CUTTING TOOL ENGINEERING

August 2019 | Vol. 71 | Issue 8
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<table>
<thead>
<tr>
<th>Machine specifications</th>
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<tr>
<td>Max. machining diameter</td>
<td>1.26”</td>
</tr>
<tr>
<td>Max. machining length</td>
<td>GB: 12.6”/1 chuck</td>
</tr>
<tr>
<td></td>
<td>NGB: 2.95”/1 chuck</td>
</tr>
<tr>
<td>Max. main spindle speed</td>
<td>8,000 rpm</td>
</tr>
<tr>
<td>Max. back spindle speed</td>
<td>8,000 rpm</td>
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   - [ ] Production Department (Non-Supervisory Position);
   - [ ] Design, R&D;
   - [ ] Purchasing;
   - [ ] Quality Assurance, Control;
   - [ ] Other (please specify)

3a. **What is the primary end product manufactured (or service performed) at this location?**

   - 331 Primary Metal Manufacturing
   - 332 Fabricated Metal Product Manufacturing
   - 333 Machinery Manufacturing
   - 334 Computer/Electronic Product Manufacturing
   - 335 Electrical Equip/Appliance & Component Manufacturing
   - 336 Transportation Equipment Manufacturing
   - 337 Furniture and Related Product Manufacturing
   - 339 Miscellaneous Manufacturing
   - 423 Wholesale/Trade/Durable Goods
   - 999 Other Manufacturing NEC

3b. **If your company does NOT manufacture AT THIS LOCATION, specify company’s primary product or service performed. (please specify)**

4. **Number of employees at your company.**

   - [ ] 1-9
   - [ ] 10-19
   - [ ] 20-49
   - [ ] 50-99
   - [ ] 100-249
   - [ ] 250-499
   - [ ] 500+

5. **Which of the following market segment(s) does your company serve?**
   - [ ] Aerospace
   - [ ] Communications, Computers, Electronics
   - [ ] Defense
   - [ ] Energy
   - [ ] Heavy Equipment
   - [ ] Medical
   - [ ] Transportation (including automotive)
   - [ ] Other (please specify)
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At Eastec 2019, Drew Strauchen of GWS Tool Group discussed the PYSTL series endmill, which is for cutting gummy, exotic materials.

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Green is the color of collaboration at FANUC America Corp. Joseph M. Baldiga showed a cage-free collaborative robot during Eastec 2019.

At Koma Precision Inc.’s booth during Eastec 2019, Adam Rosen provided an overview of the new Prime tool presetter.

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Exact Metrology Inc. helped the Cincinnati Reds celebrate their 150th anniversary as the nation’s first all-professional baseball team. A pavilion was built to honor the original 1869 Red Stockings. Exact Metrology used its software to assist with the creation of a dozen bronze busts. See this and more on CTE social media.
THIS IS NOT A FACE MILL
CAN DATA SAVE THE WORLD?

Truth is sometimes crazy. One example: The cost of the status quo keeps rising while the cost of sustainable, smart change keeps going down. That’s according to Stockholm-based Hexagon AB, which presented the message at its HxGN Live 2019 conference June 11-14 at the Sands Expo and Convention Center in Las Vegas.

Ola Rollén, company president and CEO, helped explain that crazy truth at the event’s opening keynote, “Your Data Can Save the World … and Why It Matters to Your Business.” Of course, he was quick to point out that the focus is on saving mankind, which is under threat from climate change, and not Earth itself. “The planet will do fine without us.”

Rollén provided statistics to show the negative influence of humans since the dawn of humanity. “We’ve killed half of all plant species. We’ve killed 80% of all marine mammals on the planet. Even worse, we’ve killed 83% of all land mammals.”

This occurred while people succeeded with everything they set out to do, such as growing the population to 7.7 billion, significantly boosting productivity, landing men on the moon and sending spacecraft to other planets, he added. “We’ve proved we can do anything, but we haven’t done it well, and now we need to fix that.”

Unfortunately, according to Rollén, that fix needs to be done quickly because the point of no return might come fairly soon. “They think the doomsday limit is around 2050,” he said, adding that when it occurs, there will be no more fish to eat and the level of CO₂ emissions will make it tough to breathe.

Who are “they”? A couple of them are David Spratt, research director for Breakthrough National Centre for Climate Restoration in Melbourne, Australia, and Ian Dunlop, former chair of the Australian Greenhouse Office Experts Group on Emissions Trading and former chair of the Australian Coal Association. They wrote a report that models future scenarios based on existing research, and those scenarios show an essentially unlivable Earth in about 30 years if mankind doesn’t make major changes—and soon.

One change Rollén proposed is to use data in more clever ways to drive efficiency and reduce CO₂ emissions, all with existing technology. For example, technology exists to improve the average efficiency of a conventional internal combustion engine from about 20% to 50%, which is what a Formula One race car achieves because it must complete each race using only 100 liters of fuel.

He said Hexagon worked with most F1 teams and used their metrology data to increase engine efficiency, such as improving the friction of cylinders and enabling as little compression leakage as possible. That’s no small task for conventional automakers but doable. To view the keynote video, visit tinyurl.com/yyrqe9k8.

Now is the time to act and profit. “Saving the world might just be the super opportunity for business,” Rollén said. If that’s not of interest, take action for what probably matters the most to you: your friends and family.
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SHOULDER MILL HAS TANGENTIALLY MOUNTED INSERTS: Kennametal Inc. says its Mill 4-12KT shoulder mill lowers cutting forces by 15%. The cutter accepts inserts with four cutting edges. Seven corner radii from 0.016" to 0.122" are available, along with through-coolant, medium-pitch and coarse-pitch tool bodies from 2" to 8" in diameter. The axial DOC range is from 0.019" to 0.472".
Kennametal Inc.; www.kennametal.com

APP ALLOWS REMOTE MACHINE MONITORING: Mitsubishi Electric Automation Inc.‘s Integrated Machine Analytics app allows users to monitor their MTConnect-compliant CNC machines. The app offers real-time monitoring and analysis of CNC functions and notifies users when changes or anomalies are detected. Multiple machines that have an MTConnect-compliant adapter can be monitored simultaneously.
Mitsubishi Electric Automation Inc.; https://us.mitsubishielectric.com/fa/en

BAR FEEDER INCREASES PRODUCTIVITY: Lexair Inc.’s Multi Mini Rhinobar hydrodynamic bar feeder is for CNC Swiss-style machines and has a cartridge with three feed tubes instead of the traditional single feed tube. The bar feeder simplifies multiple-stock-diameter indexing by combining three feed tubes inside one aluminum barrel. Bar-diameter capacity is from 6.35mm to 20mm. Models are available for either 6’ or 12’ bar lengths.
Lexair Inc.; www.lexairinc.com

SCANNING LASER TRACKER GOES LONG RANGE: The Leica Absolute Tracker ATS600 from Hexagon’s Manufacturing Intelligence division can scan a surface with metrological accuracy from up to 40m without the need for targets, sprays, reflectors or probes. The system works by identifying a scan area in its field of view and then creating a sequentially measured grid of data points that define that surface.
Hexagon’s Manufacturing Intelligence division; www.hexagonmi.com
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Metalworking Product Review

**Microfinishing Pins for ID Grinding**: Titan Tool Supply Inc. has introduced a line of precision diamond- and Borazon CBN-coated microfinishing grinding pins. The pins have a carbide shank for added strength. Three diameters are available: 0.016” with 500/600 grit, 0.020” with 325/400 grit and 0.024” with 325/400 grit.

Titan Tool Supply Inc.; www.titantoolsupply.com

**Drill and Tap Heads Are Gearless**: Zagar Inc. offers multiple-spindle machining center heads for high-production drilling and tapping. The heads are custom made in numerous spindle pattern configurations to meet specific requirements. The heads can be configured to adapt to many standard vertical and horizontal machining centers equipped with BT, CAT and HSK spindles.

Zagar Inc.; www.zagar.com

**Pallet Systems Reduce Setup**: Quick Loc pallet systems from Jergens Inc. are for fixtureing on horizontal and vertical machining centers, including 5-axis operations. The low-profile adapters and pallets provide 0.0003” repeatability and clamping forces of nearly 14,000 lbs. The range of receivers, risers, pallets and cubes can be configured for almost any application. The square, rectangle and round receivers are available in 52mm and 96mm patterns.

Jergens Inc.; www.jergensinc.com

**Horizontal Machining Center for Making Auto Parts**: Through its partner PCI, Absolute Machine Tools Inc. offers single- and twin-spindle, 4- or 5-axis Meteor HMCs. The adjustable distance between the two independent spindles on the twin-spindle TS630V enhances flexibility. Users can program the machine to process two identical parts, perform two different operations on the same part or simultaneously machine two completely different parts.

Absolute Machine Tools Inc.; www.absolutemachine.com

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Absolute Machine Tools Inc.; www.absolutemachine.com
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FRIENDS, EMPLOYEES DON’T MIX

One of the great things about owning a machine shop in America is to hopefully create a thriving business, whether large or small, and do it your way. Regardless of size, however, it’s wise for owners and managers to refrain from the personal lives of those employed.

As I’ve learned over the years, employees will request loans and special times off and even expect you to hire friends or family members who “just need a chance.” These scenarios can place managers and owners in an awkward situation, for once a precedent has been set, the requests become more frequent.

The best tactic is to keep your distance and avoid conversations about personal lives. This can be difficult at a small machine shop where you know everyone. Unfortunately, when you listen or console, an expectation is created that management is willing to help. However, when personal problems arise, it's not the company’s or management's responsibility to fix them.

This summer, my son’s 20-year-old friend visited my house and informed me he had become unemployed and was interested in any opportunity, even temporary work. At the time, our shop was swamped with several big projects and needed labor, so we hired him.

But soon, he was contacting my son after-hours and discussing business issues, internal operations and management decisions, even though my son wasn’t responsible for them and didn’t want to hear the opinions of a Monday morning quarterback. The friend's conversations became excessive, and eventually my son confirmed that hiring a friend wasn’t wise. Within three months, the friend quit anyway as the work was challenging and he was over it.

Ultimately, the decision to hire my son’s friend was mine. There have been similar examples over the years. Personal connections to our family can compel people to constantly tell us their ideas, situations and observations. Sadly, I had to let my son know that while our intentions may have been good, business is business and reality is reality. We’re not in business to take care of employees’ personal issues, which would establish a precedent of impossible expectations.

I don’t mean to dissuade from helping humanity. Not all experiences are bad. But hiring friends and family comes with a set of circumstances and risks. Although our caring sides may dictate some decisions, employing personal contacts can jeopardize the family peace and put you in uncomfortable positions. Perhaps you could provide referrals, reference letters or plain old good advice. But putting people on your payroll should be handled carefully, especially if they visit you at home or have your cellphone number.

As it turns out, my son’s friend is still unemployed despite the advice I gave to him, though his issues don’t impact our business anymore. And my son has learned a valuable lesson about employment and friendship. After trying to help many people, we can only hope they learned something worthwhile from their experiences.

about the author

Keith Jennings is president of Tomball, Texas-based Crow Corp., a family-owned company focused on machining, metal fabrication and metal stamping. Contact him at jennings4176@yahoo.com.
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THANKS TO A CHANGE IN THE LASER TECHNOLOGY EMPLOYED BY A NEW NONCONTACT MEASURING SYSTEM, SHOP PERSONNEL WHO SET MINIATURE TOOLS WILL STOP SEEING RED.

The NC4+ Blue on-machine tool-setting system is the first of its kind to feature a blue laser, according to West Dundee, Illinois-based Renishaw Inc. The patent pending blue laser technology produces a shorter wavelength than the red laser sources used by conventional noncontact tool setters, reducing diffraction and allowing better control of the laser beam geometry, said Dave Bozich, Renishaw’s machine tool business manager.

“When you don’t have good control of the geometry, you get divergence of the beam as it travels from the transmitter to the receiver,” he said.

As a result, the beam increases in diameter and loses energy on the trip to the receiver. In contrast, the blue laser beam, which is 25% to 30% smaller in diameter, retains the diameter and energy that it had exiting the transmitter, he said. This makes NC4+ Blue especially well suited to measure very small tools. These delicate tools can be damaged by contact tool setters. However, he said red laser systems historically have had difficulty measuring the length of tools 0.004” or less in diameter. That’s not the case with NC4+ Blue. It enables accurate measurement of tools half the size of those that can be accurately measured by conventional red laser systems, Renishaw reports.

In addition, the company states that its blue laser alternative minimizes tool-to-tool measurement errors when machining with a wide range of cutting tools. Consider a situation in which tools in a carousel range from 0.004” to 0.125” in diameter. To deal with this range of sizes, Bozich said CNC programmers add “experience values” to software. As the name suggests, these are experienced-based
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factors meant to increase the accuracy of results when measuring tools with particular diameters. With NC4+ Blue, though, these “fudge factors” aren’t needed, he said. “When you have tight control and better geometry of the laser beam,” he said, “you can set tools very accurately even when there’s a big difference between the diameters of the tools.”

NC4+ Blue also features a new measurement mode to handle the presence of coolant during the setting process. Conventional laser systems take measurements when a tool breaks the beam. But dripping coolant can break the laser beam too, causing an inaccurate reading and necessitating a retry of the measurement process. So Renishaw offers a different measurement approach in which the tool blocks the beam to begin with and then moves out of the way, with the...
measurement being taken the instant the light no longer is blocked. This method virtually eliminates coolant’s ability to adversely affect the measurement, he said.

Shop personnel can view historical tool data captured by NC4+ Blue using the latest version of Renishaw’s Reporter app, which can be installed on a machine’s control or a tablet that plugs into the machine. The app lets users perform tasks, such as monitoring how long a particular tool has been in cycle, as well as export key tool metrics for use in other software and control systems.

Although NC4+ Blue is not yet commercially available, Renishaw reports that it has demonstrated the technology to select customers. After introducing the product next month at the EMO exhibition in Hanover, Germany, the company will start selling it in winter at a price comparable to that of the noncontact laser technology Renishaw already offers. With the system soon to be available at a competitive price point, potential users should have no reason to be blue about this tool-setting option.

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REDUCE LEAD TIMES WITH ESPRIT

By Jerry Fireman

Combining the power of Camarillo, California-based DP Technology Corp.’s Esprit CAM software and Windsor, Connecticut-based Tsugami/Rem Sales LLC’s Swiss-style machines has been a boon for MacKay Manufacturing Inc., reducing the time the company takes to machine complex parts.

Founded in 1986 in Spokane Valley, Washington, MacKay Manufacturing is a job shop that focuses on aerospace parts and surgical instruments and devices. The company has more than 135 employees and runs a two-year on-the-job training program to ensure that machinists get the experience needed to handle complicated projects.

At any given time, MacKay has between 400 and 600 work orders in progress. Job quantities can range from a one-off prototype part to several thousand pieces, machined in common metals like aluminum, titanium and stainless steel, as well as more exotic materials, such as ToughMet and ceramic plastics. The parts MacKay makes are typically complex and require tight tolerances, special certifications and efficient prototyping. MacKay places high emphasis on oversight, robust documentation control and production process tracking to assure customers that the correct raw materials have been purchased and are being machined properly during each step of the manufacturing process.

MacKay’s production department runs almost 20 mills, including 11 5-axis LeBlond Makino horizontal machining centers, three Mori Seiki vertical mills and two Willemin-Macodel 408MTs. It also runs about two dozen lathes and Swiss-style turning machines, including three Tsugami 20mm Swiss-type screw machines with Iemca Boss 325 bar feeders; a Tsugami MU26; and five Tsugami 32mm Swiss-type turning centers with dual spindles, independent turrets, live tooling and thread whirling capability. The prototype department has six Mori Seiki vertical mills, two wire EDMs, three Bridgeport mills and a number of other machine tools.

To efficiently cut small parts,
MacKay purchased its first Tsugami 20mm screw machine in 1998. "We chose Tsugami because they have a reputation for being reliable, durable machines, and they’ve proved that to be true," said Manufacturing Supervisor Gabe Compton. "We also chose Tsugami because of their excellent customer service and their relationship with the Tsugami/Rem Sales distributor Ellison Technologies, with whom we were already affiliated."

All images: MacKay Manufacturing
MacKay began using Esprit in early 2010 on a Mori Seiki machine and now runs five seats of the CAM software to generate code for multiple machines, including the Tsugami lathes. “Esprit solved an issue common to many shops: How can we get a better, more efficient program to the production floor and do it before the job is ready to start?” Compton said. “We are now able...”
to preprogram the parts before they are scheduled to go into the machine. This has proved to be far more productive than programming the job at the machine, which takes up valuable time that could be used to manufacture parts. Now we have the tools staged and setup sheets created before the job is scheduled to run. We just have to load the code, set the tools and go."

Pairing Esprit and Tsugami has made MacKay more efficient, helping it reduce lead times for customers.

“The Tsugami lathes allow us to meet the requirements for increased parts production,” Compton said. “Their relative ease of use and durability have given us the ability to meet growing demand.”

For example, MacKay makes a small L-tip part for an endoscopic surgery device. The company initially ran the part as a lathe blank, meaning that all the round features would be run before sending the part to the milling department to cut the L shape. The lathe blank ran for a minute and a half on a Tsugami BS20 and then for an additional five minutes on a mill.

In the years since taking on the project, MacKay has acquired new cutting tool technology and speeder heads. Combined with increased knowledge of what is possible on a Tsugami B0326-II CNC automatic lathe and in Esprit, the company felt confident enough in 2017 to make the part using only a B0326-II.

“We can now machine this part in under three minutes and make a far better part than we had previously,” Compton said. “We have since taken on two other parts in this part family and make them entirely on the lathe as well. We couldn’t have done this without Esprit and their technical support, nor could we have done this without the capability of the Tsugami lathe.”

For more information about MacKay Manufacturing’s work with Esprit CAM software, visit https://youtu.be/PRID86abZn4.

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Dear Doc: We surface-grind lots of stock (1mm per side) off of large plates (1,000mm × 500mm). Two cross-feed options are on our machine: 1) gradual, where the bed cross-feeds at a constant velocity throughout the forward and backward strokes, and 2) incremental, motor power. So when you do incremental cross-feed, have that wheel move over 45mm after each forward stroke and back stroke.

You might wonder whether using more of the wheel will increase wheel wear and risk of burn. The answer is a resounding no. Wheel wear and burn risk depend mostly on the maximum Q-prime in a wheel. The equation is $Q_{\text{prime}} = \text{DOC in mm} \times \text{traverse velocity in mm/sec}$. Notice that the cross-feed velocity (for the gradual cross-feed option), the cross-feed distance (for the incremental cross-feed option) or the wheel width isn’t part of this equation. Using 10%, 25%, 50% or 90% of your wheel width won’t change the risk of burn or the rate of wheel wear. The only thing it will do is increase the total spindle power and the risk of chatter. Assuming we’re OK on both of those, let’s use 90% of the wheel and reduce cycle time.

That brings us to the problem with gradual cross-feed: inefficiency. Let’s say the wheel finishes traversing the part on the forward stroke. The bed slows, stops and starts moving in the opposite direction for the reverse traverse. When the bed begins that reverse traverse, continued on Page 67
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Cylindrical die thread rolling is a cool method for taking the heat off manufacturing thin, deep helical fins on long lengths of thin-walled tubing. The process is suitable for making a variety of everyday products, achieving fast, economical production when metalcutting machining just doesn’t cut it. One such product is finned tubing for heat exchangers.

Improving the energy transfer efficiency of cooling and heating fluids has been a challenge since the Industrial Revolution. Any device performing work requires a transfer of energy to make the work happen. A portion of the energy goes into the work, and another portion comes out as heat due to efficiency losses in the system. Methods that improve the energy transfer efficiency of the original device or that capture the heat loss for reuse are in constant demand. It all comes down to heat transfer.

Heat transfer can be accomplished by a heat exchanger, which transfers energy from one fluid to another liquid or a gas. One of the simplest methods of heat exchange without mixing fluids is the use of a tube through which one fluid is passed at one temperature while another fluid is passed around the outside at another temperature. Heat is transferred from
the hotter fluid to the cooler one through the tube wall. To increase heat exchange efficiency, such a tube is manufactured with fins that protrude radially outward from the tube surface, thus creating a fin tube. Finned tubing can be found at the core of most heat exchanger devices.

**Why a Fin Tube?**

The simple answer is that the efficiency or rate of heat transfer is affected significantly by the surface area of exposure. Fluids have a heat transfer coefficient, which is the amount of heat per unit area they can transfer. By increasing
Let’s Roll

the usable area, multiplying the heat transfer coefficient by that increased area results in more capacity for heat transfer. The outside surface area of a plain tube easily can be increased five to 20 times by adding fins to the outside surface.

A fin tube also can have a finlike profile on the inside surface to increase the surface area and promote directional fluid flow or mixing. Turbulence induces mixing of each fluid, which can improve heat transfer for individual fluids. Turbulence can be controlled by the geometry and arrangement of the fins on the inside or outside of the tube. A helical fin path is most common on either or both surfaces.

Before talking about manufacturing finned tubing, let’s look at the characteristics of a typical fin tube examples (above) and an example of a deep fin tube (right).
tube product. Fin tubes come in all shapes, sizes and materials with varied fin heights and thicknesses. The tubes generally are made of welded tubing in stainless and low-carbon steels, copper, brass, aluminum and exotic alloys. One important characteristic to consider for manufacturing is length. Some fin tubes are manufactured in continuous lengths of 100’ or more, which then are bent into compact shapes to fit inside various heat exchangers. Other relevant traits are tube diameter and wall thickness, fin height, the number of fins per inch and tube material grade and construction.

In simple terms, a fin tube can be thought of as a hollow, threaded rod. However, the simplicity starts to diminish when there are 60 or more thin threads per inch with an additional threaded profile on the ID over a 100’ length. Two processes traditionally are employed to produce external threads on the outside of a workpiece: thread cutting and thread rolling. Both
Let’s Roll

methods have strengths and weaknesses. Thread rolling is the process to beat, though, when it comes to manufacturing fin tubes at high rates of speed. There are also benefits with material savings, strength, surface quality and the ability to generate internal profiles without wasting material by generating chips.

When cutting an external thread on a lathe, a single-point cutting tool plunges radially into one side of the workpiece and traverses along its exposed length. Multiple passes at successively deeper depths usually are required to achieve the full thread form. It can take minutes to accomplish this task on a length less than 10” or 12”. Single-point thread cutting creates a force imbalance on one side of the workpiece due to the forces

A cross section of rolled thread grain flow.

Improving the energy transfer efficiency of cooling and heating fluids has been a challenge since the Industrial Revolution.
generated by the cutting tool. Deflection of the workpiece is always a consideration. The workpiece geometry and cutting forces dictate the limits of exposed length that can be threaded, above which deflection and stability problems will occur. Once the limit is exceeded, rolling is the best option.

Rolling Basics

When rolling an external thread of discrete length, two or three rotating cylindrical dies plunge radially into the workpiece to some depth while rotating it to replicate their geometric surface features into the periphery of the workpiece surface. This is referred to as infeed rolling. For longer continuous lengths of a threaded product, the through-feed rolling process is used by skewing the axes of the rolling dies at an angle to generate through-feeding action of the workpiece.

In either case, the blank material is forced to conform to the die geometry without removing or gaining material. Therefore, thread rolling is a constant-volume process. The starting pre-roll blank is smaller in diameter than the final thread major diameter—usually somewhere near the thread pitch diameter—because material from the blank is displaced radially outward by the dies to fill the form. Material also can and will flow in two other principal directions, axial and circumferential, depending on several factors, such as the degree of form fullness or the ratio of thread depth to root diameter.

A typical machine screw thread can be rolled into a bolt blank in a few seconds. The feeding of the bolt blank into and out of the rolling machine usually takes longer than the rolling process itself. Rolling generates an uninterrupted grain flow around the rolled root, which helps enhance strength to a rolled thread over a cut thread. Other characteristics, such as material workhardening and a highly burnished surface from the rolling action, also help increase the strength and quality of a rolled thread.

The aforementioned advantages make the rolling process suitable for mass production of a long, continuous fin tube product that has good strength.
characteristics and process stability. Hollow components have relatively thin walls, which require a form to be rolled on them, and are processed using three-cylindrical die rolling. The three dies simultaneously converge on the workpiece, trapping it on a constant centerline while substantially preventing deformation of the tube with balanced forces at each die contact. An internal supporting mandrel sometimes is positioned inside the tube under the deformation zone to provide additional stability.

As an added benefit of the rolling process, the internal mandrel can be made with a helical profile on its surface to replicate a helical form on the inside diameter of the tube, the benefits of which were described earlier. This operation would be impossible for long lengths of tubing using a cutting tool on the end of a boring bar.

Compared with cutting, the three-die through-feed rolling process can roll continuous lengths of form at high speed. Thin-wall rolling applications are also more susceptible to increased axial material flow. With fin tube rolling, depending on the depth of form and change in the cross section area in the rolling deformation zone, there can be significant axial stretching of the tubing on the order of 10% to 20%. That is 10% to 20% less blank tubing length required as raw material input.

Speed and Flexibility

It is not uncommon for fin tubes with low fin heights and 15 to 20 fins per inch to be rolled in upward of 10' or more per minute using straight annular disc dies. That’s 2 in./sec. of a finish-rolled product. Production rates depend on the number of fins per inch, the number of helical start paths on the tube, die speed, die skew angle, tube diameter and die diameter. When using straight annular discs, the disc die skew angle is matched to the part lead angle. As the number of helical start paths on the tube increases, the die skew
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angle must increase to match the higher lead angle. A higher skew angle means faster feed rates at a given disc rpm.

As previously noted, long lengths of fin tubes typically are bent into special shapes to fit inside a heat exchanger shell. It is desirable to have no fins present where bends occur when performing a bending operation. This avoids fin damage and takes advantage of the full tube cross section. Fin rolling machines can provide radial motion of the disc dies both into and out of the tube to allow spacing between finned sections as required. The tube advances axially through the dies.
A Brief History of Thread Rolling

Roll forming has existed since ancient times and can be traced back to when potters pressed and rolled a piece of clay between their hands to roll it into a new size. The first partially mechanized, hand-operated roll-forming devices for working metal appeared in the 1600s and pressed ridges into the sides of coins to deter thieves from scraping away shavings of the precious metals.

In the mid-1800s, the first fully mechanized flat die and cylindrical die thread-rolling machines were developed for rolling low-precision wood screw threads and higher-precision machined metal screw threads. Demand for higher-quality machined screw threads in the aircraft and automotive industries around the time of World War II pushed rolling machine builders to achieve a new level of quality for mass production of high-precision screw threads.

Today, the rolling process often is used as a secondary or final manufacturing operation to produce high-precision threads and other helical and annular forms in exotic alloys on critical components, such as aircraft landing gear.

—David C. Willens

during the period of die retraction to create a length of space before plunging the dies back into the tube to continue producing rolled fin. It is critical that all the fin rolling dies simultaneously contact the workpiece to maintain a constant rolling centerline and full stability during rolling. It is also critical to sustain constant radial position of the penetrated dies into the tube throughout the rolling process to maintain dimensional stability of the rolled tube root diameter and fin height. For shops with high-volume production or that struggle to cut continuous lengths of finned tubing or other helical and annular thread-like forms, consider cylindrical die through-feed rolling. Production speed, material savings, strength, quality and performance can justify the capital expense.

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When a component must resist corrosion while withstanding a high level of heat, such as one found in the combustion chamber of a jet engine, part designers often decide to make the part from a nickel-base superalloy. Whether Inconel 600, Haynes 230, Hastelloy B or another metal from that group, they all are challenging to thread or otherwise machine.

That is because those alloys have a high level of ductility, so they tend to easily workharden when cut, according to Marlon Blandon, product manager for thread milling at Emuge Corp., West Boylston, Massachusetts. As a result, prior to threading, drilling can workharden the surface of a hole to be threaded. A continuous threading application like tapping, in turn, can generate such a high level of heat that it workhardens the bore to the point that it can’t be threaded.

Blandon suggests thread milling with the appropriate tool instead. The thread mill should be made of solid carbide and have a positive rake angle and sharp
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Working Hard to Avoid Workhardening

cutting edges. “We use a proprietary micrograin carbide that allows us to grind very sharp edges,” he said. “The finer the carbide grade, the easier it is to create a sharp edge.”

Those cutting edges should then be coated to protect them against heat. A TiCN coating can be deposited to resist heat without adding too much expense to a tool. However, a multilayer TiAlN coating is even more effective because once the coating is heated, it hardens more to enhance the protection, Blandon noted.

Hold On

Once an end user has the correct thread mill, a suitable toolholder is needed. According to Blandon, avoid ER collets at all costs because they are designed for linear cutting, either in and out or side to side but not for 3-axis circular interpolation, which thread milling requires.

In addition, shrink-fit toolholders might not be adequate because they often don’t have enough thickness to surround the tool shank and enable vibration-free thread milling, he added. Vibration produces chatter marks on threads, which require re-cutting. “You don’t want to make too many passes,” Blandon said, “because every time you make a pass, you are generating heat and the material is workhardening.”

A better choice is a holder with a side-locking screw that pushes the entire wall of the shank into the holder and improves rigidity, he said. Blandon added that Emuge offers the FPC toolholding system. “It’s a gear-driven system that pulls the entire shank of the tool into a clamping sleeve. Then this clamping sleeve gets tightened with a specific torque into the holder itself. That is more than enough for thread milling.”

The next element for successfully threading nickel-base superalloys is to have the right program. To minimize heat, Blandon recommends reducing the cutting speed and...
taking a “big bite” of the workpiece so the cutting edge goes below any potentially workhardened zone. “We penetrate and grab as much as we can so the heat goes with the chip and doesn’t stay in the part.”

Circular Circuit

In addition, programming the thread mill to start cutting with a 180° entry curve instead of the typical 45° or 90° entry curve enables a “soft entry,” Blandon said. “This makes it so the point of the tool has a little bit more room to start from a small chip and work its way into a bigger chip.” Creating more room is also important when applying external coolant. To enable coolant to effectively access where it is needed, users should select a single-plane thread mill that only engages a part with one line of teeth at once rather than a cutter with a full milling section, Blandon said. “It creates a lot of free cutting. You don’t have pressure on an entire milling section.”

Although the single-plane design reduces the amount of heat in the cut, he said it also extends the cycle time, which isn’t the highest consideration when thread milling an expensive, mission-critical part. “However, for substantially higher productivity there is a three-tooth solution with a left-hand helix flute—our unique ZGF S-Cut tool design—that simultaneously roughs and finish-cuts threads in one pass. It dramatically reduces cycle times while extending tool life.”

To help ensure successful thread milling, Blandon said Emuge usually provides complimentary programming instructions, including recommended speeds and feeds, with the thread mills it sells. As industries place increased demands on heat-resistant part requirements, the need for tools to effectively thread and otherwise machine those parts follows. “We have seen tremendous expansion in the aerospace industry, at least when it comes to jet engines,” Blandon said. “There is a high demand for tools for those heat-resistant materials.”

For more information about Emuge’s Threads-all ZGF S-Cut thread mills, view a video presentation at www.ctemag.com by scanning the QR code on your smartphone or entering this URL on your web browser: cteplus.delivr.com/2uc2
SWISS BLISS

Machine shops enjoy additional opportunities with sliding headstock lathes.

By Kip Hanson

From turret lathes and machining centers to cylindrical grinders and EDMs—all machine tools present unique demands. Swiss-style turning centers, however, are in many ways more difficult to program and operate than any of the machinery just listed but offer greater opportunities for improvement. These include higher-quality parts, increased throughput and—for shops that don’t yet have a Swiss-style lathe—possibilities for new business and for higher profitability on existing work.

Let Me Count the Ways

Just as it might be challenging to maneuver a Formula One circuit with a school bus, turning parts less than 1” in diameter is not optimal on a turret lathe:

- At 6,000 rpm or less, spindle speeds are often woefully inadequate on an 8” or 6” chuck CNC lathe.
- It can be difficult to achieve the perfect

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'Traditional turning shops should avoid pigeonholing themselves with fixed-headstock, turret-only machines.'

Smaller parts frequently are turned using dead-sharp inserts with small nose radii, which may be tough to find for the 1” shank and larger stick tools typically found on most turret lathes.

Because small parts require less horsepower to machine, using a large lathe to produce them is about as wasteful as towing a bicycle with a pickup truck.

Turret lathes are also slower. “Swiss-style lathes generally have a very small work zone, much smaller than the typical CNC lathe, and use gang tooling rather than a turret,” said Derek Briggs, Swiss product manager at Tsugami/Rem Sales LLC, Windsor, Connecticut. “Because you’re only moving a very short distance to change tools rather than going all the way home, indexing the turret and coming back, chip-to-chip time is very fast. That’s where a Swiss machine can really beat out a conventional lathe.”

Avoiding the Wad

Shorter cycle times notwithstanding, small work zones are a double-edged sword. The wad of chips that falls to the chip tray on a turret lathe can quickly become pinched between the workpiece and tool on a crowded Swiss-style machine.

Aside from the annoyance and lost revenue associated with stopping production at regular intervals to pull bird nests from the machine interior, poor chip control may mar part surfaces, break cutting tools and damage machine tools. Long, stringy chips can be especially

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**Swiss Bliss**

centerline needed for turning small parts with turret-mounted tools.

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**about the author**

Kip Hanson is a contributing writer for CTE. Contact him at 520-548-7328 or kip@kahmco.net.
problematic when turning stainless steel, platinum and cobalt-chrome alloys, materials commonly used for the tiny screws and other medical components frequently turned on Swiss-style machines.

Some Swiss-style machine tool builders have addressed this particular problem with a control feature that Briggs calls oscillation cutting. By oscillating the axis back and forth in conjunction with spindle rotation as the tool feeds into the workpiece, the chip breaks into manageable pieces.

“We cut some parts at a customer’s facility recently with and without oscillation cutting,” he said. “With it turned off, we had to stop the machine after 10 parts to clear the chips. With it turned on, the chips broke into little sixes and nines, which is exactly what you want. It’s fantastic.”

Marubeni Citizen-Cincom Inc., Allendale, New Jersey, similarly has developed LFV, short for low-frequency vibration. LFV uses “perfect phasing” like that found on a C-axis to create what is essentially a serration in the material, breaking the chips on even very stringy Teflon or MP3SN nickel-cobalt alloy, said Executive Vice President Brian Such.

“Since we can adjust the number of serrations per spindle rotation,” he said, “there’s really nothing that we can’t break, even when the tool is moving in
Swiss Bliss

multiple axes simultaneously, as when interpolating an angle or cutting a radius.”

Another production element that many Swiss shops struggle with is long setup times. This is why Tsugami/Rem Sales has partnered with quick-change tooling manufacturer Göttenbodt Technology GmbH, Leonberg, Germany, and Marubeni Citizen-Cincom recommends the QS.

Although the company’s name has changed from Heimatec Inc. to Platinum Tooling Technologies, it remains the exclusive importer of Heimatec GmbH tooling in North America.
holding system from Sandvik Coromant Co., Fair Lawn, New Jersey. Both systems can simplify and speed up the tool-changing and setup processes. These systems help in other ways as well. Because they contain internal coolant channels and precision ports, they increase cutting fluid efficiency and eliminate the copper or plastic lines that tend to catch stringy chips.

“Instead of installing lines at each tool position and having to adjust them every time you set up a job, you can run high-pressure coolant right through the baseplate to the tip of the tool,” Briggs said. “It solves a lot of problems.”

Too Much Going On
It’s hard for humans to watch more than one thing at a time. Considering that Swiss-style lathes not only move quickly but often boast a subspindle, dozens of tools and the ability to simultaneously perform multiple turning and milling operations, this makes the possibility of a crash quite real. Such has a solution. “Practically all other CNCs have a rapid override,” he said. “Citizen machines don’t. Instead, there’s a process override, which lets the operator slow the rapids, the feed rates and even the M codes, all with the same knob and all at once. Timing is everything on a Swiss. Our
solution eliminates the situation where a tool that cleared the workpiece or subspindle with the rapid override set to 25% will hit when you turn it to 100%. Nothing is ever out of sync.”

Swiss-style machine tool builders also offer features such as pneumatic, self-adjusting guide bushings, reducing the need for ground bar stock. “Chucker convertible” options allow the sliding headstock to move in the forward position, eliminating the guide bushing. Convertibles also reduce the length of bar remnants—a big concern with expensive, medical-grade materials—and enable the machine to be operated as a chucker, further expanding its capabilities.

With Swiss-style CNC lathes becoming more popular, Scott Laprade, applications and technical sales representative at Genevieve Swiss Industries Inc., Westfield, Massachusetts, pointed out that the number of tooling choices available to lathe owners is on the rise. “For example, we’ve recently expanded our live tool offering with compact, planetary-geread drilling and milling attachments that offer much higher spindle speeds and consume less space in the machine’s working area,” he said. “With that, we offer a range of quick-change, ER-style Ti-Loc extensions that make it easier to reach the workpiece in tight clearance situations.”

Getting tools exactly on center normally could be a challenge for Swiss machines, especially with tiny boring bars and drills, where even the slightest deviation from centerline can mean a broken tool. But Laprade said GenSwiss’ Perfect Zero alignment system solves this problem.

“The kit contains a laptop with pre-loaded software and a camera that goes in the guide bushing,” he said. “You call up a tool, align it with the camera’s crosshairs and instantly know how much misalignment is present. You can then make an offset to correct it or a mechanical adjustment if necessary. And for rotating tools, there’s a calibration process you can use to minimize runout or eccentricity.”

A Platinum Hit
Platinum Tooling Technologies Inc., Prospect Heights, Illinois, is another Swiss-oriented tooling distributor. President Preben Hansen explained that he recently rebranded his company, Heimatec Inc., to expand his nearly decadelong exclusive relationship with Heimatec GmbH, Renchen, Germany. Heimatec GmbH’s live tooling line now includes live and static tools for Marubeni Citizen-Cincom machines, and Platinum Tooling Technologies also offers Swiss collets and guide bushings from Tecnicrafts Industries and IB spindle speeders from Suzuki Precision Co. Ltd.

“Swiss shops use a lot of very small drills and endmills,” he said, “and the available driven tool speeds don’t always provide the rpm needed for tiny cutting tools.”

He suggests that shops keep a close eye on the cutting tool and whatever it machines, no matter whose logo sits on the live toolholder. Once surface finish begins to diminish or runout moves beyond a couple of

To reduce customers’ setup times, Tsugami/Rem Sales has partnered with quick-change tooling manufacturer Göttlenbodt Technology.
Considering the broad array of tooling options, faster setups and machines that are easier to operate than before, he said use of Swiss-style CNC lathes is becoming more widespread. Still, not everyone has seen the light.

“Traditional turning shops should avoid pigeonholing themselves with fixed-headstock, turret-only machines,” he said. “They need to broaden their customer base, and Swiss-style lathes are a great way to do that. And if they’re already producing smaller parts, the chances are excellent that a modern Swiss machine will make them faster and more accurately.”

Mike Estes
–OD Grinder

Speeder heads like the one shown provide the high rpm needed for small cutting tools.

tenths, he said, that’s a good indication it’s time to send out the live tool for a rebuild. If a shop waits too long, bearings could seize, possibly destroying an expensive piece of tooling.

He further recommends ultra-precision collets and guide bushings, which can make the difference when a finish cut is wanted on the bar’s exterior, thus saving precious seconds of cycle time.

“Most customers go for the ultra-precision, knowing that it provides 5μm maximum runout for a fairly small cost delta,” he said.
Over several decades, precision part manufacturers have adapted to resource constraints, cost pressures and increasing global competition by embracing the principles of lean manufacturing. While lean manufacturing has many tenets, the primary focus is elimination of waste. Cellular manufacturing is one way manufacturers have sought to reduce waste in manufacturing processes.

Cellular manufacturing is a broad term encompassing many methodologies and philosophies. It generally combines all manufacturing processes needed to produce a product or family of products into a common area, which allows a person or small team to operate and manage the processes.

A work cell usually houses all processes used in the production of a single part. A good example is my former employer and the individual components it used to manufacture power steering gears. Steering gears are assembled from several major components, one of which is a rack bar. Rack bars are long shafts that must be turned, milled, broached, ground, heat-treated and polished. All these activities are completed in one cell. Bars enter the cell as cut blanks and leave as finished
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Work Cells Work

components ready for assembly.
In other situations, a cell may handle one manufacturing process that delivers multiple configurations of the same type of part. Another former employer in the aerospace industry built a cell to machine cast-aluminum flanges. These complex parts required milling, drilling, tapping, reaming and boring. In this case, machining operations were combined into one machine, a horizontal machining center, which allowed a machinist to produce the entire family of parts in one location and in any quantity needed. Prior to installing the cell, flanges had to travel around the shop, stopping at a few different machines, and were processed as a batch before moving to the next machine.

Manufacturing processes in an efficient cell have balanced cycle times so each process is completed in about the same amount of time. Line balance is the term that describes activities used to calculate, plan and build cells with balanced cycle times and efficient flow. When a cell is balanced, products arrive at a rate that satisfies demand with no more or less than is required. This is the foundation of just-in-time manufacturing.

Advantages
A significant advantage of cellular manufacturing is reduced lead time. When parts are manufactured in a balanced cell, the time they spend at a shop before arriving at their destination is dramatically reduced. When parts are processed in a batch, the first part arrives at the same time as the last part, delaying the start of subsequent operations. When parts flow through a cell from one operation to the next, finished parts are delivered as they are completed, creating an even flow of parts rather than arriving in one bundle.

Reduced lead time at a shop results in a reduction of work-in-

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about the author
Christopher Tate is engineering manager of advanced manufacturing engineering and machining at the Savannah, Georgia, facility of Mitsubishi Hitachi Power Systems Americas Inc., Lake Mary, Florida. Contact him at chris23tate@gmail.com.
process inventory. Consider the rack bar example. If 100 parts are needed per day to support assembly, then batch processing would require about 600 parts to be in process at all times—100 at each operation. But if a cell is built that allows operations to be performed one after the other, there will be only six parts in process at any time.

Cellular manufacturing also reduces the amount of floor space needed. Well-designed cells are compact and efficiently consume space. Because they produce less inventory, storage locations are minimized. Reducing the amount of space needed to support production allows construction of smaller spaces and better utilization of existing ones.

Cells provide an ergonomic benefit to shop personnel. Compact, U-shaped cells enable technicians to travel from process to process in a continuous path, minimizing distances traveled during a workday. The cellular design typically permits multiple operations that incorporate many different motions, so the opportunity for repetitive motion injuries is reduced.

Automating processes is easier in a well-designed cell. When the power steering gear manufacturer started making large gears for trucks, we decided to integrate robots into the cells because people would not be able to move the heavier bars by hand all day. Cell layout had been so well refined that integrating robots was easy and required minimal redesign.

Production scheduling also becomes much easier. Scheduling individual machines and processes is not necessary in a cell as each machine is dedicated to a specific operation and nothing else. Planners and schedulers no longer are burdened with scheduling and monitoring individual machines—only the cell must be scheduled. Because parts typically never leave a cell, shops often eliminate the need for routers and travelers.

Cells help close the potential skills gap by reducing complex processes to simple tasks. Efficient cells have capable, robust processes that
remove variation. Vigorous processes erase the requirement to have process experts, instead allowing team members to learn specific, critical steps. Centerless grinding is an important operation for rack bar production, and learning the intricacies of centerless grinding can take many years. However, there was no expectation for our rack bar team members to be grinding experts. The workers were expected to master only the few steps needed to produce good rack bars. Proper cellular design simplifies complex tasks like grinding, making it easier to add and train staff.

Cellular manufacturing has become the standard at many organizations and is no longer just for large manufacturers, such as automakers. As manufacturers enter the Fourth Industrial Revolution and are transformed by the internet of things, cellular manufacturing methodology will migrate into every corner of manufacturing.
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Managers at machine shops with saws closely monitor downtime associated with blade changes due to wear or breakage and spend a considerable amount of time and energy finding ways to increase efficiency.

The service life of a bandsaw blade and the quality of the imparted surface finish are not determined solely by the product design from a blade manufacturer. Machine maintenance and operating practices can impact performance.

The sawing process has many variables, including the choice of blade for the job at hand, the selected feed rate and cutting speed, the rake angle and how a saw is broken in.

Break It Easy

Saws themselves shouldn’t need to be broken in, but blades do. Breaking in a bandsaw blade essentially means honing each tooth to form a microfine radius. This smoothing removes microscopic rough edges, which could rip off and cause tiny imperfections at the tip of each tooth as a result.

A new saw blade is comparable to a newly sharpened pencil point.

“When you first remove the pencil from the sharpener, it will take only the slightest amount of pressure to inadvertently break that point right off at the tip,” said Richard Klipp, president of Morgantown, Pennsylvania-based Behringer Saws Inc. “However, after a few minutes of writing, the point becomes less sharp and ultimately less susceptible to breakage.”

Teeth on new bandsaw blades have very sharp edges, which easily can be chipped unevenly or destroyed if run at full speed with full feed pressure on the initial cuts and not broken in properly.
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He said the same holds true for a saw blade. Right out of the box, a saw blade tip is very sharp and more susceptible to damage, such as a broken tooth, than after being used for a short period. Blade suppliers therefore often recommend running at a reduced down feed rate—usually 20% to 50% of the suggested rate—until tips are broken in. Afterward, the feed can be set at the recommended rate.

This process allows a blade to travel through the guides and become aligned correctly for cutting. Also, this increases the temperature of the blade, which permits imperfections in the material to bend.

When a blade is properly broken in, premature tooth edge damage can be avoided.
instead of breaking blade teeth. The warming—followed by natural, inherent cooling—helps strengthen the blade substrate.

“Typically, blades need to be run with break-in in mind for two to three hours,” said Ebony Goldsmith, office manager and bandsaw specialist at Aldan, Pennsylvania-based Kaast Machine Tools Inc. “A blade that is not broken in will likely only last about an hour. A properly broke-in blade should last 100 to 150 hours.”

Saw specialists agree that a broken-in blade should see significantly increased service life yet conceded that users may have different perspectives.

“Some feel it is not worthwhile enough to slow down the cutting operation to break in a blade,” said Tim O’Loughlin, saws and hand tools product manager at The L.S. Starrett Co., Athol, Massachusetts. “However, while the break-in

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**about the author**

Yesenia Duran is a Chicago-based freelance journalist who covers cutting tools and technology. She can be reached at sennyx@gmail.com.

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‘A blade that is not broken in will likely only last about an hour. A properly broke-in blade should last 100 to 150 hours.’

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Choosing the Correct Blade

While it is best to consult with a blade manufacturer or supplier to determine the optimal blade for an application, some general guidelines are helpful.

The process to break in a bandsaw blade varies depending on the characteristics of the workpiece material, said Jay Gordon, North American sales manager of saws and hand tools at L.S. Starrett. When breaking in a blade, users should run the machine at the normal blade speed.

For softer materials, such as carbon steel and aluminum, adjust the feed to 50% of the normal rate for the first 50 to 100 sq. in. Then, gradually increase the feed rate to 100%, he suggested.

For difficult-to-cut materials, such as nickel-base alloys, hardened steel, tool steel and stainless, adjust the feed rate to 75% of the normal cutting rate for the first 25 to 75 sq. in. Gradually increase the feed rate to reach 100% after 50 sq. in. As the feed increases to the 100% rate, be careful not to create unwanted vibrations by increasing the rate too quickly.

Once teeth are honed and broken in, a blade will cut faster and straighter and last longer than an incorrectly broken-in blade. Following a proper break-in process is a simple, easy way to ensure maximum productivity in a sawing operation.

Users should consult a machine manufacturer for the best blade width, except for contour cutting in vertical machines when a chart can be referenced. (See the blade width graph on Page 60.) As for blade length, it varies according to the bandsaw machine type and specifications. The correct blade length should be shown in the bandsaw machine user manual.

Counting Teeth

Blade pitch, defined as the number of teeth per inch, must be selected, O’Loughlin said. The number of teeth that contact a workpiece can affect blade performance and durability. Too many or too few teeth can cause strippage, especially when the feed rate or speed is too high or low.

For example, too many teeth per
other fluids but are expensive.

3. Straight oils are not diluted or water-soluble. These are made with an oil base and sometimes contain fat and vegetable oils, as well as sulfur and chlorine. Oil-based products present the best lubrication but the worst cooling when compared with other fluids.

4. Semisynthetic fluids are a mix of synthetic and soluble fluids and share some of their characteristics. Semisynthetics are cheaper than synthetics. Insufficiently or overly diluted coolant can result in production of foam, inadequate chip removal or a lack of cooling during the cut.

Source: Ebony Goldsmith, office manager and bandsaw specialist at Kaast Machine Tools Inc.

These images show a saw blade before and after the break-in process. The rough edges in the top image are realigned in the bottom image.
inch can greatly reduce the cutting speed and ultimately make material impossible to cut. At a lower cutting speed, there is less penetration per tooth, causing more rubbing than cutting, which can result in substantial workhardening of material and strip the teeth. Workhardening also is compounded by an inability to evacuate chips because gullets load up more easily in fine-pitch blades, increasing friction.

A constant-pitch blade can increase harmonic vibrations. By varying tooth spacing, sawing rhythms are interrupted, chip evacuation improves and vibration abates, resulting in less noise and a better overall cut.

Consider whether constant or variable pitch is better. With constant pitch, which is typically for

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Bend the stem to reach inaccessible locations, in confined areas, down in a hole, inside a cavity or in a buried feature which cannot be seen.

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Ball Width

<table>
<thead>
<tr>
<th>Blade Width</th>
<th>Radius</th>
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<tbody>
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<td>¼&quot; (6mm)</td>
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<tr>
<td>⅜&quot; (10mm)</td>
<td>⅛&quot; (16mm)</td>
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<td>1/₄&quot; (6mm)</td>
<td>1 ½&quot; (38mm)</td>
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<td>⅜&quot; (5mm)</td>
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<td>⅛&quot; (3mm)</td>
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Consult a machine manufacturer for the best blade width, except for contour cutting in vertical machines when the chart shown above can be referenced.

Long in the Tooth

contributor

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Under Pressure

Also known as down feed, feed pressure represents the amount of force that pushes a blade into material. Feed pressure can be static or adjustable, dependent on the machine being run, and is set by the saw operator.

Feed rate is the speed at which material is removed by the teeth of a blade, usually listed as square ipm. The rate is determined by the material being cut, the blade used and the blade speed.

Blade speed, which typically is measured in sfm, refers to the speed at which a blade travels around the guide wheel. Harder metals, such as steel, require a slower blade speed than softer materials, such as aluminum, to achieve a smooth cut.

Source: Ebony Goldsmith, office manager and bandsaw specialist at Kaast Machine Tools Inc.

general-purpose sawing, all teeth on a blade have uniform spacing, gullet depths and rake angles throughout the full length. Variable-pitch teeth have varying teeth sizes and gullet depths to substantially reduce noise levels and vibrations. The latter cuts all structural, tubing and solids smoothly and quickly.

Rake It In

The rake refers to the tooth shape, specifically the angle of the cutting end of the tooth. Most bandsaw blade teeth have a 0° rake or slight positive rake. The more positive the rake is, the more aggressive the blade cuts. A positive angle increases the tilt of the tooth face and is best suited for heavy-wall tubing and thick solids. Straight or less positive rakes are preferred for bundle and structural cutting. A variable rake indicates that teeth are set to different entry angles, resulting in different amounts of material removed by each tooth.

“Typically, a variable rake is used for cutting at a slow rate,” Goldsmith said. “A ‘hard’ rake has a larger angle, allowing more room for chip formation. A ‘soft’ rake has a narrower angle with less room for chip formation.”

Wide material requires a hard rake as the chips will be larger than those produced when sawing narrow material. The “set” refers to the pattern in which the teeth bend away from the centerline of the blade to create space for it to fit through the cut slot. In an alternate set, every other tooth is bent the same direction away from the centerline, and the other half of the teeth are bent the opposite direction away from the centerline. In a raker set, some teeth are not bent outward but left in the center to rake waste out of the cut. In general, raker sets are used with aggressive cutting blades.

“Choose the proper tooth rake based on the material and shapes to be cut,” Goldsmith said.

Head Machinist Davin Erickson has followed top CNC machining channels on Instagram and YouTube for years. Always looking for inspiration from other machinists, he was impressed when he saw a robot operating a machine without caging. Despite the common fear that robots steal jobs, he and some co-workers suggested to management that the use of collaborative robots, or cobots, be considered.

“We then began to see these collaborative robots everywhere on social media and at trade shows,” Erickson said. “We tried to convince our CEO that this would be great for our factory. It took a few tries. But since it was very difficult to find good human help around here, we finally welcomed our first robot in the summer of 2018.”

Empowering people is what made CEO Craig Zoberis decide to proceed with Universal Robots USA Inc., Ann Arbor, Michigan, and Robotiq Inc., Lévis, Quebec, as partners for his cobots project.

“I read this Lean Robotics book written by Samuel Bouchard, which taught me many things, but the most important is that robots help fulfill human potential,” Zoberis said. “So instead of having our staff loading and unloading machines every 10 minutes, they can focus on machine programming and any other value-added tasks.”

Fusion OEM deployed four cobots in less than a year. The automated application starts with parts—presented on a nesting system—being picked up by Robotiq’s Hand-E adaptive gripper (single or dual setup), which is mounted on a Universal Robots UR5e or UR10e cobot depending on a machine’s requirements. The gripper then opens the door and carefully inserts the part into the chuck using Robotiq’s Force Copilot software, which is UR+ certified, meaning that it interfaces seamlessly with Universal Robots’ cobots. The robot then closes the door and signals to the machine to start the cycle.

The gripper, which is for precise insertion of parts and has customizable fingertips, was a perfect match for Fusion OEM’s machine-tending operations.

“[W]e’re able to connect the grippers directly to the robot’s wrist, get feedback on position and force and...
‘BROBOTS’

A Robotiq Hand-E adaptive gripper with a dual setup that’s mounted on a Universal Robots cobot tends to a Haas CNC machine at Fusion OEM.

know if there’s a part where there should be one and if it’s the right part,” said R&D Manager Stephen Milchuck, who needed only a few minutes to begin operating Hand-E with its software interface. Inserting a part into a machine chuck requires many programming steps, especially when using a robot’s force control for better accuracy and repeatability. “The program was getting pretty

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big because we were trying to have the robot accomplish all movements through different axes to place the part,” said Engineering Manager Jacob Miller. “Then, by adding one or two lines of code through Force Copilot, we let the software generate all the part positioning in a much faster and simpler way.”

The new application quickly proved its value. Chief Operating Officer Ken Chess started gathering data on the company’s most frequently recurring order.

“We often do lots of around 500 parts for this customer,” he said. “Before the robots arrived, it would take almost six days to deliver. But now with the cobots running overnight, it takes three days, and our defect rate has gone down since robots make fewer mistakes than even the best machinists out there.”

Fusion OEM relies on Robotiq’s Insights monitoring software to send text and email alerts to
employees if production stops for any reason. If an employee is off-site, he or she even can log in remotely to solve a problem.

“We also get predictive signals that tell us when a raw part supply is almost empty,” Chess said. “With all these tools helping us maximize runtime, we get a much better margin on the job.”

What started as an exploratory project rapidly showed its reliability. “We monitor the productivity of each robot with Insights data,” Chess said. “We can spot areas of improvements for those robots and plan accordingly for future robot deployment.”

He estimates that running a job on a given machine with a robot is four times cheaper than operating manually.

The addition of robots has helped employees in different ways. Machinist Brian Wroblesky now spends more time on value-added tasks, such as programming machines without having to load them.

“There’s more consistency in the loading and unloading of the parts,” he said. “It’s taken away some of the human error.”

Ease of use is another major plus for employees. Production Supervisor Chris Wenzel had seen numerous industrial robots and was impressed by the offerings from Robotiq and Universal Robots.

“The programming, the interface—everything is easier,” he said. “Now we talk about each program in terms of minutes rather than hours.”

The humans and robots get along pretty well. For Jenny Kim, a machinist, the robots are just like any other equipment inside the shop.

“I call them brobots because they’re like your brothers,” she said. “You have to treat the machines kindly. Respect them, and they respect you back.”

Fusion OEM’s goal is to have robots tending all 14 CNC machines by early 2020. In the next year, the company hopes to double production capacity, increase machine uptime and continue maximizing human potential.
**Note to readers:** After 2019, the People & Companies department no longer will appear in the print and digital issues of Cutting Tool Engineering. However, the existing, expanded People & Companies section of CTE’s website will continue unchanged. Please refer to it for ongoing People & Companies news.

**PEOPLE**

- Schaumburg, Illinois-based **TDM Systems Inc.**, which develops tool data management systems, started a smart manufacturing initiative for North America, appointing **Robert Auer** global business development manager, **Dan Speidel** and **Dave Morley** senior account executives, **Gerhard Buk** service manager and **Eric Graber** and **Henry Miller** product specialists.

**COMPANIES**

- Osseo, Minnesota-based **Die Technology Inc.**, a machine shop and manufacturer of stamping dies, created Osseo-based sister company **Nanotech Precision LLC**, which manufactures small and microsize components.
- Machine tool builder **Doosan Machine Tools Co. Ltd.**, Changwon, South Korea, hosted a record number of attendees from 50 countries at the Doosan International Machine Tool Fair.

**corrections**

The product announcement for contact and radial ball bearings from GMN Bearing USA Ltd. on Page 10 of the July issue contained incorrect information about the ball bearing materials. The company offers steel bearings with silicon-nitride ball material. CTE regrets the error.

The article about extended-reach toolholders in the July issue incorrectly referred to a product from BIG KAISER Precision Tooling Inc. The company’s line of modular mill/turn tools for mill/turn centers is called CKB. CTE regrets the error.
what fraction of the wheel is it using? Zero percent. That gradually becomes 10%, 20%, 30% and finally 90%, if that’s what you’ve set the velocity to achieve. It’s foolish to use only 0%, 10% and 20% of the wheel at the beginning of the stroke.

That’s why incremental cross-feed is better. When you get to the end of the stroke, you can move over almost the entire wheel and immediately use almost all the wheel. There’s no gradually decreasing overlap—just use the entire wheel.

This is illustrated in the figure on Page 24. Gradual cross-feed requires two strokes, forward and back, to get to 90% of the wheel. (Faster cross-feed velocity will cause you to overshoot and miss some of the workpiece.) Incremental cross-feed requires only one stroke. You can do the same job—with the same risk of burn and chatter—in half the number of strokes.

Also, if you use an Al2O3 wheel on a “soft” workpiece, such as steel, hardened steel, stainless steel or a nickel-base alloy, you can get even fancier. Here’s how: 1) Dress the wheel supersharply. 2) Remove almost all the material at deeper DOCs while cross-feeding 90% of the wheel width (the roughing cycle). 3) Dress the wheel semidull. 4) Remove the last 50μm using 12.5% of the wheel width with a smaller DOC and traverse velocity (the finishing cycle). Granted, after the roughing cycle the surface will be a mess, but who cares. We’ll clean that with the duller dress and smaller cross-feed distance.

Using this method, it’s unbelievable how much you can reduce cycle time. I’ve had people attend my three-day class, return to their shops the next morning, try it and email me that evening saying they cut cycle time from eight hours to one with no adverse effects.
ONE GOOD TURN DESERVES ANOTHER

By Robert Weinstein

The past century certainly has seen a variety of developments with turning. Some, including new substrates and chipbreakers, have fine-tuned the process, making it more effective. But overall, turning has remained basically the same. Even indexable inserts used for contouring are set at fixed angles. The inserts have remained static.

Ceratizit SA, Mamer, Luxembourg, hopes to change the turning process altogether with High Dynamic Turning and FreeTurn tools.

The goal is to move from static positioning of the spindle and inserts to a more dynamic position that allows a full range of motion, said Lothar Schmid, innovation manager at Ceratizit’s Innovation Center in Reutte, Austria.

“HDT is the machining concept that uses FreeTurn tools in application,” he said.

Central to HDT is the idea that the spindle essentially can have 360° of freedom. Ceratizit states that this flexibility comes without risk of collision. Also, the approach, or lead, angle can be adjusted during cutting, an especially useful feature when contouring.

The tool body is stable when combining its slender shank and the rotational freedom. The FreeTurn insert attaches by screw and has multiple cutting edges with different properties, including various angles, corner radii and chipbreakers.

The combination of motion and multiple edges means that the FreeTurn tool can cut above and below a piece without having to reposition or change the insert.

“Companies that use HDT with FreeTurn tools will benefit in many ways,” Schmid said. “They will save considerable time changing tools. They’ll save time by having fewer tool changes, less air cuts and higher cutting data with different approach angles. Our customers will also enjoy longer tool life due to the more efficient use of the whole cutting edge. Reduced vibrations can also provide an advantage, and there will also be fewer number of places needed in the tool magazines.”

As the technology and tools develop, machinists will be able to work with the inserts based on job requirements, including different coatings and cutting materials.

To apply FreeTurn tools, a machine needs X, Y and Z linear axes and B and C rotation axes. So far, the technology is compatible for programming with FANUC, Mazatrol and Siemens Sinumerik 840D software.

“We will have a starting standard program of tools at EMO 2019,” Schmid said. “But of course the high flexibility in the FreeTurn tools and inserts allows lots of customized possibilities in cooperation with our customers.”
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