGINEERS’ ROLE IN U.S. MANUFACTURING: In a recent article at Forbes.com, Bill Conerly of Conerly Consulting LLC, Oswego, Ore., discussed how U.S. manufacturers need engineers to thrive because engineers invent products and optimize production methods.

He noted engineering is mostly complementary to production and maintenance jobs, which account for the majority of factory employees. “But you would also count clerical jobs, people doing scheduling and that sort of thing,” Conerly told CTE. “It includes people who work in the manufacturing sector who maybe are not even in a factory—like sales people. You don’t get engineers unless you have sales people; you don’t get sales people and maintenance people unless you have engineers.”

However, finding high-quality engineers can be difficult. According to Manpower’s annual list of the 10 hardest jobs to fill, engineers rank ninth and rising in the ranking. Immigrants make up a significant portion of these engineers. In U.S. science and engineering fields, 27 percent of workers are foreign-born, according to a 2014 National Science Foundation report. That’s because, Conerly explained, people who earn college degrees in science and engineering look for the best job opportunities and, if they’re from a relatively poor country, the U.S. is high on the list of possible countries with the best opportunities.

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<thead>
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</thead>
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<tr>
<td>Coating Color</td>
<td>Violet Grey</td>
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<tr>
<td>Features</td>
<td>Increased Cutting Stability, Protection Against Abrasive, Wear &amp; Erosion</td>
</tr>
</tbody>
</table>

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attract talented engineers, including foreign-born ones, retaining them is the first priority for a manufacturer, Conerly emphasized. But retaining them doesn’t necessarily require a high starting salary or frequent raises.

“In general, engineers don’t start looking for another job because of wages,” Conerly said. “They start looking for another job because their boss is a jerk. Then when they finally get fed up with the boss, they look around and half the time they find they can make more money.”

Therefore, manufacturers need effective first-line managers to retain employees. “Regardless of the job, the best advice I would give a company is make sure your advisers are giving frequent feedback,” Conerly said. “Whether it is negative or positive doesn’t make a lot of difference, but employees who get feedback about their performance are much more likely to stay.”

—A. Richter

**U.S. CUTTING TOOL SALES REVERSE COURSE:** After dropping for 4 consecutive months, the total billings index for member-companies of the United States Cutting Tool Institute was up 7 percent in January, at 90.7 percent, compared to December 2016. Compared to January 2016, the index for January 2017 increased 4.7 percent.

For more information about USCTI, call (216) 241-7333 or visit www.uscti.com.

**Total Billings Index**

(The index uses 2012 annual data, which equals 100 percent, as its baseline.)

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
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<th>2017</th>
</tr>
</thead>
<tbody>
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<td></td>
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</tbody>
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The USCTI collected the above data from member-companies.
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TOO MUCH MONKEY BUSINESS

The following letter was in response to Michael Deren’s “Machinist’s Corner” column about lean manufacturing in the January issue.

I started CNC programming in the mid-'70s. We had a book about machining that, while very good in some ways, damaged the future of CNC machinists because throughout the book were pictures of monkeys running machines. Management, it seems, read the book and, not knowing anything about CNC machines, were influenced by the pictures. To this day, many people who are not smart enough to run CNC machines, but are smart enough to run major corporations and universities, think monkeys can run CNC machines.

In the '70s, we had draftsmen, designers, tool engineers, manufacturing engineers … I can go on and on. These people wanted to be good at their jobs and we all wanted to get better and move up, such as a draftsman wanting to become a designer.

Fast forward to 2017. We have lean manufacturing, and management has again looked at the pictures of monkeys running machines. As a result, we have factories where nobody knows enough to do anything well, but they get by.

I believe some of the lean factories have more indirect people (those not directly involved in manufacturing) than we had in the '70s, but try working with them on a print. When I call some of these guys to question prints, they say, “Well, I am not very good at CAD, so you can make changes if you need to.”

The term I use to describe what is happening is “management by magazine article.” I wonder if the articles will ever cycle through and go back to being about people being good at their jobs.

Jimmy Ream
QMS Inc.

APPRENTICESHIP APPROVAL

The following letter was in response to Michael Deren's “Machinist's Corner” column about apprenticeship programs in the May 2016 issue.

I served in a machinist apprenticeship program in Baltimore from 1973–1977. My career has taken many turns over the last 40 years, since graduating as a journeyman. Many of these turns have been in an effort to survive in light of ever-changing demand. I have lived in northeast Georgia for 34 years, after relocating with a plant that was built in a nonunion environment.

I have changed jobs three times since my relocation, due to plant closures or downsizing, all with large companies. I am still in the metalworking field, but in a more support/maintenance role with a major player in the automotive parts supply chain, which uses a great deal of CNC machinery.

The one thing in your article that hit home with me was the term “button pushers.” A large majority of coworkers and HR types whom I
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Letters to the Editor

have encountered in the Southeast have no earthly idea what it takes, or even means, to be a journeyman machinist. At one interview, the HR manager told me that she could offer me a job if I would agree to attend the local trade school and take the 2-year machine technology course. At first I just kind of laughed, but soon realized she was serious. Needless to say, I moved on to other opportunities.

I’ve had many conversations of late with peers about the need to step back from the now-popular “multi-craft” roles and move back to trades. Public schools no longer offer industrial arts or vocational curriculums, because the job market is more geared to service, selling and computer tech stuff—not making things. The main problem I see with this is the lack of young people with the basic skills needed to support the “make-things” culture in all the traditional skilled trades—not just machine shops.

Van Bartell

OUT WITH LIGHTS OUT

The following letter was in response to Bill Leventon’s “Machine Technology” column in the February issue about alternatives to manually feeding parts into machines.

I have two Okuma LB3000 EX-II lathes, one with a bar feeder, and I deal directly with Okuma distributor Morris South.

I enjoyed reading your article, but I don’t agree with Jeff Estes, director of Okuma’s Partners in THINC, about letting a bar feeder run unattended. First, you’re not leaving just the bar feeder unattended—you’re, of course, leaving the whole machine unattended. The bar feeder needs to pay for itself, just like the machine, the tooling on it and the machinist who runs it. That payback is achieved by the work you put on it and the money you make from that work.

Every shop can choose whether or not to leave its machines running unattended. I do not advocate it, especially the previously mentioned model. There are just too many things that can go wrong.

Furthermore, Estes mentioned having a machinist in a multiple-machine work cell. Let us not forget...
that when more than one of these machines goes down, the machinist can fix only one at a time. I’ve always been a firm believer that if you can afford the machine, you can afford the machinist to run it.

I agree with Estes’ quote, “There’s nothing wrong with having a qualified machinist there.” However, I’d like to weigh in about his follow-up question, “But where do you find these people anymore?” As someone who has close to 30 years of experience in the trade, I can tell you that those people are out there—albeit not as many as we’d like to see. Perhaps not as many people are interested in this kind of work anymore. I accept that, but I place a lot of blame on employers.

First, employers don’t want to pay a fair wage. To offer someone with my experience $16 to $17 an hour is insulting, especially when that employer says, “That’s all we will pay.” That tells me they think everyone is the same and experience counts for nothing.

Second, shops can try to hire machinists from other shops. I kind of like this poaching idea (LOL).

Third, employers should stop using placement agencies. Most of these people—recruiters, headhunters, whatever you want to call them—do not know the difference between a lathe and a milling machine. Time and time again, I’ve had to explain this to them. And these are the people working for the agencies, which just want to get a machinist in the door because their payment is probably $6 to $7 an hour above what the machinist makes an hour.

What is really sad is employers know this, but they relish the fact that they don’t have to pay benefits for the machinists, who technically work for the placement agencies. I know of two major manufacturers in the Asheville, N.C., area that use only placement agencies. Their workers will never become company employees because if the manufacturers laid them off, they’d have to pay unemployment benefits. They won’t take the chance.

Employers, you need to rethink how you get good machinists and other workers. Invest in people and maybe you’ll be surprised.

Michael Fazio
Trend Performance
Metalworking Product Review

**COOLANT SUITABLE FOR ALL METALS:** Enterprise Oil Co. says its Duracool BR 300 semisynthetic cutting and grinding fluid is suitable for all machining applications, including tapping, aluminum and gundrilling. The coolant is formulated to resist biological degradation, eliminating “Monday-morning odors,” and does not contain chlorine, sulfur, nitrates, phenolics, heavy metals or dyes. According to the company, its heavy-duty corrosion package prevents rusting on all machine surfaces and toolholders. The fluid will not foam in high-pressure coolant systems, even when exceeding 1,000 psi (69 bar).

Enterprise Oil Co.; www.entoilusa.com

**LINEAR AUTOMATION SYSTEM IS FLEXIBLE:** EROWA Technology Inc.'s ERD 150L linear automation system can be expanded modularly as production capacity increases. The telescoping transfer arm can extend up to 54” (1,372mm) and handles up to 330 lbs. (150kg). The central control unit is equipped with only those connections that are needed for the relevant cell; additional connections can be integrated as components are required. The system can service up to 12 machines, and the selective magazine racks can be configured for a mix of pallets, electrode holders and fixtures.

EROWA Technology Inc.; www.erowa.com

**MODULAR MACHINES FOR LINE PRODUCTION:** EMAG LLC USA’s VL series of machine tools are built on a common machine base but allow the use of a range of technologies. Modular machines are available for turning, gear hobbing, chamfering, grinding and induction hardening. Special designs can be ordered for laser welding and electrochemical machining. The machine base supports a compound slide rest equipped with an X-axis and a Z-axis, allowing the working spindle to move. An optional measuring probe can be installed alongside the part-loading position.

EMAG USA LLC; www.emag.com

**CARBIDE BURS FOR NONFERROUS APPLICATIONS:** The ALU/NF CUT carbide burs from PFERD Inc. are optimized for deburring aluminum and soft nonferrous metals, such as brass, copper and tin, as well as harder materials, such as alloys with a high-silicon-carbide content, titanium and bronze. Shank diameters range from 1⁄8” to ¼” (3.18mm to 6.35mm), and bur diameters range from ⅛” to ⅝” (3.18mm to 15.88mm). For deburring softer aluminum alloys, the HICOAT version is available, which has an additional coating.

PFERD Inc.; www.pferdusa.com

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METALWORKING PRODUCT REVIEW

TOOL DRILLS COMPOSITES AND REMOVES CORES: Controx Inc.’s Decoring Cut tool drills through honeycomb-composite panels and undercuts the skins, thereby removing the cores in one step without delamination. An aggressive diamond-shaped tooth design removes and pulverizes the material without the typical “pushback” of conventional tooth designs, according to the company. The PVD-coated solid-carbide or cobalt-HSS tool is available in different lengths, allowing standard ¼", ½" and ¾" (6.35mm, 12.7mm and 19.05mm) panels to be processed in one pass.
Controx Inc.; www.controx.com

DIAMOND GRINDING WHEELS PROVIDE LONG LIFE: Innovative Products of America Inc. offers the #8150 4.5" (114.3mm) diamond grinding wheel. The wheel’s 3D contour with topside abrasive coating and thin profile edge enable cutting, back cutting, gully cutting and bead finishing. The wheel reportedly maintains its size and shape throughout its life, providing consistent reach and performance when, for example, dressing welds and accessing corners. Depending on the application, the company says the wheel will last 20 to 60 times longer than a standard wheel.
Innovative Products of America Inc.; www.ipatools.com

CAM SOFTWARE REDUCES PROGRAMMING TIMES: CAMWorks 2017 from Geometric Americas Inc. offers tolerance-based machining, wherein the software uses tolerances and nongeometric data in a 3D CAD model to select optimal machining strategies and automatically create toolpaths. According to the company, this approach can increase productivity by up to 70 percent or more, compared to traditional CNC programming, while providing the ability to capture and reuse best practices. It also improves part quality by automatically selecting the best machining strategy to meet the required quality requirement.
Geometric Americas Inc.; www.geometricglobal.com

GUNDRILLING MACHINE WITH INDEPENDENT SPINDLE CONTROL: The Eldorado M30-30T from Kays Engineering Inc. is a twin-spindle gundrilling machine that can simultaneously perform two independent drilling cycles. The machine has a 3⁄8"-dia. (7.94mm) drilling capacity and a 30° (762mm) maximum drilling depth. According to the company, it has high-speed cartridge spindles to enhance drilling performance. The machine incorporates flame-hardened and ground cast iron box ways and hand-scraped spindle housings to dampen vibration, extend tool life and impart fine surface finishes.
Kays Engineering Inc.; www.kays-dehoff.com
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BELT GRINDER ENHANCES PRODUCTIVITY: Palmgren’s #9682415 dual-station universal belt grinder is equipped with two belt heads. It is suitable for rough grinding, intermediate grinding, blending, finish grinding and polishing. It has a production-duty two-speed motor; a direct-drive design with an oversized shaft and bearings; enclosed, adjustable guard; and spark shields.

Palmgren; www.palmgren.com

BACK-WORKING SPINDLE FOR SWISS MACHINES: IBAG North America’s 25mm (0.984”) back-working spindle is for Star Swiss-style machines that have a 60,000-rpm spindle speed with grease-packed lubrication or an 80,000-rpm speed with oil-mist lubrication. Applications include micro milling and drilling, engraving and fine milling. The spindle has rigid bearings near the spindle nose that reportedly enhance true running, ensuring fine surface finishes and high machine accuracy.

IBAG North America; www.ibagnorthamerica.com

MILLING HEAD DELIVERS VERSATILITY: Carmex Precision Tools LLC engineered its high-performance milling head for use with its standard CMT toolholder (S35 type). The head accepts four triple-edged, round-profile indexable inserts for threading, grooving, chamfering and facing. The cutting diameter is 41mm (1.61”), the thread pitch is up to 4mm (0.16”) and the groove depth is up to 9mm (0.35”).

Carmex Precision Tools LLC; www.carmexusa.com

COOLANT FILTRATION REMOVES FINE PARTICLES: Superfiltration systems from Eriez HydroFlow remove particles as small as 3µm from cutting fluid while maintaining a stable fluid temperature. Primary applications include grinding, tool sharpening, lapping and honing. The systems are commonly connected to automatic lathes to filter oil recovered from centrifuges and oil applied when drilling at high pressure.

Eriez HydroFlow; www.eriez.com
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FINE POINTS OF MODERN SHARPENING

By William Leventon

Just how big is the change that has come to tool-sharpening equipment? To get an idea, consider the increasingly small size of up-to-date sharpening operations.

“Today, companies don’t have whole tool-grinding departments,” said Jeff Toycen, president of Cuttermasters, an Ottawa, Ontario, maker of drill and endmill grinders. “In a toolroom we just set up, we replaced a room half the size of my house full of old tool grinders with some machines on a benchtop that do the same work.”

Tool-grinding options cover a wide range of sharpening needs. “We have sharpeners for shops that need to handle 20 drills a week all the way up to thousands of
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drills a week,” said Jim Wiltrout, operations and engineering manager for drill grinder manufacturer Darex LLC, Ashland, Ore.

To reduce the cost of its light- and intermittent-duty sharpeners, Darex installs some nylon parts in the units’ drill-holding chucks. Sharpeners with these nylon parts offer good value to small machine shops that need to sharpen five to 50 drills a week, according to Matthew Prell, Darex’s industrial sales lead.

However, heat generated by continuous sharpening may eventually deform nylon parts, adversely affecting the results of the process. So for shops that are constantly sharpening tools, Prell recommends a continuous-duty sharpener with all stainless parts.

Darex’s light-duty manual sharpeners start at about $1,500. At the other end of the spectrum are the company’s fully automated, 4-axis CNC drill sharpeners for high-volume applications. Starting at $33,000, these machines allow operators to enter desired tool attributes, such as web thickness, relief angle and facet overlap. Prell said, “All the user has to do is chuck the drill in, select the program and hit a button, and the sharpener will do everything from alignment to grinding and honing.”

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current going to the motor, these CNC machines can tell when a drill has reached maximum sharpness, according to Prell. The machines can complete the sharpening process in as little as a minute, Wiltrout said, adding that “our precision is usually beyond what the [tool] manufacturer offers.”

How often do tools need to be sharpened? According to Cuttermasters’ Toycen, the answer depends on a number of factors, including the workpiece material, tool substrate, machining parameters for the tool and whether or not coolant is being used in the machining process. Generally speaking, however, “I would say that in the average shop with 10 to 20 machines, you could keep somebody busy all day sharpening drills and endmills, if you were doing it right,” he said.

As for the results of the process, “with the new machines, you don’t have to measure anything,” Toycen said. “They are accurate enough that if you run them through their steps, the tool that comes out should look and feel sharp.”

For the most part, Toycen said, drill grinders cost about $500 for smaller drill diameters to $2,500 for larger ones. The latest models eliminate the need to buy expensive drills for specific jobs. Instead, shop personnel can simply get a drill from the toolroom and put the required tip on it. “By taking control of the tip of the tool, you can use the drills you have in stock,” he said. Top-notch drill sharpeners can produce tip angles from 90° to 140° and offer excellent repeatability, according to Toycen. What’s more, getting the desired results is fast and easy.
SWISS SMARTS

By Kip Hanson

The first look at a Swiss-style CNC lathe, with its multiple slides, spindles and turrets, will have even experienced machinists scrambling for the instruction manual. For those new to machining, the complexity of Swiss lathes may leave them rethinking their careers. Fortunately, a variety of training options exist to quickly get operators and programmers up to speed.

One is the Advanced Machining Swiss program at Chippewa Valley Technical College (CVTC), Eau Claire, Wis. Machine tool instructor Dave Thompson said the program is three semesters—48 weeks—long, with 6 hours of instruction per week. Graduates receive nine credits and a certificate.

The first semester, Swiss 1, covers basic machine...
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<table>
<thead>
<tr>
<th>Machine specifications</th>
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<tbody>
<tr>
<td>Max. machining diameter</td>
<td>GB: 12.6”/1 chuck</td>
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<tr>
<td></td>
<td>NGB: 2.95”/1 chuck</td>
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<td>Max. machining length</td>
<td>8,000 rpm</td>
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<td>Max. back spindle speed</td>
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concepts and operations like tool setting and offset entry. Swiss 2 prepares the operator for programming with G and M codes, and program optimization. The final semester, Swiss 3, teaches students how to use CAD/CAM in a Swiss environment. Thompson said students in the school’s 2-year machine tooling techniques program learn some of these skills. However, the Swiss-certificate program is for two groups: Those who have graduated with a machining degree and want additional education on Swiss technology, and experienced machinists looking to add to their skill set. Like most vocational-technical schools, CVTC offers placement help to students.

“Here in Wisconsin, there are seven jobs available for every graduate,” he said. “There’s a definite need for qualified machinists.”

Head west across the St. Croix River and you’ll find a similar program at the Hennepin Technical College (HTC), Brooklyn Park, Minn. Students pursuing a 2-year machine technology degree must attend the 6-week introduction-to-Swiss-machining course. They can then continue into advanced operation and programming, which would give them a total of 192 hours of dedicated Swiss instruction. According to faculty member Bruce Ellingson, a number of area machine shops send their employees for this training, and the class is generally filled to its 14-student capacity.

It’s important to achieve “muscle memory” when learning to operate a Swiss machine, Ellingson said. Students, therefore, set up and program nine different parts during the course and program and set up their final project for the programming part of the course. They are

About the Author

Kip Hanson is a contributing editor for CTE. Contact him at (520) 548-7328 or khanson@jwr.com.
encouraged to use flash cards to become familiar with and, in some cases, memorize the large number of complex G and M codes for Swiss machines. “Probably the biggest thing students struggle with is G50, or work coordinate setting,” he said. “It can be tough to understand how that works, especially when you throw in absolute vs. incremental coordinates.”

As president of Diligence Inc., a machine shop in Maple Grove, Minn., Ellingson understands the need for well-trained employees. During his manufacturing career, he learned first-hand how underutilized many Swiss machines are because of inadequate operator training. “Quite often, you find shops programming these machines as they would a conventional CNC lathe, performing one operation at a time,” he said. “They’re capable of so much more.”

Part of the curricula at HTC comes from Tooling U-SME, which offers a series of online training programs, ranging from blueprint reading to metallurgy, through its website. Chad Schron, senior director of Tooling U-SME, said online classes are often used to augment traditional training programs. They educate visitors on machine theory, tooling concepts, mathematics, programming and the various operations that can be performed on Swiss lathes, while leaving the hands-on aspects of education to brick-and-mortar counterparts.

In addition to online programs, Tooling U-SME offers instructor-led classes, either on-site or via virtual presentations.

“The skills gap in the U.S. continues to be a big problem,” Schron said. “For example, we spoke with a large manufacturing company just recently that will soon be losing close to 75 percent of its workforce due to retirement.”

He added that attendance in Tooling U-SME is up. “There’s huge demand today for trained individuals,” Schron said.

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Setup reduction should be the goal of any machine shop. The need to reduce setup time is acute, especially for low-volume, high-variety work. For long production runs, the costs for tooling, setup and overhead are amortized over a large quantity of parts, making those jobs more palatable while keeping part costs low.

To reduce setup—as well as overhead costs—in a job-shop environment, first examine the workholding methods. For example, it is fairly common for shops to machine disc-shaped parts such as flanges, rings and spacers that have a narrow area for workholding.

One setup-reduction method involves making a chuck backing plate. This plate fits between the moving jaws of the chuck and supports the part parallel to the chuck face. A chuck backing plate is simple to fabricate for use with all available chucks. It comes in handy for those one-off or small-volume, thin-disc parts that can be challenging to hold. Chuck backing plates are quicker to set up than commercial soft jaws and are reusable for a long time.

The chuck backing plate allows you to position the disc or flange close to the end of the chuck jaws and to provide a stable Z datum.

Figure 1. The chuck backing plate allows you to position the disc or flange close to the end of the chuck jaws and to provide a stable Z datum.

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you to position a disc or flange close to the end of the chuck jaws and to provide a stable Z datum from which to work (Figure 1). This basic style of backing plate covers a range of diameters and is fully adjustable. You can machine against the solid thrust surface it provides. Its utility is in the simplicity of its construction and speed of setup. Four screws adjusted near the outer rim of the plate set the distance, which is measured with a caliper or height gage.

The backing plate works well, but there is an even better method: adjustable backing stops. These stops require a higher initial investment to fabricate, but they are worth the extra cost and trouble. Traditionally, they would be built when the workload was slow and the shop was being upgraded. Designing and building a set of adjustable backing stops is an excellent project for machinists and apprentices early in their careers.

Figure 2 shows a set of adjustable backing supports for a 4-jaw chuck. I had been looking at the radial slots for a while, wondering how I might make use of them. During the winter holidays, I had some time between projects to make some workholding upgrades. These stops are the kind of setup-reduction tools that allow seamlessly moving from one job to the next without any heroic or sketchy workholding setups. Existing radial slots in the chuck are used to mount the adjustable stops. Luckily, the 4-jaw chuck has some existing slots for radially adjusting the bars. These can easily be exchanged for a slot in the bar and a pair of tapped holes in the chuck face. Some chucks already have those tapped holes, which can be

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Adjusting the individual stops is a simple matter of adjusting the radial position to suit the workpiece being held, then indicating the faces of the stop bolts to the same Z-axis position. I face the contact surface of the fine thread fasteners to provide a nice, smooth backing surface that I can indicate. The side-locking screw clamps the backing bolt and prevents it from moving during use. In practice, I leave these clamp screws snug so the backing bolt doesn’t move but still allows me to make adjustments with a wrench while indicating.

These radial backing stops have important advantages when compared to the plate method. First, they have a through-hole, thereby making rings a cinch (Figure 3). The second advantage is, because you are adjusting each point, you can easily and precisely establish a plane perpendicular to the spindle axis. With the plate method, you are stuck with whatever the overall flatness of the plate happens to be.

Unlike pie or soft jaws, there are no spaces or recesses where chips can hide and throw the part off. Furthermore, the radial backing stops are much faster to set up. This system works equally well with manual and power chucks.

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**About the Author**

Tom Lipton is a career metalworker from Alamo, Calif., who has worked at a variety of job shops. For more information, visit his blog at oxtool.blogspot.com and his video channel at www.youtube.com/user/oxtoolco.

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**Figure 3.** Compared to the plate method, these radial backing stops have a clear through-hole, thereby making rings a cinch.
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Dear Doc: I cylindrical-grind steel shafts. Over the years, the surface-finish and tolerance requirements have been getting tighter and tighter. Tolerances are currently ±0.0001". I can hold the finish, but roundness and size are killing me. What can I do?

The Doc Replies: Holding those requirements is very doable, but only if you have all your ducks in a row. Let’s look at these ducks one by one.

Duck 1: Use the right grit size. Finer surface finishes require smaller grits. As surfaces get smoother, operators should switch to finer grits. But typically they don’t. Instead, they stick with their big grits—say, 60 instead of 120 mesh—and then dress the wheel dull. This approach results in a finer finish. However, it also creates a large tangential force (the force that resists rotation of the wheel, which is proportional to heat generation), causing burn, and much larger normal forces (the forces that pushes up on the spindle), causing part deflection and burn.

Duck 2: Avoid integer values during finishing and sparkout. Divide the wheel rpm by the workpiece rpm. Your answer should be something like 8.4523421 or 11.3962452. You want to avoid 8.00434, 11.003515 or anything close to a whole number.

Duck 3: Avoid hydroplaning. Here things get tricky. During grinding, you want effective cooling. But effective cooling creates hydroplaning forces, which can be as high as 50 lbs./in. of wheel width. During sparkout, that hydroplaning force is much bigger than the grinding force, causing both roundness and size issues. The solution is to gradually throttle back coolant pressure during finishing and sparkout. For tight tolerances, reducing hydroplaning forces helps enormously.

Duck 4: Chill your coolant, not because it helps suck away heat (the difference is minimal), but because hot things like to expand. If the workpiece temperature is 90°F in the machine because the coolant is 90°F, and then the workpiece is sent to the inspection room, which is 70°F, it will shrink. Keep the coolant temperature and inspection room temperature the same.

You’ll have to get these four ducks in a row if you hope to hold tight tolerances.

About the Author
Dr. Jeffrey Badger is an independent grinding consultant. For more information, visit www.TheGrindingDoc.com. He will be giving his High Intensity Grinding Course in Cleveland May 1 to 3 and in Sheffield, England, May 30 to June 1.
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Eight machining centers steadily crank out parts in a former bearings factory that, today, is home to MTU America Inc. When the company moved its manufacturing operations from Detroit to the factory in Graniteville, S.C., in 2010, the area now occupied by MTU’s machining department had a dirt floor.

“We gutted it completely and put in all new infrastructure,” said Jeremy Diebel, senior manager of machining and apprenticeship coordinator for MTU.

The 320,000-sq.-ft. facility houses the only North American machine shop operated by MTU—the Friedrichshafen, Germany-headquartered manufacturer of diesel and other engines for off-road and stationary applications, such as mining equipment, tanks and standby power sources.

Because North America is one of MTU’s largest markets, Diebel said, the company wanted to have a manufacturing presence on the continent and brought production of “high-running” parts to the U.S. He considers a part to be high running if it requires at least 100 machine hours per year.

MTU America initially made only the same parts for the same engine models that MTU Friedrichshafen GmbH did. About 2 years ago, however, the South Carolina plant began producing some parts that were not made in Germany, Diebel said. From product concept to delivery consumes about 10 months, but one project had a 4-month timeframe—“and we did it.”

Highs and Lows

The low-volume, high-complexity parts that MTU machines are primarily made of cast iron. Most castings come from Europe. The low volume creates a challenge when a manufacturing change is required, Diebel pointed out. In a high-volume application, the response to a change is almost immediate—parts are produced in rapid-fire succession and a manufacturer

About the Author

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can quickly determine whether a part is good or bad after a change occurs.

In contrast, the cycle time for, say, a power take-off unit at MTU is 3 hours, followed by up to 3 hours more for the part to be washed and then inspected on a coordinate measuring machine. That means up to 6 hours pass before the change is determined to be successful or not.

“As lean as we are, with one-piece flow in sequential production, there are some parts where, if we make a small change, we may be on a totally different part number by the time we get a response from the CMM lab,” Diebel said. “That adds complexity because now the fixture is off the machine or the tooling was changed. We have variables that weren’t there before.”

Diebel said the alternative, which occurs when a change is critical enough, is to run one part, stop production and wait for the CMM results. But with
the company’s focus on achieving just-in-time deliveries, MTU tries to avoid taking that route as much as possible.

Cutting tool changes are sometimes made to achieve the company’s annual goal of reducing standard machining times by 3.5 percent, Diebel said. “Last year, a very large percentage of that 3.5 percent was from one change, going from a gundrill to a carbide-tipped drill,” he said, adding that the switch reduced a 14-minute cycle by about 2 minutes.

In another switch, he noted MTU cut multiple minutes out of a cycle time with a new milling cutter. “That thing screams,” Diebel said. “We are always looking for new technologies.”

When considering a new cutting tool, MTU first discusses a specific part feature it is targeting with a manufacturer or OEM, explained Darrell Miller, manufacturing engineer at MTU. The sales and application engineer then recommends a tool that best matches the application, based on its geometry and recommended machining parameters. Next, MTU schedules a date to test the tool by cutting the targeted part feature in one of its machining centers and checking the part with a CMM.

“We are always looking for new technologies.”

“If successful, we will run the tool till it wears out, which is determined when part dimensions cannot be held,” Miller said, adding that the life of the new tool is compared to the previous one.

Nonetheless, Diebel emphasized that those technologies must create capacity on MTU’s machine tools by significantly reducing cutting times rather than, say, cutting a 30-second tool-change time in half. “That’s not something we need. We have 30 seconds for a scheduled tool change outside the machine.”

Diebel added that the company’s cutting tool cost is about 1 percent of a part’s total cost, compared to an industry average of around 3 percent.

**Built on Lean**

A cultural transformation built on lean manufacturing principles has led to new growth opportunities at MTU America’s South Carolina plant, enabling workers to provide customers with the highest-quality product, on time and at the lowest cost, the company reports.
Diebel pointed out that producing the highest-quality product requires implementing a production system—the MTU Production System—that includes its guiding principle of having zero defects. This principle is essential because many of the engines MTU manufactures are in mission-critical applications, such as providing backup power for hospitals and rescue ships. “If somebody is in the operating room and the power were to go out, the engine needs to go to rated power within a few seconds and start feeding into the grid,” he said. “There is once, Miller said, adding that relapped or rebrazed inserts run at the same machining parameters as new ones. “MTU has an interest in new technologies, so we are excited to participate in this project,” he said.

—A. Richter

Parts manufacturers typically recycle or simply discard their indexable inserts. But that’s not the case with MTU America. The company’s Darrell Miller said MTU began refurbishing PCD- and PCBN-tipped inserts after North American Carbide indicated that refurbishing reduces tool costs.

One process involves grinding an insert’s brazed tip to remove wear and another involves resetting, or rebrazing, the tip. Robert Gralke, president of North American Carbide, Orchard Park, N.Y., explained that grinding is performed with a 1,200-grit wheel. “Because the wheel is so fine, some consider it lapping,” he said.

Compared to a new insert, Miller said lapping reduces the cost of an insert at MTU by 20 to 25 percent, while resetting saves 5 percent.

North American Carbide, which determines when an insert can be refurbished, primarily resets the tips via vacuum brazing, which provides a stronger braze between the superhard material and the carbide substrate than induction brazing, according to Gralke. He added that the company also performs some induction brazing.

Vacuum brazing is performed in a reactor using a special gas, so there is no atmosphere present, Gralke explained.

This prevents heat from damaging the carbide and its cobalt binder. “We’ve retipped carbide inserts up to 15 times, in tests, to prove we haven’t deteriorated or embrittled the material.”

To date, MTU has not applied an insert that has been refurbished more than

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According to the company, the backbone of the MTU Production System consists of standard lean tools and concepts. It is bolstered by visual triggers, a standard problem-solving technique and a coaching routine that promotes development of thinking skills.

Diebel said one such lean tool that MTU America employs is “kata,” which is based on a Japanese system of repetitive movement. In an industrial production environment, a coach uses the tool to ask questions and develop employees in a way that optimizes their brainpower. The coach takes deliberate steps, via the questioning process, to allow employees to work through the process, creating a series of “ah-ha” moments until they reach the goal, or North Star. The coach might ask about defining the challenge and current and target conditions, the obstacles that are preventing an employee from reaching the target condition and the expected next step in the process. Ultimately, this process helps employees solve problems themselves instead of simply receiving directions from a supervisor.

“Kata creates muscle memory, where the brain is the muscle,” Diebel said.

Continuous improvement at MTU also involves questioning whether a production deviation should be accepted as a new production standard. It is, if the deviation proves to be beneficial and sustainable.

In addition to being MTU America’s senior manager of machining, Jeremy Diebel is also the company’s apprenticeship coordinator.
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For example, Diebel said an end-of-the-day goal is to have one day's worth of inventory ready for the assembly line, which equals about 52 to 56 cylinder heads. However, at one point this year, there was no inventory for about a week, and there were no negative consequences. Jöerg Klisch, vice president of North American operations at MTU America, wondered why the goal shouldn't be zero and be extremely just-in-time instead.

“That’s his way of challenging and pushing us,” Diebel said. “What I see as a negative, he sees as a positive: we have less inventory.”

A German Flavor

In 2012, MTU America launched its apprenticeship program, modeled after an approach to European vocational training, including the apprenticeship program its German parent company has successfully employed for more than 30 years. The program enables high school students to develop work skills sought by...
MTU, and other employers, while earning money. Diebel said graduation from the program requires students to complete 600 hours of classroom training at the Aiken County (S.C.) Career and Technology Center and 1,000 hours of paid work at MTU’s machine shop.

MTU reports that the process begins with teachers at Aiken County high schools nominating sophomores, with six selected each year based on math assessments and interviews. In 2016, 28 students applied for the six positions. As high school juniors, students work 2 days at MTU, attend classes at their high school half a day 3 days a week and attend classes at the technology center the other half days. Apprentices work full-time at the plant during the summer. As seniors, the schedule is the same, but apprentices rotate through various MTU departments to increase their knowledge of the company’s operations.

Upon completion of the program, students are certified as basic industrial mechanics. Those who also successfully complete the optional final practical, written and oral exams receive certification as a skilled metalworker, which is recognized in both Germany and the U.S.

After the apprentices graduate from high school, MTU America does not guarantee or require employment at the company, but one graduate did work full-time for a couple of years at MTU before challenging himself by taking a position at another area manufacturer. Another works part-time while studying mechanical engineering at a local technical college, Diebel said. “We also started a second complementary program filled by two recent graduates of the youth program.”

He explained that MTU doesn’t put a high emphasis on selecting students who specifically want to pursue a career in manufacturing. Many are undecided at that age or want to earn a degree from a 4-year program.
The design of the knee mill goes back to 1936, when Rudolph Bannow’s company produced a knee-and-column vertical mill with a rotating turret and sliding-ram head. The mill became known by the company’s name—Bridgeport—which, like Kleenex, became the generic signifier for mills of similar design.

Eighty years is a good run for a single design. But now we often hear that the venerable knee mill’s time must be closing. Newer, multiple-axis CNC machines that can do much of what the knee mill can—and more—will fill its niche.

But that hasn’t happened—at least not yet. The knee mill remains popular with many manufacturers. Recently, one builder of knee

**THE KNEE MILL: STILL STANDING**

The venerable knee mill might have had its niche filled by more versatile CNC machines—but it remains popular. Why?

The design of the knee mill goes back to 1936, when Rudolph Bannow’s company produced a knee-and-column vertical mill with a rotating turret and sliding-ram head. The mill became known by the company’s name—Bridgeport—which, like Kleenex, became the generic signifier for mills of similar design.

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mills has even seen a noticeable uptick in sales. Why does the knee mill still stand tall?

**Simplicity and Speed**

Munn Manufacturing, Freeport, Mich., uses 12 CNC mills and 11 CNC lathes for complex tooling and production runs for aerospace, heavy truck, automotive and aftermarket work. Started in 1963, the company has sections for production machining, tooling and pipe bending. About 2 years ago, the company purchased two Clausing manual knee mills “for use on jigs, fixtures and the like,” said owner Steve Buehler.

“Sometimes it’s just easier to put a part into a knee mill, pop in a couple of holes or tap something, make a little cut in it and you’re done.” Buehler contrasted that with the longer work of programming those tasks on a CNC mill. “Sometimes the knee mills are just easier for us. That’s why we keep them here.”

Kevin Mungovan, president of Clausing Industrial Inc., Kalamazoo, Mich., thinks cost is an important reason why the knee mill remains popular. “Why pay more to drill a hole than you need to? You could put a 2-axis control on a knee mill, take the part off the $100,000-plus machining center and put it on a $30,000 knee mill. Let it do what it does well—drill the bolt pattern. Let that other machine do what it does best—make chips,” he said.

‘We’re seeing more applications where the knee mill provides support for a CNC machining center.’
“We’re seeing more applications where the knee mill provides support for a CNC machining center. Or it is used for a second operation.”

That’s in line with how Munn Manufacturing uses its knee mills, according to Buehler. “Suppose a run on a CNC machine is from 30 minutes to an hour,” he said. “While it’s going on, our machinist can make other parts on a knee mill—or on a manual lathe, if that’s what is needed—instead of trying to program the tasks into a CNC mill or lathe.

“It’s absolutely easier,” Buehler added. “You don’t have to write code or set up tools on the CNC mill. With the knee mill’s collet, you can just put in a drill or tap or endmill. We get the throughput we’re looking for.”

This fits with what George Young, sales manager for knee-mill builder Kent Industrial USA Inc., Tustin, Calif., sees in the industry. He said manual knee mills “are still popular in most toolrooms, most machinists are familiar with them,” finding them much faster and easier than a “full-blown” CNC machining center for setting up and machining simple parts.

Kent has provided many multiple-machine installations for large companies, such as Plantronics, Gulfstream Aerospace, Honeywell, Schneider Electric and Magna, in addition to selling knee mills to many small- and medium-size job shops.

Kent makes a CNC version of the knee mill, as do others. The Kent version features “an easy-to-use, conversational control that’s ideal for small shops learning or getting into CNC machining at a more affordable starting price,” Young said. “They are also handy for full CNC shops when doing a second operation, prototyping or quick, small-lot-quantity part runs.”

Another benefit for small shops: “Many of our models can also run on single-phase power, so they can be put into a ‘garage’ shop for someone who is just starting out,” Young said.

Wide Open Spaces
Young pointed to the traditional advantages of the knee mill’s design to explain its popularity. “The tiltable head, movable ram and

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It all began with the Bridgeport, back in 1936. This is the newest iteration of the Bridgeport Series 1, made by Hardinge.
turret make the machine versatile and allow for a flexible work envelope,” he noted. “Its ‘open’ nature means an operator has easy access for quicker setups.”

Dickinson Manufacturing Solutions, Madison, Wis., takes full advantage of that open design. The company, which works with materials from plastic to aluminum, steel and titanium, employs six machinists on a single shift who use eight Haas CNC machines and a Clausing manual knee mill, purchased in 2011.

“We do everything from work for engineering firms selling specialized equipment to the oil and gas industry,” including prototypes and small-lot first runs, said founder Keith Dickinson. “We do work for the biotech industry, repair work for local companies like DuPont and low-tech work, such as all of the tap handles for startup Wisconsin Brewing Co.”

The old-school, unenclosed design is a major source of the knee mill’s appeal.

“We were doing a lot of our larger flat-panel work, like cases for instrumentation, in our [Haas] VF3s and VF4s,” he explained. But the work envelopes of the CNCs were too small and the Z travel too short for the necessary end work. “A standard VF3 has 25” in Z—you have to fit the tool in there too. Anything over 25”, if you need a hole in the end of your workpiece, you’re out of luck. But on the Clausing, you can hang it off of the table and get the distance from the spindle nose to the floor to accommodate the length.” Dickinson raised the knee mill on 3”-high (76.2mm) aluminum blocks to get even more height.

The knee mill lets Dickinson use real cutting-tool engineering for another niche customer, who makes 40”-long (1,016mm) practice swords. The noncutting end of the shaft starts out square. “We made a fixture to hold the end, then backbore it to a round, tap it and thread it.” The handle screws on to that threaded end.

The University of Wisconsin Engine Research Center had engine
heads that needed a plug port opened. “If you had to fixture it in a CNC,” Dickinson said, “you’d spend at least a day on tooling. There’s $600 wasted. But you can put it up on the Clausing, tilt that head until you indicate onto a best-fit pin, and you’re lined up ready to open the hole.”

Occasionally, the company uses the knee mill for a secondary operation on a workpiece that first went into a Haas, Dickinson said. Usually, though, the knee mill is used on niche pieces that can’t be practically milled on a CNC.

It wouldn’t be worth buying a CNC with a large enough work area for some of those jobs,” Dickinson noted. “I can work on the end of a 50” plate with the knee mill. I don’t know what size machine you’d need to get 50” of travel in Z, but it would be huge. It wouldn’t make sense to buy a machine for a single application—one we don’t see that often—if we didn’t have to.”

Lean on Me

Both Dickinson’s and Buehler’s thinking about using the simpler machine when possible makes economic sense. It is also a tenet of lean manufacturing, as first developed for the Toyota Production System, to stay as simple as possible. That means, among other things, to never buy more machine than necessary to do the job. The goal of lean is to eliminate waste in all its forms. Unused machine capacity that one has paid for is waste.

‘Sometimes it’s just easier to put a part into a knee mill, pop in a couple of holes or tap something, make a little cut in it and you’re done.’
Toyota itself follows the practice in regard to knee mills, according to Clausing’s Mungovan. “We have a knee mill with a CNC on it in a Toyota plant in Texas,” he reported. “It’s in their toolroom, just for making brackets and fixtures and repair parts. Everybody is expected to learn how to program it.”

According to what the Toyota machinists told Mungovan, before the knee mill was purchased, if they needed even a simple part or prototype, “somebody would draw it up, somebody would send the drawing to a machine shop, get a quote and wait for the part to come back.” Sometimes the process took 2 weeks. With the knee mill on hand, “if something’s down, they need a little prototype, or the engineer simply wants to try something, they go to the toolroom and get it done right away.”

**Teach Your Children**

The Bridgeport knee-mill line, now owned and made

Machinist Taylor Wardell checks a part on a Clausing knee mill at Dickinson Manufacturing Solutions.
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The Knee Mill: Still Standing

by Hardinge Inc., is still popular, said Hardinge Marketing Manager Allan Snider. “Manufacturers buy Bridgeports for the same reason someone buys a Harley,” he said. “It’s an iconic brand known for quality. Our customers’ brand loyalty is vast.”

‘Versatility is the first term that comes to mind when thinking of a knee mill.’

Mike Marshall, manager of customer support services – North America, said small job shops make up the highest percentage of Hardinge’s knee-mill customers. “Coming a close second would be OEMs purchasing them for their maintenance departments,” he added.

What accounts for the Bridgeport’s appeal over CNC options? “Versatility is the first term that comes to mind when thinking of a knee mill,” Marshall said.

The second is ease of use. That quality explains why—at least for Clausing—sales have not only held steady but actually increased: The knee mill is both easy to use and easy to teach. With the growing skills gap between retiring shop veterans and the new generation of workers who need training to replace them, the knee mill is a great starting point.

The Clausing Model 3VS knee mill is popular with educators for its ease of use.

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Clausing sponsored a national skills competition for years. By the early 2000s, though, fewer schools were participating. “One of the program heads told me that a lot of high schools were getting rid of their machine shops because of the cost of materials and liability issues,” Mungovan said. An Oklahoma vocational school teacher told him the school’s board wanted to replace manufacturing education with construction skills.

Mungovan believes some schools that dropped their machine shops are recognizing the value of good manufacturing jobs—and getting back in the game. A common early purchase is a knee mill. Mungovan has sold many to community colleges and trade schools, and also to secondary-education systems—even the military. Aside from their use in MRO, Shepherds Air Force Base invested in new machines from Clausing because, he was told, they weren’t getting recruits with any machining in high school and were having the same problem as private companies finding skilled people.

For all of these reasons, the knee mill’s near-term future seems assured. Still, multiple-axis CNC machines keep getting better. Their makers promise the day is coming when they can be programmed and tooled fast enough to replace the need for a separate knee mill.

Munn Manufacturing’s Buehler isn’t convinced. “Maybe it depends on what industry you’re working for,” he said. “In terms of the work we do, I’d say, no. There will always be times when we need a conventional knee mill or lathe because it will be the simplest way for the kind of work we’re getting from our customers.”

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Say the words “rapid prototyping” and most people think of 3D printing. But until recently, most prototyping was performed by skilled machinists who cranked the handles on knee mills and engine lathes to make parts far more quickly than was possible with cam-driven and, subsequently, CNC production machines.

That decades-old paradigm has begun to shift. Machine tool builders, tool suppliers and software developers now deliver technology that makes it possible for CNC operators to set up jobs in minutes rather than hours, and deliver parts in days instead of weeks.

**Pieces of the Puzzle**

Jeff Estes, director of Partners in THINC Technology Centers for Okuma America Corp., Charlotte, N.C., said numerous technologies are needed for machining-related rapid prototyping, including quick-change tooling and workholding, smart software systems and offline tool presetting, as well as a flexible machine tool and CNC.

“You have to look at all the pieces,” he said. “It’s about doing whatever you can to save time.”

Some shops use 5-axis mills or multifunction lathes to achieve that. Estes noted, however, that shops with even basic equipment can take several easy steps to improve throughput. One is cataloging cutting tools...
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into groupings able to perform various types of work. “When you’re making one of this or three of that, you can’t afford tool changeovers,” Estes said. “You want to find the commonalities among all the tools resident in your turrets or carousels, standardizing wherever possible and organizing the work for your machines based on what kind of tools they carry. This helps minimize those that need changing.”

Estes added that this grouping comes naturally to machinists, who mentally keep track of what tools are in which lathe or machining center and set up jobs accordingly. The key is documenting what’s in everyone’s head, collecting tool types, drawings and dimensions, and then placing all this information into a central location for everyone to see. This documentation is especially important as older generations of machinists retire and new employees take their place.

In some cases, standardizing the tool set means using a cutting tool that is less than optimal. This is a big no-no in a production environment, but it certainly reduces setup time when prototyping. “If it takes you 10 minutes to change a tool and set the offset, who cares if it takes 30 seconds longer to machine the part using the existing tool?” Estes asked. “You’re saving 9½ minutes of changeover during the setup. That’s what people need to think about.”

Push the Button

Workholding is something else to think about. “For job shops and production manufacturers alike, rapid prototyping requires the ability to load a workholding device and get a part in the machine as fast as possible,” Estes said. “This is where automation and tooling come together, and where we can leverage our experience in aerospace and defense.”

Rapid Rules

Conversational controls make machine operation more efficient while reducing setup times, both of which are important factors for anyone doing prototype work.
in the machine without having to probe its position or set a work offset, and have confidence it will be within two-tenths (0.0002”) of where it was the last time you used it,” said Brad Evans, workholding product manager at Schunk Inc., Morrisville, N.C. “You should be able to drop a fixture, vise or rotary table on the machine and hit ‘cycle start.’

Many shops without a quick-change capability toe-clamp their indexers or 6” machinist’s vises on the machine table, leaving them there indefinitely. They know moving them is not worth the hassle. Leaving them in place, however, not only consumes valuable working space, it also reduces flexibility. Then when these shops have to change over, several hours are lost in the process.

Evans suggests modular workholding as an alternative, one where quick-change receivers are bolted to the table, dialed in one time, and then used as datum points for whatever pallets, vises or workholding fixtures are required.

Worried about the cost? Don’t be. Reducing downtime by even a few hours a week brings a quick return on workholding investment—often measured in months—and provides opportunities that didn’t exist previously. “I recently worked with a shop in Wisconsin that implemented our VERO-S system,” Evans said. “His best customer called with a rush order for a part he needed that same day. Normally, this order would have been a problem, but because the shop could change over in a few minutes, they were able to break into an existing setup and run the job in a few hours. By the time the driver left with the new part, the shop was back making chips on the previous job. The customer was happy, the shop received a nice premium for the rush order and did it without disrupting the production schedule.”

Get Modular
Along with toolholding, modularity offers the flexibility shops need if they’re to compete in the rapid-prototyping realm.

“The time savings and convenience can have a huge impact on productivity, especially with prototype work, where every minute counts.’

Success with rapid prototyping benefits from modularity,” said Tom Raun, milling product
manager at Iscar Metals Inc., Arlington, Texas. “The first thing that comes to mind is the toolholder, where quick-change adapters have long offered big setup-time savings. But there’s also the cutting tool itself to consider. The ability to customize the tool in terms of reach, type of application and type of shank is a huge benefit for rapid prototyping.”

Examples include the need to quickly switch from a longer tool to one that’s shorter and load a tool with a reduced shank diameter to clear a vertical wall, he added.

Shops specializing in one-off and low-volume work never know from one day to the next what customers are going to order. Because of this, Raun recommends a cutting tool system like Iscar’s Multi-Master, Iscar’s Multi-Master system is modular in nature, making it easy to switch cutting tools as needed for various machining conditions.
which offers more than 40,000 combinations on a single platform. This allows manufacturers to quickly change to a variety of heads that encompass all types of milling applications. The heads are made of carbide or steel and can be used on steel, carbide or heavy-metal shanks. Repeatability should be better than ±0.0004” (0.0102mm).

“The Multi-Master system uses a screw-on head,” he said, “which allows tool replacement in seconds, even in tight quarters or where tools are difficult to reach—on Swiss-style lathes, for example, or a 90° head on a machining center. The time savings and convenience can have a huge impact on productivity, especially with prototype work, where every minute counts.”

Go Offline

Dr. Gregg Bigleman is the tool management solutions (TMS) manager at Zoller Inc., Ann Arbor, Mich. He said operational organization, which is crucial to quick turnaround and profitable prototyping, starts with a centralized database of tool information. The company offers such a database, separately or as part of its offline tool setting and measurement systems. According to Bigleman, Zoller’s database eliminates the silos of information common in many shops.

“Everyone ends up with their own spreadsheets or individual software systems,” Bigleman said. “This results in duplication of data and increases the chances for error. It also means that, when an order comes in, the person responsible for preparing the job has to walk out on the shop floor to see what inventory is available. He’ll check with the tool crib and, perhaps, the machine operators to see if they have the gages, tool holders, inserts and fixtures needed to run the part, and then he can start developing the process. All these steps take a lot of time—something you especially can’t afford with prototype or low-quantity work.”

Having one database for tool and machining information is like conducting an orchestra where everyone’s playing from the same sheet of music, Bigleman said. Better yet, it provides an easy way to connect with external systems such as MachiningCloud (an independent aggregator of cutting tool data),

‘One of the first things that has to be done on any job is verifying how it will fit in the machine tool.’
speeds access to tool data and increases programming efficiency.

Those concerned about the effort needed for a plant-wide TMS implementation needn’t fear. “Zoller TMS is modular,” he said. “You can start small and add to it as needed. You never lose what you build on. The database—which is the same one the presetter uses—can also be used for cutting tool inventory, for fixture and gage management, and for the shop floor itself. You can see what jobs and tooling are in the machines. We also have a module for production planning. TMS allows you to minimize changeover time and make the most efficient use of resources.”

Redefining Throughput

The CAM system is another important element to increase prototype throughput. Don Davies, vice president of Americas for Camarillo, Calif.-based DP Technology Corp., the makers of ESPRIT CAM software, agreed that setup-time reduction is an important first step for any prototyping shop. He noted, however, the activities that take place prior to machine setup are just as important.

“One of the first things that has to be done on any job is verifying how it will fit in the machine tool,” Davies said. “That means pulling all the cutting tools, fixtures, clamps, chucks, vises—everything needed to machine a part—into a virtual environment and checking to see how they function. The more complex the machine, the more valuable this exercise becomes, but it’s a necessary step for any shop looking to increase efficiency on the shop floor.”

The CAM system is an important part of the equation, Davies said, but users also need the digital data to support this virtualization, something manufacturers and their suppliers have traditionally struggled with. That’s beginning to change as more companies embrace 3D modeling of their wares. Shops can view the machining process in a virtual world before pushing any buttons in the physical one.

One final consideration is automation. This doesn’t mean robotics and pallet changers, although these certainly have their place in some prototyping shops, but, rather, software automation. To Davies, software automation provides the ability to write specialized routines and macros that help eliminate much of the manual effort behind toolpath programming and simplify the “art to part” process.

“Some CAM systems provide an application programming interface, or API, that allow you to develop customized functionality,” he said.

Davies offered an example of a manufacturer in Minnesota that has automated roughly 80 percent of its toolpath generation using the APIs available in the ESPRIT system. Upon receiving an order, a clerk enters various part criteria, whereupon the system generates the machine code and decides what tools are needed to run the job.

“If I were to start a machine shop today, I’d hire people with the skills needed to understand manufacturing—speeds, feeds, tooling and what not—but also make sure they have knowledge of software programming,” Davies said. “That’s where our industry is headed.”

contributors

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Drilling, reaming and boring are the basic holemaking operations of machining. In simple terms, drilling creates a hole in a workpiece where there was no existing hole. Reaming and boring accurately enlarge holes that already exist.

Boring operations on turning machines are generally less complicated than boring operations on milling machines. With lathes, the boring tool is moved incrementally by the machine whereas with mills, the boring tool (boring head) must be adjusted to achieve the desired hole size. In theory, boring tools for turning can make any size hole as long as the bar will fit into the hole. Boring heads for milling machines, however, are limited to a specific range.

**The Basic Boring Bar**

Found in every machine shop, basic boring bars that accept carbide inserts work well in most applications and are economical. Unlike drills or reamers, single-edge boring bars have a single point of contact with the workpiece. As a result, the bar is unsupported, which sometimes leads to vibration, or chatter. Problems with chatter are the only significant drawback to these cutting tools.

Steel bars tend to chatter once the axial DOC exceeds 4 diameters deep. So, an end user would likely experience chatter on a 1"-dia. (25.4mm) bar if it protrudes from the turret by more than 4" (101.6mm). A machinist would say it has too much “stick-out.”

**Chatter Away**

Chatter during boring operations on a lathe can be overcome. The easiest way is to apply a larger-diameter boring bar. However, a larger bar is not always an option and other means would be necessary.

Sometimes the solution is as simple as working with cutting speeds and chip loads to alter the cutting pressure on the tool. It is possible to increase tool pressure by increasing the feed rate, decreasing the cutting speed or doing both at the same time. Changing the radial DOC will also put more pressure on the tool. Sometimes users must adjust all of these variables to achieve success.

Because of their lower cost, steel boring bars are the most common, but other materials are also available. For example, cutting tool manufacturers have developed heavy-metal and carbide bars to fight chatter. Heavy-metal bars are made from tungsten alloys, which are denser than steel. These alloys work to damp

**About the Author**

Christopher Tate is operations manager of the combustion shop for Mitsubishi Hitachi Power Systems Americas, Savannah (Ga.) Machinery Works. Email: chris23tate@gmail.com.
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vibration. Although heavy-metal bars are more expensive than steel ones, they can be applied at higher length-to-diameter ratios. Whereas steel allows a 4:1 ratio, heavy-metal bars can boost the ratio into the 6:1 or higher range with some speed-and-feed tuning.

Tungsten-carbide bars provide even higher depth-to-diameter ratios. Carbide bars are made by brazing a steel head that is machined to accept an insert onto a carbide bar. Carbide is extremely dense. It provides superior damping, allowing length-to-diameter ratios in the 8:1 or higher range.

Carbide bars above 1" in diameter are not practical because of the expense. In situations where carbide would be cost-prohibitive, a tunable bar may be warranted. As the name implies, these bars have an adjustment feature that enables a user to tune the bar to a specific application. An internal mechanism alters the natural frequency of the bar, preventing chatter and allowing very large length-to-diameter ratios. Some tool manufacturers have reported the ability to make cuts at 20:1.

Boring and Mills

Unlike the boring bar for a lathe, the tool used on a mill must be adjustable to achieve the correct size. Boring holes on a milling machine requires the use of an adjustable boring head, which adds complexity to the setup.

The most commonly used boring heads shift the boring bar closer to or farther away from the axis of the hole to achieve the desired hole diameter. These boring heads are inexpensive. Users can bore a large range of hole sizes with these heads because the boring bar can be mounted in several different positions.

Boring heads are typically associated with conventional milling machines, but they can be used on CNC machines.

You can engage more than one cutting edge when boring on a mill, unlike a lathe. Some boring heads are used frequently in high-production environments. Twin boring
heads are set up one of two ways. In the first way, each cutting edge is set to the same diameter, allowing a fast feed rate. With the second method, the cutting edges are set on two different diameters, thereby removing more material per pass.

Finishing Touches
Twin-style heads are best-suited for roughing because they are not easily adjusted for those times that small incremental changes to the boring diameter are necessary. When finishing, it is better to select a finish-boring head to make those small adjustments to the diameter. Finishing tight-tolerance holes often requires special boring tools that can be accurately adjusted in small increments. These boring heads are often referred to as fine boring heads—some can be accurately adjusted in increments as small as 0.0001” (0.0025mm). Fine boring heads come in several styles. Some utilize basic round boring bars and others utilize special insert holders. They are expensive and are typically reserved for boring holes with diametric tolerances less than 0.001” (0.025mm).

Boring operations and tools require machinists to pay as strict attention to details as other processes and cutting tools. Although many factors influence whether a boring operation is successful or not, adhering to the following rules will help ensure the desired results:

- Keep the workpiece materials well supported.
- Minimize unsupported tool length.
- Use the largest-diameter tool possible.
- Fight chatter by adjusting tool pressure before investing in more-expensive technology.

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Scientific Cutting Tools
There’s a variety of ways to finish sharp edges between two faces of a part. Hand finishing and vibratory tumbling are two options, but they can be inconsistent and ineffective. Chamfering tools can provide a transitional edge at 90° angles, and also be used for deburring. For some contract manufacturers, however, eliminating the chamfering step proves valuable when deburring.

That has been the case for Zodiac Engineering, a contract manufacturer in Orange, Calif. It typically applies a 90° solid-carbide chamfering tool when there is a specified edge-break size or angle callout, said company owner Ken Spaulding. But when he just needs to deburr the edges, chamfering tools add programming and machining time. They must be either reground or replaced when worn.

In addition, Spaulding wanted a tool that could effectively smooth feed lines on the knife blades that Zodiac manufactures.

Spaulding viewed some videos online that showed NamPower abrasive nylon disc brushes from Brush Research Manufacturing Co. Inc., Los Angeles. Spaulding then purchased a 60mm-dia. (2.36") Dot-style brush.

The brush proved to be effective, and Spaulding added to his tool library 60mm- and 100mm-dia. (3.94") Dot-style brushes with a variety of grit sizes, including 320, 180, 120 and 80. “With a little trial and error, I figured out which brush works the best for me for different applications,” he said.

“I run our abrasive nylon brushes over any fairly flat part I have going in the mill,” he added. “I don’t want to use a chamfer tool for edge breaking or deburring if it’s not necessary.”

The disc brushes, which are composed of flexible nylon filaments bonded to a fiber-reinforced thermoplastic base, incorporate a combination of ceramic and silicon-carbide abrasives.

The abrasive filaments work like flexible files, conforming to part contours, wiping and filing across part edges and surfaces. They are suitable for a host of workpiece materials, including nonferrous metals, cast iron, mild steel, ductile iron, stainless and alloy steels, titanium and nickel-base superalloys.

Zodiac makes some aerospace parts and molds. The majority
of the company’s machining work, however, is producing pocketknives and components for BMX road and mountain bicycles. Spaulding sells products of his own design and performs contract manufacturing.

Spaulding applies the NamPower abrasive discs on his CNC and manual milling equipment for light deburring and surface finishing. For the pocketknives, the types of metals include stainless steel for blades and titanium and zirconium for frames and handles. For the bikes, the metals include 6061 aluminum for stems and 7000-series aluminum for sprockets.

“With the brushes, I get a very predictable and consistent edge break and surface finish,” Spaulding said. “I can do it in-line, and it is a lot more predictable and reliable than breaking edges by hand.”

He added that, as the brushes wear, the bristles fracture and expose new abrasives. This enables the tools to stay sharp.

For the cycle sprockets, for example, Spaulding runs the brushes over the teeth in a single pass on each side of the part. “The brushes deburr pretty much every side of the tooth, so I don’t have to run a chamfer tool around the edges. Also, tumbling doesn’t really get inside the teeth the way the brush does,” Spaulding explained.

Even when chamfer tools are specified, part edges may still require deburring.

“Chamfering tools are just half of the puzzle,” he said. “The other half is some sort of abrasive method, such as tumbling. However, tumbling can be impractical for larger parts or anything that needs to remain dimensionally unaffected.”

Instead, he finds that the abrasive nylon brushes are complementary not only to 45° chamfering tools,

The NamPower disc brushes are composed of flexible nylon filaments bonded to a fiber-reinforced thermoplastic base.

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**Brush Research Manufacturing**

The NamPower disc brushes are composed of flexible nylon filaments bonded to a fiber-reinforced thermoplastic base.
but also to chamfered holes.

According to Brush Research, the brushes are available in two fill configurations: The Dot style for general-purpose deburring and surface finishing, and the Turbine style, which has a higher-density fill, for more-aggressive deburring action.

In addition to 60mm and 100mm, 125mm and 150mm (4.92" and 5.90") diameters are available at trim lengths of 18mm or 38mm (0.709" and 1.496").

“With the different grits, diameters and trim lengths, the abrasive nylon brushes are extremely versatile, as long as you have a few different sizes and styles,” Spaulding said, adding that he applies only brushes with 18mm trim lengths.

Zodiac Engineering applies NamPower brushes to smooth feed lines on the pocketknife blades that it produces.

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PEOPLE

- Abtex Corp., Dresden, N.Y., hired Carolyn Ribble as purchasing agent for Abtex Systems Group and John Sherman as customer service representative for its deburring brushes and consumables.
- Machine tool builder BLM Group USA, Wixom, Minn., named Andrew Dodd North American sales director.
- Farmington Hills, Mich.-based machine tool builder EMAG LLC USA added Joseph Thompson and Steve Cox as regional sales managers and Mark Ashworth as national key-account manager. Thompson will represent Wisconsin and the Chicago metropolitan area; Cox will represent Arkansas, Mississippi, Tennessee, western Georgia and northwestern Florida; and Ashworth will represent eastern Michigan.

VOLLER DEMOS MACHINES DURING WORLD TOUR: The Vollmer Group recently hosted a series of “industry days” that showcased the German company’s machines for producing cutting tools. The world tour stopped in China, Europe and Myrtle Beach, S.C.

One reason Vollmer mounted the tour was to introduce its V Pulse 500 wire-erosion machine for manufacturing PCD-tipped cutting tools. A distinguishing feature of the 5-axis VPulse 500 is its rapid-pulsing generator. It reportedly allows higher material-removal rates and facilitates finer finishes than earlier generators.

Vollmer also demonstrated its VGrind 360 tool-and-cutter grinder. During an interview at the Myrtle Beach event, held Feb. 27 to March 1, Peter Allen, president of Vollmer of America Corp., Carnegie, Pa., said most tool grinders feature one spindle and a wheel changer or two spindles and no wheel changer. “We have two spindles and a wheel changer on the V360, which allows us to completely rotate in the center of the machine.” Having two vertical spindles with wheels set in

Vollmer of America President Peter Allen with the VGrind 360 tool-and-cutter grinder displayed during a company event held in Myrtle Beach, S.C.

the C-axis pivot point shortens linear-axis travels, thereby shortening processing times.

Vollmer started building tool-and-cutter grinders in 2013. “We’re new to the tool-and-cutter grinder industry, but we’ve got more than 100 years in the tool-grinding industry behind us,” said Allen. “We’re the leader in saw-blade-machine building.” In 1909, company founder Heinrich Vollmer developed the first saw setting and filing machines.

When asked what’s most important to today’s cutting tool users, Allen said “consistency. They want to run 24 hours a day, 7 days a week and get consistent results. They cannot afford to scrap parts, so it’s important that we have reliable, consistent machines that are going to give them the tooling they need.”

Allen—who has 30 years of industry experience, including 18 with Vollmer—expects tools to become more complex in the future. “People want to perform more than one application with one tool,” he noted. “I think tool geometries will become more complicated.”

Vollmer welcomed nearly 60 customers, prospects and industry partners to the South Carolina event. The partners exhibited their products and services, and a number gave technical presentations. Among the speakers were representatives from Haimer USA LLC, Rush Machinery Inc., Zoller Inc., Element Six, NUM AG, Ceratizit Group and Iljin Diamond, as well as CTE columnist Dr. Jeffrey Badger (Ask the Grinding Doc). —Don Nelson
GF Machining Solutions LLC named Martin Gorski head of sales for the western U.S. and Stephan Swanson head of sales in central U.S. The Lincolnshire, Ill., company provides machine tools and automation equipment. Waterjet manufacturer Jet Edge Inc., St. Michael, Minn., promoted Michael Wheeler to engineering manager. Stacey Schroeder was hired as workforce development director for the National Tooling and Machining Association. She will work with NTMA’s education team and support training needs for its members. Osborn named Scott Scheider product marketing manager for its Load Runners division of idler rollers. The Richmond, Ind.-based company makes industrial brushes, polishing compounds and buffs. Wall Colmonoy Corp., Madison Heights, Mich., appointed Nathan Stroud commercial director of its European headquarters in Wales, U.K. The company manufactures surfacing and brazing products, castings and engineered components. Walter Surface Technologies Inc., Pointe-Claire, Quebec, appointed Marc-André Aubé president and COO. The company makes abrasives.
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Machining Cloud Inc., Camarillo, Calif., has partnered with Ingersoll Cutting Tools, Rockford, Ill., and North American Tool, South Beloit, Ill., to provide product data from the toolmakers on MachiningCloud.

Toolmaker Midwest Industrial Tool Grinding Inc., Hutchinson, Minn., was named Manufacturer of the Year (small-company category) by the Manufacturers Alliance, a Minnesota association that promotes education.

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People & Companies

Toolmaker Walter USA LLC, Waukesha, Wis., appointed Thomas Benjamin director of business development for North America.

Companies

Toolmaker BIG KAISER Precision Tooling Inc., Hoffman Estates, Ill., formed a technical alliance with NASCAR’s Team Penske, Mooresville, N.C.

North Kingstown, R.I.-based Hexagon Manufacturing Intelligence formed a technology partnership with Wichita State University. The company will lease 3,000 sq. ft. of space on WSU’s Innovation Campus.

MachineTools.com, Birmingham, Mich., an online marketplace that connects buyers and sellers of new and used machinery, announced that the site provided its 2-millionth lead since its founding in 1999.

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Machining Power continued from page 53

college or university. [Editor’s note: In May, after 15 years working in manufacturing, Diebel will receive his Bachelor of Science degree in organizational administration from Central Michigan University, via the school’s online program; it was paid for by the MTU tuition-assistance program.] “We have a lot of success stories outside of us hiring them,” Diebel said. “It’s a long-term vision.” In addition, a downturn in the markets MTU serves, particularly oil and gas, has limited the number of available positions.

“We also see the advantage of them going through this program and then, in their junior or senior year of college, coming back and doing an internship with us,” Diebel said, adding that MTU employs about a dozen interns at any given time.

Although there are some up-front costs to establishing an apprenticeship program, such as equipment and human resources, Diebel pointed out that MTU doesn’t employ an independent trainer to conduct classes for the students. Instead, shop employees provide the primary training. In addition, the company brings in a lead trainer from its German facility to conduct about 4 weeks of training.

On the flip side, having an apprenticeship program enables MTU to avoid the expense of recruiting someone from a shallow skill pool, and the starting wage for a graduate is less than a skilled mid-career employee, Diebel said. As a result, he noted, a manufacturer can see up to a 36 percent return on its investment from apprentice training.

“It’s also better from a development standpoint to be able to bring them in at that stage and mold them to your company’s culture,” he said.

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HUMANIZING ROBOTIC MOVEMENT

The classic 1956 science-fiction film “Forbidden Planet” failed in one respect: The “futuristic” robot was supposed to be scary, but anyone could see that its slow, stiff legs meant no more than a push would topple it. Mobile industrial robots in the present-day world have wheels for mobility purposes. On most surfaces, wheels work fine—but, still, the mobile robots lack anything like human agility.

To advance humanoid robotics to the capability of human bodies, EOS GmbH, a Munich, Germany-based builder of additive-manufacturing systems, is working with the Swiss Devanthro Society and the Technical University of Munich on the Roboy Project. The vision is to iteratively improve models of Roboy (as in “robot boy”) until its performance is comparable to humans in dexterity, robustness and flexibility. They believe the more human a robot can be in its capabilities, the better it can replace workers who do dangerous or repetitive tasks, or both.

The project’s first prototype, Roboy Junior, has artificial muscles and tendons rather than motors in its joints. Building complex, functional geometries without classical fabrication constraints allows the project team to implement functionality directly into the geometrical parts.

Consequently, the complexity of building Roboy Junior was reduced and, according to EOS, many of the otherwise necessary assembly steps could be omitted. For example, Roboy Junior’s hands and forearms were manufactured in one piece, including several joints and individual phalanxes for each finger.

“In software development, rapid development cycles allow software improvement by testing it ‘in the wild,’” noted Rafael Hostettler, Roboy project leader. “Additive manufacturing allows us to apply this approach to robotics, enabling a rapid development to find optimal functional parts in a fraction of the time.”

The Roboy team also collaborates with the European Union’s Human Brain Project, which plans to simulate the human brain. It’s hard for science fiction to stay ahead.

For more information about Devanthro Society, Ennetbaden, Switzerland, visit www.roboy.org or email info@devanthro.org.

For more information about EOS, visit www.eos-usa.com or call (800) 886-9177.
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STIFF COMPETITION

Stiffness is a must in precision machining. Traditional machine tools depend on massive structures and large beds and footprints to enhance stiffness. But the massiveness that ensures predicatable stiffness all the way to the end of the cutting tool also ensures that the machine itself isn’t easily moved. For example, a 5-axis machine able to drill accurate 50mm (1.97”) holes in titanium could weigh as much as 20 tons (18,184 kg) and have a 3-sq.-m (9.84-sq.-ft.) footprint.

Robot arms used in assembly and other operations are much easier to move, but lack the necessary stiffness needed for precision machining. Robot arms and machine tools traditionally work as a series of serial links between the base and the end effector, which, in the latter’s case, is the cutting tool. The more links, the less stiffness.

The goal of parallel kinematics machines (PKMs), which have been in development since the mid-1990s, is to provide the stiffness necessary for highly precise machining without as much mass as conventional machines. PKMs have parallel rather than serial links between the base and the working end. The links that control the X-, Y- and Z-axis movements of the end effector aren’t connected serially, with one stacked on the other. Rather, they each have their own connection to the end effector, which allows improved stiffness with much less mass.

(Imagine four acrobats standing on each other’s shoulders. The one at the bottom has to be strong, but no matter how strong he or she is, the acrobat at the top isn’t going to want to thread a needle up there. Now imagine three acrobats on the ground, working together to hold the fourth one up as if they were the legs of a stool. That’s a rough approximation of serial vs. parallel kinematics.)

Exechon Enterprises LLC, Abu Dhabi, United Arab Emirates, has introduced the XMini PKM, which merges the flexibility and high dynamics of an articulated-arm robot with the stiffness and accuracy of a rigid machine tool. The machine can apply 7-kN tool force, offers 3G acceleration and maintains a positioning accuracy of ±10µm. At the same time, it is made of carbon fiber and is modular. It can be broken into five modules, each of which is manageable to carry by one or two people, and be reassembled inside spaces traditionally hard to access by machines or people.

XMini is equipped with a flexible frame, XFrame, and frame-integration software, XFIS, which reportedly allow it to adapt to any existing jig or fixture. Exechon asserts that a factory can go from identifying a need to starting the XMini in 72 hours. PKM pioneer Kalle Neumann, who designed the XMini, said Boeing and Airbus each approached him in 2012 for help in doubling their respective production capabilities by 2020 without doubling floor space and employee head count. The result was Exechon Enterprises LLC—a joint venture comprised of U.A.E.-based Injaz National, U.S.-based Lockheed Martin and Sweden-based Tecgrant AB—and the XMini.

“The paradigm shift is in taking

continued on page 86
Composite Routing with the VULCAN

The VULCAN compression end mill is designed with up cut and down cut flutes to compress the composite material preventing delamination. The spiral flute design creates a shearing action to cleanly cut the fibers. Utilizing a positive rake angle, the compression end mill makes quick sharp cuts minimizing heat and preventing the formation of resin burrs.
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