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A quote from the late British artist Henry Moore states: “Art is not to do with the practical side of making a living. It’s to live a fuller human life.”

I thought about the role of art when writing this issue’s Shop Operations column about metal sculptor Chris Bathgate (see Page 18). For nearly two decades, he’s been making sculptures out of machined metal parts that serve no function other than to be aesthetically pleasing.

I heard about his work when reading the agenda for Okuma America Corp.’s latest annual Winter Showcase, which was in late November in Charlotte, North Carolina. I didn’t have the opportunity to attend, but Bathgate shared his Microsoft PowerPoint presentation with me. Early in it, he asked why an artist should be on such an agenda. “What does the pursuit of beauty and art have in common with manufacturing? After all, as an artist, I don’t technically make anything useful.”

Bathgate answered that manufacturing has a lot in common with artistic endeavors when both are performed correctly. “From a process perspective, creating art and creating a utilitarian good often look the same,” he stated.

“For me personally, leveraging technology has allowed me to scale industrial processes that have historically been inaccessible to artists and bring them into my artist practice for experimentation,” Bathgate added.

“To say it another way, machine tools are expensive, artists are often poor, and so we rarely get to play with them for the purposes of creating art.”

To overcome that economic obstacle, Bathgate learned to build his own machine tools when he started sculpting with machined metal. His first CNC milling machine cost about $6,000. As those machines eventually wore out, he replaced them with low-cost commercial models rather than building new ones.

“I think a lot of people would reasonably conclude it’s best to buy an entry-level machine than to build their own,” Bathgate said.

As he learned more and more about machining, Bathgate said the designs of the equipment and tooling inspired his sculptures. “I’m really interested in the tools and the forms that they lend themselves to and building interesting concepts. At any given time, I’m working on something that is interesting from an engineering standpoint, such as a toolholding challenge or some sort of fixturing.”

For the past seven years, Bathgate has managed to support himself financially by selling his art. One of his projects involves reaching out to professional machinists and engineers and encouraging them to experiment with art and to feel that it’s acceptable to produce art for its own sake.

“There is a whole group of people that I think just need a nudge to say it’s OK to make something that’s just interesting in itself,” Bathgate said. “Let’s look at what’s fun and interesting about machining other than making a widget that makes other widgets. I’m getting a bit of traction there, but engineers are die-hard, practical people.”

about the author

Alan Richter is editor of CTE. Contact him at 847-714-0175 or alanr@ctemedia.com.
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One of the great things about operating a machine shop is the potential to succeed and thrive, whether the shop is small, midsize or large. You certainly don’t have to be big to be profitable.

Machine shops are often small businesses where employees personally interact with owners and managers. Many shops are family-owned, with employee relationships being more intimate than at larger companies. This presents unique challenges for shop managers, including how to maintain good relationships with employees, earn their respect and show concern for their well-being. At the same time, managers must not allow themselves to become too involved with employees’ personal lives. They should remain objective and manage from a safe distance. That balancing act between professional and personal can be difficult.

At our shop, 12 employees have been with us for at least 10 years. These workers are almost like extended family. Managing a smaller shop requires balancing family-like relationships in a fair, unbiased manner. This is not an easy job, and it’s important to show respect and even empathy for employees’ personal difficulties. However, establishing boundaries is essential to ensure that employee relationships remain appropriate and aboveboard.

Prior to his retirement from managing our shop, my dad employed people he knew personally outside work—or at least he tried. He was an involved, pushy boss, but he also was generous and gave a shot to people when others wouldn’t. This benefited the company at times, though not always.

One reason my dad succeeded at dealing with employees and balancing his personal and professional relationships was his ability to compartmentalize situations. Even if it was a reprimand or an otherwise unpleasant experience for the recipient, he could block out the personal aspect of the relationship and move on. He had the capacity to handle such circumstances without causing distress.

I try to embrace Dad’s thoughtful qualities, understanding that some people deserve a second chance in life. The daily grind of managing a shop can make one cynical about people and their problems, but employees are human and have issues.

A related challenge arises when a worker is promoted to manage people who were previously his or her co-workers. It’s not an easy situation to tackle, and much thought should be given to how this arrangement may impact employee relationships. If you’re climbing the career ladder to become a manager but finding that doing so causes friction with other employees, maybe your management ambition would be better applied at another company. But if you are capable of incorporating my dad’s knack for compartmentalization and aren’t overly sensitive, managing friends and peers can work. There are many examples of shop owners and managers who were once regular employees at those shops.

Small businesses, including machine shops, employ tightknit groups of people who must find a way to operate in a professional manner. If you’re able to put personal history aside for the benefit of the company, you likely will be far more successful at managing your team.

**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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When high-speed machining, excessive vibrations can cause unacceptable surface defects. Can 5G, the latest generation of cellular mobile communications, transmit critical machining data fast enough to slash the number of such part defects in industrial settings?

One partnership aims to find out. Fraunhofer Institute for Production Technology, Aachen, Germany, has joined forces with telecommunications firm Ericsson, Stockholm, and machine tool builder GF Machining Solutions Management SA, Geneva, to create an extremely fast-acting process monitoring system based on 5G technology.

Fraunhofer IPT, which researches production technology, developed the system’s wireless sensor. It is basically an accelerometer attached to a workpiece during milling, explained Niels König, the institute’s head of production measurement. Ericsson supplies the 5G communication technology that transmits sensor data, and GF is responsible for making the wireless sensor technology work in machine tools.

GF machines can house more than 200 sensors, but none are placed on the part being machined, noted Roberto Perez, the company’s head of innovation for digital transformation. “Sensors with wireless 5G connectivity are a new means of providing information about (part) vibration and potential defects,” he said.

According to the partners, wired sensing systems and even wireless LAN cannot meet the speed demands of this application. 5G, they say, is the only option for transmitting production data in under one millisecond, thereby minimizing troublesome latency. The goal is to allow real-time monitoring of sensor vibration data and dramatically shorten reaction times when cutting parameters need to be adjusted to prevent defects.

With its high-value components and stringent quality standards, the partners believe that the aeronautics industry may be an early adopter of 5G production technology. In this industry, any small defect is a risk, Perez said. In their battle against part defects, he said, aircraft companies spend a good deal of time and money reworking parts and incur the cost of high scrap rates.

5G technology could help. Consider the production of a blade-integrated disk, or blisk, a component of a jet engine compressor. During milling, the action of the cutting tool can cause a blisk to vibrate at its resonant frequency, König said. This produces a wavy surface, he said, which is typically dealt with by manually reworking it. In conventional blisk production, rework rates can be as high as 25 percent, the project
partners report. Using 5G technology, however, blisk manufacturers could measure critical vibration frequencies in real time and adjust the milling process when necessary—slightly increasing the spindle speed, for example. “That gets the blade out of its resonant frequency, and you get a smooth surface,” König said.

In addition to aeronautics, 5G process monitoring could help other industries with demanding surface quality requirements, including medical, automotive and mold and die. The project partners estimate that their technology could save up to $30 million a year for a single factory.

At IMTS 2018, the partners demonstrated their technology, integrating it into a live machining process to take acceleration measurements. But the current state of the technology will not do for commercial applications.

“Right now, we have quite bulky 5G transceiver systems,” König said, adding that the partnership’s current system is roughly the size of a shoebox. He thinks that the system needs to be shrunk down to thumbnail size to meet industrial footprint and power consumption requirements.

Such a system might be commercially available in the not-too-distant future. “We are a research institute, so it’s not our task to deliver products,” König said. “That’s why we usually work with partners.” But after noting that San Diego-based Qualcomm Inc. has delivered the first 5G chipsets, he said, “I think it might take two or three years to have a market-ready sensor.”

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**about the author**

William Leventon is a contributing editor for CTE. Contact him at 609-926-6447 or wleventon@gmail.com.
A metal blisk or heat exchanger component can certainly be aesthetically pleasing, but those and the vast majority of other machined metal parts serve a practical function first and foremost. The metal parts Chris Bathgate machines don’t.

That’s because Bathgate is a metal sculptor. “My approach to sculptures is most purely about the engineering involved, using machine work as the creative medium,” he said.

Bathgate explained that he started to learn welding while in high school and studied sculpture at art school but became disillusioned and dropped out. He continued to weld sculptures but soon tried another approach. That was 18 years ago.

The Art of Machining

Using handmade tools and automated CNC milling and drilling machines, artist Chris Bathgate crafts complex sculptures.
“I started dabbling with machining and quickly found it infinitely more fascinating than welding and shaping steel with the torch,” Bathgate said. “That led me down the road to learning machining.”

Being a struggling artist and with a dearth of low-cost machine tool options, with the possible exception of micromachining centers, Bathgate decided to build his own equipment “using cheaper Chinese iron and off-the-shelf electronics.” Even without a mechanical engineering background, he built two milling machines and two lathes over the years, as well as a 3D printer for making fixtures and models.

“As those machines have worn out and broken down, I’ve substituted them with lower-cost entries,” he added.

In addition to a limited budget, Bathgate’s shop/studio in the basement of his house in Baltimore has a ceiling height of only 6’6”. “Some machine heads go up between the ceiling joints. I’m working in special circumstances for sure,” he said, adding that he’s looking to move to a ground-level studio.

The selection of workpiece

**Examples of Chris Bathgate’s machined metal sculptures.**

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materials Bathgate machines includes aluminum, steel, brass, bronze and copper bought from stock, and he rarely repurposes metal objects. One exception was copper cores from a linear accelerator. “It is oxygen-free copper, which is the absolute softest and gummiest material you will ever cut,” he said. “It was difficult to hold without damaging it, and then it was difficult to cut from the standpoint that it was welding onto all my cutters.”

While a challenge to machine, Bathgate added that the copper had a nice, deep orange shade after powder coating, which is a process he also learned to perform and developed the equipment for doing.

At first glance, his sculptures look like they would be right at home on the set of “Flash Gordon,” but that’s not the plan. “I don’t intentionally design anything to art deco or raygun gothic aesthetic, but machine work lends itself to it,” Bathgate said. “I’m not interested in creating objects that have a fictional back story.”

After working primarily in isolation for the first 10 years, he found people with similar interests through social media groups and communities and has occasionally collaborated on projects. Those include face-to-face collaborations working at each other’s shop and a project in which the collaboration was strictly via the design process. “I’m pretty picky, and I don’t do it very often,” he said.

Bathgate is also a bit picky about who purchases his large, one-of-a-kind works, which might require hundreds of hours of machining, finishing and assembly to produce and can sell for upward of $50,000. He is choosy because he sometimes needs to borrow his art for exhibitions. As a result, overseas fans of his work aren’t able to buy direct.

For those on a more limited
budget, Bathgate sells smaller kinetic art for as low as $200. “I make a lot of small editions these days,” he said. “That stuff is highly collectible and in its own separate world.” Overall sales are steady enough that he was able to quit his day job seven years ago.

In addition to machining and continuing to learn new techniques and technologies, Bathgate is reaching out to metalworking professionals to help show them how much fun they can have producing something highly engineered that’s beautiful for its own sake.

“I feel like a lot of engineers and machinists who would be inclined to experiment with art don’t feel like they have permission to,” he said. “They have spent their lives making things that are functional and have justification for their existence. Engineers are just wired that way.”

For anyone running a machine shop who is seeking an experienced machinist, Bathgate is not that guy. “People have asked me if I would work for a machine shop, and the last thing I would want to do is work in a machine shop all day and make parts that I didn’t want to make and do work that I didn’t find satisfying and then come home and try to do some creative work with that same process,” he said. “It was better to keep those things distinctly separate—the day job versus what I would consider my real work.”

For more information about Chris Bathgate, visit www.chrisbathgate.com.

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When was the last time you looked at your shop? I know: You look at it every day. It seems fine, right? Maybe not.

I’ve been recommending and purchasing capital equipment for about 20 years. What amazes me is that once machines are purchased, installed and running, in many cases they look 10 years old within the first year. Operators don’t bother to wipe down machines at the end of their shifts. Employees don’t wipe up coolant or oil spills. What about hosing down the interior work area? Don’t tell me that these same machines have a decent preventive maintenance program. If they look like hell on the outside, you can probably rest assured they’re as bad on the inside.

I’ve been fortunate to travel to many shops and manufacturing facilities of various sizes across the U.S. and Canada and overseas. The company where I started out decades ago was the filthiest place I have ever worked. After three months, I couldn’t take it anymore and left, vowing never to work in manufacturing again. Oh, well, never say never.

I’ve worked at and visited machine shops that machined industrial plastics, including graphite. At some of these shops, I couldn’t tell they machined graphite, because their dust collection was awesome. At others, as soon as I walked past a machine that cut graphite, I would blow my nose and black particulates would come out. I knew that this was coming because everything had a coating of black dust. I didn’t want to touch anything, but the employees and management were not concerned.

However, shops that machined aerospace and medical components were usually clean, typically with state-of-the-art machines. But they had many older machines in the 5- to 10-year-old range. These machines were pristine. If I didn’t know the age of the machines, I would swear they were only a year or two old. There were several reasons for this. The shops machined parts for critical industries. The machines were inspected frequently. Customers would stop by to see how their products were coming along. Parts had to be clean before shipping them.

I once went to Singapore and visited a facility that machined components that required a metalized spray coating. The shop had banks of machines. It was temperature-controlled, and I could almost eat off the floor. Talk about clean. Most machines were in the 5- to 10-year-old range and looked almost new. There were no oil stains or drips from the viewing window or door. There were no oil spills or leaks on the floor by the machines. People took pride in their machines and facility.

I’ve worked at shops where if they knew that customers were coming the next day, everyone took a couple of hours to clean up extra well. For a shop with 30 workers, that would mean 60 hours of lost production. But companies do this a lot and think nothing of it. If you take pride in your equipment, it will show. When customers walk in, they will see the pride in your shop.

Take a look around your shop again. Do you see it in a different light? Is it worthy of visitors all the time, or do you have to scramble when notified of expected visitors?

about the author

Michael Deren is a manufacturing engineer/project manager and a regular CTE contributor. Contact him at mderen1@wi.rr.com.
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A moldmaking shop increases productivity with femtosecond laser technology.

Cover Story
By GF Machining Solutions LLC

Femtosecond laser technology represents a new frontier in moldmaking. The aim of this laser is not to replace traditional machining methods but to complement them in a way that ultimately leads to increased productivity for mold shops and other part manufacturers alike.

Providence Texture LLC, Smithfield, Rhode Island, is a shop leading the way and showing how much femtosecond lasers can do. Applying the latest technology to moldmaking is a family tradition for President and CEO Matt Melonio. In 1982, his father, Hank, and uncle, Don Sr., established New Castle, Pennsylvania-based Custom Etch Inc., where Matt got his start in the industry right out of high school in 1991. Custom Etch went on to help pioneer the use of 5-axis laser texturing this decade when it was among the first shops in North America to incorporate Lincolnshire, Illinois-based GF Machining Solutions LLC’s AgieCharmilles Laser 4000 5Ax, which handles workpieces up to 4m × 3m.

In 2016, Matt left his family’s business to strike out

A femtosecond laser machined this cavity in a mold for a medical implant. Providence Texture cut the cavity, injection runners, venting, guide channels for over-molding and identification information in a single setup. The blurry lines in the foreground indicate 1mm increments.
Second to None

on his own and focus on the future of laser technology, given that femtosecond lasers and 5-axis capabilities were growing in prominence. He worked closely with GF Machining Solutions’ applications engineers and R&D department as he formed Providence Texture with the AgieCharmilles Laser P series as its foundation, including the first dual-source Laser P 400 U in a North American job shop.

“The femtosecond laser technology was so new that when I got it, many aspects were undergoing active development,” Matt said, adding that he traveled to GF Machining Solutions’ global headquarters in Geneva twice in late 2016 to perform proof-of-concept work. “I quickly found myself with jobs that required the new laser technology.”

Rapid Rate

Femtosecond lasers are, as their name implies, lasers with pulses in the range of a femtosecond, or one quadrillionth of a second. This pulse length puts these lasers in the category of ultrashort pulses. A prominent advantage of this extremely short pulse length is the reduction of heat absorption, a quality that has made femtosecond lasers useful for medical applications, particularly ophthalmological procedures, such as LASIK.

Naturally, the avoidance of heat transference and a high degree of precision make femtosecond lasers excellent tools for intricate mold and part production. Nanosecond lasers are widely known to produce recast and burrs during ablation and can produce sufficient heat

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Several AgieCharmilles laser texturing machines at Providence Texture are connected with a System 3R palletized automation system.
to harden materials and damage coatings. Femtosecond lasers avoid these issues, making femtosecond lasers suitable for heat-sensitive parts. The ultrashort pulse of the laser prevents workpiece materials from entering a fusion state during ablation, thus eliminating recast or burr formation, imparting an exceptionally fine finish and avoiding residual heat-affected zones.

Unlike sinker EDMing or conventional micromachining, laser micromachining has relatively few requirements. One is simple line of sight, a far less restrictive requirement than with other machining operations. As a noncontact tool, the laser allows Providence Texture to create small mold features at working distances unobtainable with sinker EDMing and reach places otherwise impossible even with the smallest-of-diameter spindles.

Another requirement involves the working distance to the part or mold surface. Because lasers use amplified light as the cutting tool, they rely on lenses and relative focal distances—the distance from the lens to the workpiece—for their material removal capabilities. Many femtosecond laser options on the market are optimized for micromachining or cutting and have a working distance of only 1mm to 3mm, owing to a pulse diameter of just a few microns. This allows for amazing detail on flat or tubular surfaces but makes 5-axis work impossible.

Providence Texture’s 5-axis femtosecond laser has a flexible working distance that ranges from 73mm to 300mm depending on the lens.
option, which is an incredibly generous range for laser texturing and other moldmaking applications. At these distances, laser pulse diameters, or spot sizes, can range from 18µm to 70µm at full power. However, refined parameters may yield spot sizes measured in the single-digit microns. The laser’s 5-axis movement also excels in terms of angles of attack, with high-quality cuts remaining possible at up to 70° angles.

**Automated Production**

The production cell at Providence Texture’s 5,000-sq.-ft. facility includes a Laser P 1200 U with a 50w infrared nanosecond laser, a Laser P 1000 U with a 30w infrared nanosecond laser and a Laser P 400 U, which features a dual-source 20w infrared femtosecond laser and a 30w infrared nanosecond laser. The 1000 U and 400 U are connected with a System 3R palletized automation system featuring Dynafix and Macro standard pallets with custom fixturing, as well as 28’ of linear track for a Transformer robot.

Providence Texture has found that the key to maintaining the highest levels of part precision during production is automation. With its System 3R automation and custom fixturing designed around the laser’s capabilities, the shop keeps repeatability within ±3µm. Automation capacity also makes it possible for the shop to handle a high-mix, low-volume manufacturing environment and easily adapt to high-volume production when necessary. Production lot sizes range from one-offs to tens of thousands of parts.

“I would definitely recommend a laser paired with automation,” Matt said. “With our custom fixtures, we can program a reference offset and know that we’re within 2µm to 3µm of accuracy when that fixture goes back in front of the laser. That kind of precision is key when you’re working at the micron level. We keep the ambient shop temperature within 4°F to ensure the greatest possible accuracy.”

Obtaining that level of accuracy with laser micromachining requires a different approach from traditional material-removal operations, Matt said. Unlike the speeds and feeds in milling and turning, the parameters used in laser operations involve the laser’s power output, the laser’s frequency and the speed of the galvanometric mirrors that control the laser’s movement across the workpiece.

Generally speaking, power is the most straightforward of these factors: Set the laser’s power to 20 percent and in most cases the output is 20 percent. The laser’s oscillation frequency has a more complex relationship with DOC and detail. As a rule, higher frequencies create higher-quality cuts at slower removal rates. There similarly is a correlation with the speed of the galvanometric mirrors’ movement across the material surface, affecting both removal rates and surface quality. By managing these factors, whether through trial and error or the use of known parameters, operators can significantly vary the DOC per slice.

Since starting Providence Texture, Matt has had the opportunity to rethink and establish many of the parameters he uses today. His background is in mold texturing dominated by packaging, consumer goods and automotive, but his company also serves a range of other industries, such as medical, aerospace, lighting, defense, and more.

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For more information about Providence Texture LLC, view a video presentation at www.ctemag.com by scanning the QR code on your smartphone or entering this URL on your web browser:

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jewelry, sports equipment and electronics. The shop produces a vast scope of textures, including those with extremely low $R_a$ value surface finishes. However, more and more the company uses its Laser P 400 U to micromachine part features.

Many of these part features are deceptively simple, such as V-shaped grooves to add pressure to gasket seals that may be as little as 0.005” deep or 1mm to 2mm threaded features on a plastic syringe barrel injection mold. Femtosecond lasers can create many of these features faster and at less expense than a typical sinker EDM, as well as features that demand micron-level tolerances that would be difficult or impossible to achieve with traditional techniques.

Matt plans to soon add a second Laser P 400 U to conduct more research on the potential of femtosecond laser technology.

“I see many, many new applications to come,” he said. “And a second machine will let me explore those possibilities without bottlenecking production. We’re only scratching the surface of what the femtosecond laser is capable of. It’s only a matter of time before it changes the whole industry as we know it.”

For more information about Providence Texture LLC, call 401-642-9490 or visit www.providence texture.com. For more information about GF Machining Solutions LLC, call 847-913-5300 or visit www.gfms.com. Matt Melonio will speak at the ANTEC 2019 conference in Detroit March 18 about machining with lasers.

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What’s in a name? For KRC Machine Tool Solutions, a lot.

The Independence, Kentucky-based company launched 30 years ago as Kentucky Rebuild Corp. and focused on retrofitting, rebuilding and remanufacturing machine tools. The company later became KRC Machine Tool Services.

“We wanted to get away from the idea that we could only service the state of Kentucky,” said KRC Machine Tool Solutions Marketing Manager Caitlin DeVore, adding that KRC has a presence in almost every state and has done work internationally. “We have a new division of our business in California that we call Complete Maintenance Solutions. We have about 25 employees out there that do all the maintenance and repair work for an aerospace manufacturing facility.”

But KRC doesn’t just offer services for machine tools already producing parts and therefore rebranded itself in 2019. “The new direction is now machine tool solutions,” DeVore said. “That way, people understand we can encompass everything from service and repair at a customer facility all the way to building a new machine.”

In addition to building custom, multi-axis machine tools and the new Fusion VI large-format gantry machine, which has a
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milling mast and secondary mast for abrasive waterjet trimming of composites, KRC recently launched a private-label line of vertical turning lathes and supplies Lazzati boring machines, Mario Carnaghi milling machines and Velocity vertical turning centers. KRC also is an authorized distributor of products for Heidenhain, Aries, Renishaw, FANUC, Siemens and Fagor.

The company remanufactures machines too and offers them as KRC-certified used machines. “From time to time in the marketplace, we will find a good machine that still has life left,” DeVore said. “We will buy it, retrofit it, do the mechanical rebuild and then sell it as a certified used machine with a new machine warranty on it. We label it as a certified used machine because we know that just like with our rebuilt machines, this machine is going to have the alignments and accuracy of OEM specifications or better. We typically do one or two of these per year, and we have four or five in storage.”

The Three R’s

Basically, three options exist for
getting a used machine into like-new or better condition: retrofit, rebuild or remanufacture. KRC states that a retrofit is for a mechanically sound machine with an outdated control and involves replacing the control, servo and spindle motors, drives and electrical components, along with installing new wiring. A rebuild involves reconstructing all mechanical components, replacing all bearings and seals, grinding hardened ways, hand scraping wear surfaces or replacing linear guides, repairing or replacing ballscrews, rebuilding the hydraulic and lube system, repairing or replacing way wipers and way covers, painting the machine and returning machine geometric alignments and positioning accuracy to OEM specs or better.

“It’s usually better,” said Jerry Mullins, a scraping contractor who has worked at KRC for 18 years. Mullins added that he received training from someone at the former Cincinnati Milacron Inc. about seven years prior to scraping for KRC. “He said I would probably never use this because scraping is a dying art and

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nobody does it. I do more scraping now than I ever have.”

When rebuilding a circa 1976 vertical turning lathe, hand scraping consumed about eight hours a day, 40 hours a week for three or four weeks, Mullins said. “Some machines are bigger and take longer to scrape, and smaller machines you can do in a couple of weeks. With proper preventive maintenance, a good scrape job will probably last 10 years.”

A remanufacture includes all the rebuild steps, a CNC retrofit and at times a machine redesign to enhance its capabilities and improve its productivity. According to KRC, remanufacturing a machine costs about half of a new machine and is most appropriate when replacement costs exceed $600,000.

Remanufacturing or rebuilding a machine also can save time because the lead time on a new machine is usually longer. “Typically, it’s half the time to get them the machine and half the cost when rebuilding,” DeVore said.

She added that depending on the machine condition and work scope, a retrofit can take six to eight weeks, a rebuild takes roughly three to four months depending on part availability and delivery, and a remanufacture is typically at least a six-month project. Additional time might be required if replacements for worn components are no longer available and must be re-engineered and produced.

KRC annually performs five or six retrofits, about five complete in-house rebuilds at its 35,000-sq.-ft. facility and six or seven partial rebuilds at customer facilities, DeVore said. “We can never do a complete rebuild at a customer facility. There are just too many parts and not enough room, or you can’t keep the manpower out of service that long.”

The company also remanufactures or customizes two or three machines each year. “Some customers come to us with a special application or a part that they can’t quite fit on the setup of an existing piece of equipment,” DeVore said. “We have a full engineering department here that can redesign their existing machine and expand

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about the author
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its functionality, or we can redesign and build a brand-new machine for that special application as a one-off custom machine.”

Managing a Project
DeVore emphasized that project management and the strategic planning that goes into project management provide significant value to KRC customers. “At the beginning of a project, the customer is given a detailed, mapped-out, specific line-by-line plan of how that project gets laid out. We do everything we can to hit the delivery date that we give them.”

That effort might require making strategic adjustments in labor allocation, for example, if KRC finds that it is running behind or ahead of schedule, she added. “Our customers have a commitment to their customers to deliver parts. So we have to execute on our end and make sure the delivery date that we tell them is exactly what it is. If this machine is late, that is going to cost our customer money.”

DeVore said KRC’s project plan covers milestones, part ordering and the installation and engineering functions. “It breaks down exactly what’s going on and how many days it’s going to take. Every single week, it is updated and sent to our customer.”

Whether it is a time-sensitive project or whether the work is performed in-house or at a customer’s facility, finding workers with the required skills can be even more challenging than in other manufacturing sectors.

“She do everything we can to hit the delivery date that we give them.’

“The guys that we bring in have to know a wide variety of machine tools,” DeVore said. “Our value is that when we take a service call and someone goes to a facility, he can service and troubleshoot almost every piece of equipment in that facility.”

To assist that effort, KRC is reaching out to trade schools to develop partnerships and relationships with them and help them create curricula for providing the proper training, she added. In return, KRC would...
Rebuilding Capacity and Efficiency

It’s no secret that grinding machines age through wear and tear. After decades of heavy use, especially with deferred routine maintenance, grinders’ accuracy and geometry begin to suffer as the machines essentially grind themselves away. When downtime becomes more frequent than production time, however, the newly expanded rebuild department at United Grinding North America Inc., Miamisburg, Ohio, has the capability to put equipment back in service, restoring it to its original specifications or even adding functionality. United Grinding North America began performing rebuild services in 2010.

In less than a decade, the company has expanded from providing basic parts and services to doing full tear-down rebuilds that replace virtually every part, yielding like-new equipment. With materials, parts, machine shops and technicians under one roof at company headquarters, the rebuild department offers enhanced capacity to bring machines back to productive life.

To maintain brand-specific capabilities and specifications for Blohm, Mägerle and Walter grinders, technicians train at factory sites in Europe. For select brands and machines, the department can even update software and controls to match and interconnect with newer products. By 2020, the department plans to add Studer to the roster of brands handled in-house.

Overhauls begin with a full tear-down, close examination of every part and replacement of all worn components. Externally, the basic casting undergoes steam cleaning followed by abrasive blasting and three fresh coats of epoxy paint. Cleaning, blasting and painting refresh the enclosure, which also receives new windows and modern brand styling. The results recertify as new, potentially doubling the life cycle.

Although these procedures require help with their training and possibly provide employment. “That way, we are bringing in young talent while we have so many seasoned people here who are just full of knowledge that they can share. A lot of guys have worked here for 10, 15, 20 years.”

Next Generation

To help continue its growth trajectory, KRC launched the Fusion VI series of multiple-process gantry-style machine tools with a movable bridge and dual vertical masts on parallel rails suspended above the work area. Last year, KRC entered into a technology agreement with Flow Aerospace Systems LLC, Jeffersonville, Indiana, and its partner, Ascent Aerospace LLC, Macomb, Michigan, for the rights to the design and manufacture of its Gen 5 gantry composite machining centers.

DeVore explained, however, that Flow Aerospace has since “shut their doors, and we were able to work with some of their former employees and bring them on board.” Those employees included the chief engineer and project manager.

With that expertise and KRC’s designing, building and retrofitting experience, KRC introduced the sixth-generation Fusion VI machine, which can perform trimming, drilling, routing, milling, marking and inspection in one setup. The two machining heads move in either five axes for milling or six axes for abrasive waterjetting, powered by Flow ultrahigh-pressure intensifiers and cutting heads, along the defined toolpath to produce a completed part. This configuration is ‘Our value is that when we take a service call and someone goes to a facility, he can service and troubleshoot almost every piece of equipment in that facility.’

Better Than New

The Fusion VI gantry-style machine tool has two machining heads that move in either five axes for milling or six axes for abrasive waterjet cutting.
customers to ship equipment for service rather than relying on a local rebuilding service, the OEM knows the equipment that it built better than any third party. So the OEM-trained rebuild department uses only OEM parts, offers a one-year warranty for rebuilding work and supports rebuilt machines on the shop floor.

Rebuilt grinding machines cost about 75 percent of the price of new equipment. Nonetheless, a rebuilt grinder looks, works and produces like new, with recommissioned geometry, renewed guide ways and enhanced precision. A rebuilt machine can maintain familiar control procedures, reducing the need to retrain operators on new equipment. Furthermore, depending on how a company classifies expenses, a rebuilt machine may qualify as a maintenance cost rather than as a capital outlay.

Retrofitting adds innovations that manufacturers introduced after older models went into service. Examples of such technologies are LED lighting, glass scale motion encoders, updated controls and the ability to tackle new forms of production. Advantages of these retrofits include up-to-date developments in the human-machine interfaces, which replace code entry procedures with intuitive Q&A sequences that can eliminate confusion and open up machine operations to a broader range of personnel. The on-site service that adds these options minimizes downtime.

The rebuild department also can add capabilities to an existing machine. To accommodate high-pressure coolant and advanced grinding wheels, for example, an enclosure may be designed for an open-configuration machine. Repurposing can add robotic automation and rotary dressing to machines.

—Harold Tuttle, senior field service manager, United Grinding North America Inc.

tailored for processing composite aerostructures, as well as large parts made of various materials, according to the company.

“Composites is huge in aerospace but is also getting bigger in automotive,” DeVore said. “As we continue to grow, we will find ourselves filtering into different industries and markets based on where the demand is.”

CTE

For more information about KRC Machine Tool Solutions, call 859-283-8300 or visit www.krcmachinetoolsolutions.com.
The conventional method of producing components from hardened tool and alloy steels has long been to rough in the soft state, heat-treat and then EDM or grind all critical features to size. But this decades-old paradigm began to change as cutting tools and tool coatings became more wear-resistant, toolholders became more accurate, machine tools became more rigid and CAM software became more capable. Pioneering machinists learned they could not only finish heat-treated mold and die components but rough them fully hard, significantly boosting productivity and reducing lead times.

Navigating Uncharted Waters
Corey Greenwald is one such machinist. When the owner of the small shop he worked at in 1995 purchased a Yasda vertical machining center, he began experimenting with what seemed impossible at that time: milling CPM tool steel hardened to 64 HRC.

"People thought I was crazy," Greenwald said. "But within six months, I was able to produce punch tooling for connecting rods.
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that previously required four separate operations and 80 hours of manual work. I’d spend a couple hours getting everything ready, push the green button and come in the next morning to a set of four completed punches.”

Greenwald was so successful at this underutilized, often misunderstood machining practice that in 2004 he left to start his own company, Hard Milling Solutions Inc., Romeo, Michigan. He’s since made hard milling a science, carefully building a database of feeds and speeds, step-downs and stepovers, chip loads and other operating parameters that allows his shop to machine virtually any hardened material unattended, without tool breakage and without failure “a majority of the time,” he said.

There’s more to Greenwald’s success than the right parameters, however. He said he was among the first to adopt remote monitoring technology, mounting cameras on each machine and equipping employees with smartphones and laptops so they could keep an eye on production from outside the plant. The team also makes extensive use of broken-tool detection and in-process probing, allowing verification of critical process steps and corrective action to be taken when something goes awry.

As a result, Hard Milling Solutions has machined everything from forging dies for the automotive industry and knee and hip implants for medical applications to tab tooling for can manufacturers. All parts are made of superalloy or equally challenging grades of hardened steel,
and all have tight tolerances.

“We have a 12-piece order on our floor right now for an aerospace customer,” Greenwald said. “The parts are made of 60-HRC A2 tool steel and have 0.0004” tolerances all over the place. That’s a fairly typical requirement for us, but I have to say that every job is unique. Even today, we’re experiencing geometry and materials we’ve never seen before, so we are continuously being challenged. That’s what it takes to keep us engaged.”

**Hard Choices**

If a shop wants to follow in Hard Milling Solutions’ footsteps, it likely will need to climb “one heck of a learning curve” as Greenwald did, although much of the technology he uses is now commonplace. High-quality CNC machine tools comparable to the Makino V56 VMC that he started his company with, for example, are readily available.

Ernie Dickieson, technical sales representative at CAD/CAM provider Open Mind Technologies USA Inc., Needham, Massachusetts, agrees that hard milling is among the most challenging of all machining operations. But he thinks that it is not nearly as difficult as it was even five years ago.

“CNC machines are more robust and rigid,” Dickieson said. “The cutting tools are much better. Perhaps most importantly, there’s far more information available now on how to cut hard materials. And from the programming perspective, I think we and others have done a great job at creating toolpaths that are smoother and more efficient, taking into account the harder materials. Overall, hard milling has become a very achievable task for most shops.”

One example of smoother toolpaths is a new feature in Open Mind Technologies USA’s hyperMill CAM software, which Dickieson said eliminates a common concern for shops making mold surfaces and other fine-featured components:

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**Hard milling has become a very achievable task for most shops.**

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*Kip Hanson is a contributing editor for CTE. Contact him at 520-548-7328 or kip@kahmco.net.*
faceting.

“Most modern CAD/CAM packages apply what is essentially a series of tiny triangles to the workpiece surface—a mesh, if you will—and use it to create the toolpaths,” Dickieson said. “But as machine tools have become better able to precisely follow programmed coordinates, mesh models can actually create a faceted appearance, something that’s problematic on very smooth surfaces, like those used for optics. With our latest hyperMill release, we’ve added the ability to create the toolpath directly on the workpiece surface, eliminating any faceting.”

Dickieson noted that hard milling has traditionally been done on 3-axis machining centers, but this paradigm is beginning to change as mold shops and others embrace 5-axis machine tools. Because of this, he advises shops to rethink their CAM strategies in favor of software effective at tool center point control, collision detection and 5-axis smoothing functions. The type of cutting tool used also plays a role in CAM selection, he added, pointing to conical barrel cutters—also known as circle segment endmills—as an example.

“This is an area we as a company feel very strongly about,” Dickieson said. “Open Mind originally developed programming for barrel cutters to machine large planar surfaces in an efficient manner and presented the new process idea to Emuge to design a tool that would work with the programming. Since then, we’ve developed two machining cycles in our software specifically for conical barrel cutting and have just added a third with the latest release. It’s a very effective solution for moldmakers and others cutting deep, complex cavities.”

The Right Stuff

Another company that feels strongly about hard milling is Tungaloy America Inc., Arlington Heights, Illinois. Vic Dodd, product manager for rotating tools, explained that a number of new, often proprietary hard metals and coatings have hit the market of late—materials that require a new approach to cutting tools.

“It seems to me that a lot of parts are simply getting harder and more difficult to machine,” Dodd said. “Where molds were generally in the 38 to 40 HRC range a few years ago, we’re seeing more of them in the 45 to 50 HRC range today. And several of our customers have asked for help cutting the extremely hard coatings that some manufacturers are applying to plastic injection molds and forging dies. In certain applications, a ceramic milling product might be the first choice, at least until you get below the coating into the softer metal below.”

Even here, steps must be taken to resist the extreme abrasion and subsequent tool wear that come with machining hardened metals, lest tool life “be almost zero,” Dodd said. To this end, Tungaloy America has introduced an MH-style chip-breaker and multiphase coatings to its DoFeed line of indexable, high-feed cutters specifically for hard milling and has adjusted insert geometries as well.

“For the most part,” Dodd said, “this means a larger nose radius to increase fracture resistance, a larger T-land to reduce chipping and a neutral or near neutral rake angle for optimal edge strength.”

Whatever cutting tool is applied,
Dodd mainly recommends dry cutting steel with an air blast to remove chips and using the most rigid, accurate machine tools and toolholders available.

Andy Moon, product manager for milling and GM300 at Guhring Inc., Brookfield, Wisconsin, said much the same thing, suggesting that a high-precision mechanical chuck is generally the best method of holding milling cutters.

“If you’re not down inside a pocket and aren’t concerned about holder interference, I’m most likely going to lean toward one of our HPC milling chucks,” Moon said. “These offer an extremely high level of rigidity, great clamping strength and—because of the mass and the size of the toolholder itself—good vibration dampening.”

Where greater reach is needed, Moon said shrink-fit toolholders offer the best compromise between rigidity and reach, although tool changeover takes several minutes longer and an investment is required in a shrink-fit machine. He also recommends that shops invest in a machine tool with an HSK spindle—the bigger the better—or at least one with a 50-taper if possible. Whatever the spindle interface, steer clear of ER collet chucks for everything except drilling applications, and avoid side lock holders for fine finishing work.

“The importance of a rigid spindle and high-quality toolholders when hard milling is the same as the importance of toolholders in regular milling but even more so,” Moon said. “Because the materials are harder, the cutting forces are greater, which means any runout, vibration or lack of rigidity will be amplified. I find that the shops that are doing well and making the most money are those that have moved to premium toolholders and good-quality machines. This is especially true when they’re faced with hardened steels and other difficult materials.”

**contributors**

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Traditional inspection methods and devices, like surface plates, height gauges, air gauges and dedicated hard gauges, can be expensive to purchase and maintain. They also can be rendered obsolete as jobs come and go. In addition, a gradual increase in the use of geometric dimensioning and tolerancing has made the application of hand tools challenging when measuring things like the true position of holes. Coordinate measuring machines have proliferated in this evolving manufacturing environment.

Introduced in the late 1950s, CMMs have become increasingly common over the past two decades. CMMs have not always been affordable for some part manufacturers. However, as advances in software, machine construction and manufacturing techniques have significantly reduced the cost of CMMs, industry has seen a steady increase in their use.

A CMM can be more desirable than measuring with manual instruments, such as micrometers, calipers and height gauges, because a CMM automates the process. Automating part measurement with a CMM can decrease the need for skilled personnel in the same way a CNC machine tool can. It is common for experienced personnel to program and set up CMMs and then have other employees operate them.

Removing Rigidity

Flexibility is another common reason for buying a CMM. Hard gauges, as their name implies, are rigid. They are built for one part or family of parts—often for measuring just one feature. If the part or process changes, hard gauges must be reworked. CMMs, on the other hand, require only a revision in their program.

Paired with machine tools in a manufacturing cell, a CMM can collect, process and transmit data to be acted on by the other manufacturing equipment. This arrangement substantially lessens the need for humans to interact with the manufacturing process, thereby eliminating opportunities for error.

Although acquisition costs have decreased, the overall ownership costs can be
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daunting, with calibration and repair being most significant. Calibration of a CMM necessitates a visit from the manufacturer, often lasting several days, with costs that can run easily into the tens of thousands of dollars. Most mechanical repairs of a CMM require recalibration after completion, so ensuring that machines receive proper maintenance and care to prevent mechanical failure is critical to controlling costs. Fragility of CMM technology—sometimes real, sometimes perceived—often drives users to segregate CMMs from the shop floor by installing them in climate-controlled quality labs or special enclosures.

Keeping a CMM sequestered from the shop floor calls for the parts needing inspection to travel to the CMM, wait for inspection and then travel back. If deviations are found and the machine tools must be adjusted, the process will begin again. The result is a lot of nonvalue-added activity.

CMM power and flexibility have encouraged manufacturers to aggressively adopt CMM technology, but the fragility of the machines historically has made their use inefficient. Lean manufacturing and basic economics of production have driven demand for machines that can be near the work.

On the Move

Portable measurement arms with CMM-like functions have been avail-

Mitsubishi Hitachi Power Systems does not house its CMMs in a laboratory or special room. This one is integral to a welding cell, and its measurements guide the assembly process.

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- Accurately measure the pitch diameter of bearing races, threaded surfaces and of gears.
the other machines. Manufacturers market these as “shop-floor CMMs.”

Besides producing more robust machines, CMM makers have started creating machine configurations that improve efficiency of the inspection and manufacturing processes. Machines are becoming more compact, which allows them to be integrated into manufacturing cells much easier. CMMs traditionally have been bridge-style machines with stationary tables to support the work and with a movable bridge to carry the ram and probe perpendicular to the table, like a vertical machining center.

Newer designs offer an orientation like that of a horizontal machining center, where the probe is held parallel to the table. Manufacturers also have begun offering features like tactile scanning, optical measurement and industrial internet of things connectivity to enhance the capabilities of CMMs, making them more powerful tools.

While working at a cutting tool manufacturer, I had the opportunity to see firsthand how a floor-based CMM could drive significant improvements. The company manufactured special drills in a robotic cell where the drills were periodically inspected using a lab-based optical system. Each inspection took 45 to 60 minutes, and we routinely wasted a shift at machine changeover.

To overcome this issue, a shop-floor CMM with tactile scanning and optical inspection was purchased and positioned in the cell. Inspection time was reduced to four minutes, and data was provided in a spreadsheet that told operators exactly which offset to adjust with magnitude and direction. Changeover time was reduced to 10 minutes.

Putting CMMs on the manufacturing floor directly improves productivity and efficiency. It is true that inspection is a nonvalue-added activity to customers because they rarely are willing to pay for inspection like they do for welding, forming, machining or assembly.

Despite that viewpoint, inspection, testing and monitoring will never disappear from manufacturing. Integration of CMMs onto shop floors and as a component of manufacturing cells helps decrease shops’ nonvalue-added activity and increase the amount of time they have to add value through other processes.

**about the author**

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IN THE ROUGH

Surface roughness measurement can be challenging.

In an interview with CTE Editor Alan Richter, Ira E. Friedman, precision tool education manager for The L.S. Starrett Co., Athol, Massachusetts, discussed surface roughness measurement, including the latest equipment developments, common challenges, noncontact measurement applications and profile parameters.

Cutting Tool Engineering: What are the latest trends and developments in surface roughness measurement equipment?

Ira E. Friedman: Users of metrology instruments, especially hand-held metrology devices, expect those instruments to have fundamental features, including the ability to communicate with smart devices. Full-color screens and graphical displays, which were rare only a few years ago, are now expected as standard features. Users also prefer USB charging, USB data storage and Bluetooth connectivity. Engineers and quality managers also now have surface measurement tools to examine numerous part parameters. With this development comes a host of quality improvements. While $R_a$ may appear on the print, now they can examine a host of parameters, archive the data and explore ways to improve the process.

CTE: What common challenges do metrology equipment manufacturers and end users face?

Friedman: Surface roughness measurement devices are being used more and more in challenging environments, such as directly on the shop floor. This is forcing metrology manufacturers to design more robust systems while still offering the sensitivity to measure the finest details at high levels of accuracy. Surface roughness

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measurement equipment is evolving with new interfaces and smart technology. With the influence of smartphones and other intuitive devices, surface roughness measurement is easier, faster and less demanding to perform with a high degree of accuracy and reliability. However, the setup for measuring very small parts with a minimum radius can be difficult to achieve. This challenge is typically overcome by using a smaller cutoff value, resulting in a shorter trace. And in some cases, operators will benefit from training to interpret data.

**CTE:** What are the pros and cons of noncontact and contact surface measurement?

**Friedman:** Noncontact measurement has several key advantages over contact measurement, especially for measuring optical and fragile parts and when speed is critical. However, this typically comes with the disadvantage of significantly higher instrument cost. Contact measurement still tends to be preferred in industries that are more cost-sensitive when making the initial capital tool purchase, where more robust instruments are required and where existing standards are in place based on traditional contact methods. I do not see this changing in the immediate future. While conscious of high throughput demands, it comes at a price. Additionally, exploring new parameters and the need for smaller, user-friendly surface finish measuring devices is on the rise. We try to take the...
mystery out of surface roughness as the methodologies to collect the data have changed from the old surface finish sample card, where you would compare a sample from a texture card to a rapid reading. Now, highly accurate, smaller, intuitive packages that archive data points and allow a user to parse the data and explore a surface finish are available.

CTE: What are some of the approaches to parameter selection?

Friedman: Many surface roughness measurement instruments on the market come with a host of parameters built in—not just different parameters but also different filters and parameters based on different standards, such as ISO, JIS and ASME. One approach to parameter selection is to make sure you conform to the best practices in your industry. Many industries have trade associations that help define parameters used for certain parts or manufacturing processes. Another approach is to identify the characteristics of the specific fault being tested for and choose parameters sensitive to these characteristics. Also, many instrument manufacturers are happy to help with parameter selection. Default and/or automatic selection of parameters or filters is rarely a good practice because it will simply select the most common, not the most suitable. The main issue here is what factors about the part being tested are important. If the part is a crankshaft, it will experience different kinds of stresses versus a flat part. The user should strive to understand the application of the correct parameter, along with the correct cutoff value and filter, to eliminate both noise and much of the variability in the process, ultimately achieving a high level of repeatability and process capability.
Anodizing is an economical approach to resolving surface finishing challenges.

By Jeff Elliott

To permit the use of aluminum instead of other, heavier metals in industrial applications, many cylinders are anodized to create an extremely hard surface that resists wear and corrosion, is nonconductive and is lubricious. Because anodized surfaces are porous, they also improve adhesion of coatings, as well as accept a variety of dyes for coloring. Given the myriad benefits, anodizing is popular for a variety of cylindrical items, including lift mechanisms for chairs; lift cylinders for hatchbacks; shock absorbers and forks for bicycles; fuel pumps; water pumps; pneumatic and hydraulic cylinders; spool valves; valve stems; and valve bodies.

By definition, however, the anodizing process means that part dimensions grow dimensionally and the surface finish becomes rougher. For a cylinder, that includes both an increase to the OD and a decrease to the ID. There are several types or classes of anodizing methods, and each reflects a range of coating thicknesses. As a rule, thicker coatings provide greater corrosion protection. Therefore, surfaces last longer in harsh environments, such as salt air.

As for surface finish, a hard coat anodized to 0.002" thickness generally results in an Ra two to three times the original bare metal finish. For example, a machined Ra of 16 easily can become 30 Ra or more after anodizing.

For many parts, this is not an issue. However, when a part is cylindrical and mates with another part, often using a seal, increased dimensions and a rougher surface finish can be problematic.

Anodic coatings are very hard—only slightly less hard than diamond and harder than hard-chrome plating—and increased surface roughness may abrade sealing materials. Seal
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Sharp Ideas for Carbide Cutting Tools
wear and coating irregularities might provide a path for leaks. For this reason, parts require a fine surface finish for reliable sealing and long component life. To accomplish this, many companies utilize honing tools as an economical approach for treating the surface before or after the electrochemical process to control the dimensions and create a smoother surface.

The results are a cost-effective method to resolving finishing challenges in the anodizing process and the consistent yield of high-quality products at a competitive price.

Honing Tools
Manufacturers traditionally have used grinding, lapping and rigid honing to improve the surface finish of anodized and hard-coat anodized parts. For several reasons, however, machine setups are difficult and must be extremely precise. First, the anodized coating is very hard. Second, the total coating thickness is very thin. Third, the high and low points of the anodized coating are not absolutely symmetrical around the centerline of the cylinder ID. When rigid honing is used with anodized parts, the honing stones contact only the coating’s high points, so areas of the cylinder ID remain untouched.

Rigid honing has other issues. Because anodized coatings are thin, just a very small amount of material should be removed. Yet rigid honing works best with heavier cuts and greater material removal. Fine cuts combined with tool loading can contribute to smeared surfaces.

The Flex-Hone Tool from Brush Research Manufacturing Co. Inc., Los Angeles, provides a better way to improve the surface finish of anodized and hard-coated cylinders. The Flex-Hone consists of abrasive globules permanently laminated onto the ends of flexible nylon filaments. Because the diameter of the tool is greater than the diameter of the bore, the Flex-Hone is used in an oversized condition and self-centers, self-aligns and self-compensates for wear.

Importantly, the tool’s globules float to ensure that all parts of the bore—not just the high spots—are

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**about the author**
Jeff Elliott is a Torrance, California-based technical writer who has researched and written about industrial technologies and issues for the past 20 years.
Sizing Up Anodizing

surface-finished. Unlike rigid honing machines, Flex-Hone setups are simple. Surface finishes can be improved with just a few strokes of the tool, and results are consistent.

The tool may be used prior to anodizing to control the size in anticipation of shrinkage in ID. Honing also removes fuzz, sharp edges and any amorphous material that might adhere to the surface and affect the quality of the anodizing.

The most common use for the tool is after anodizing, when correcting unanticipated size and surface finish issues. When quality of the final anodized finish is of utmost importance, some users apply the tool before and after.

With anodized coatings, the recommended abrasive types are 400-, 600- or 800-grit Al₂O₃, and extra-fine levigated alumina. Choice of grit depends on the type and thickness of the anodized coating and the final surface finish specification. Flexible honing tools are available in sizes from 4mm to 36”.

For more information, contact Brush Research Manufacturing Co. Inc. at 323-261-2193 or visit www.brushresearch.com.
**DRILLING.** Nachi America Inc.’s newest drill, the Aqua REVO, improves all three aspects of a cutting tool. A new carbide, geometry and surface treatment provide longer tool life and enhanced versatility. This efficient drill is a welcome entry to the world of product manufacturing.

Nachi America Inc.;
www.nachiamerica.com

**3D IMPORTING.** Hurco Cos. Inc.’s new control feature eliminates extra steps. 3D importing with 3D DXF technology for both 3- and 5-axis machines is a skills gap buster for shops. The control provides integrated CAD/CAM and toolpath simulation. Transform planes are created automatically for easy five-sided conversational programming with no data entry required.

Hurco Cos. Inc.;
www.hurco.com

**HOLEMAKING.** Holemaking operations are less challenging with Kennametal Inc.’s KenTIP FS, such as when chain-hole drilling steel. When drilling steel, it is important to concentrate on coolant delivery to the rake and to remove heat from the contact zone between the chip and rake surface. The new HPG geometry is designed especially for steel and comes in the new, highly wear-resistant grade KCP15A.

Kennametal Inc.;
www.kennametal.com

**DRILLING.** Allied Machine & Engineering Corp.’s new 4TEX drill delivers optimal chip formation and evacuation and provides higher penetration rates than standard twist drills for light-duty machines. This indexable-insert drill excels in applications with interrupted cuts or when drilling angled surfaces. The design increases core strength, improving hole size accuracy and straightness.

Allied Machine & Engineering Corp.;
www.alliedmachine.com

**ENDMILLING.** Precision Cutting Tools LLC’s 360 series endmill improves chip evacuation. The design consists of an eccentric OD, a large gullet and a 1° radial land. The series increases metal-removal rates and minimizes chatter. The endmill is ideal for milling aluminum. Benefits include an increased DOC, improved accuracy, higher speeds and feeds and superior surface finishes.

Precision Cutting Tools LLC;
www.pct-imc.com

**TURNING.** Tungaloy America Inc.’s T9215-grade insert provides wear and fracture resistance when turning ISO P15 materials. A thick, homogenous CVD Al₂O₃ coating and a ceramic layer with 1.5 times the hardness of conventional technology promote wear resistance. The surface treatment enhances machining stability and helps prevent microcracks.

Tungaloy America Inc.;
www.tungaloy.com
Kyocera Precision Tools Inc.'s MFH-Raptor high-feed milling tools allow full radial engagement. They make it possible to quickly and efficiently face large surface areas. The tools can machine deep slots using a unique convex edge design for smooth entry into the workpiece, reducing vibration and enhancing chip evacuation.

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Whether baking a soufflé or trying to beat a red light, timing is everything. So when Brent Schelske, process improvement engineer at Valley Machining Co., Rock Valley, Iowa, stumbled across an advertisement on the Fair Lawn, New Jersey-based Sandvik Coromant Co.’s website for a new kind of parting tool, he immediately contacted the company.

VMC was established in 1980 when founders Len Van Otterloo and Chuck Ver Steeg opened a small machine shop that specialized in multiple-spindle turning. The company has since grown to 85 employees and 100,000 sq. ft. of manufacturing space while serving customers worldwide.

The Wickmans and New Britains on which the business was built are still present, but now there are half a dozen machining centers and more than 20 CNC lathes, many of them twin-spindle multiturret machines with live tools and Y-axis turning capabilities. It was one of these twin-spindle machines that motivated Schelske to contact Sandvik Coromant.

“I was looking something up for a job I was working on, and this video popped up on the screen talking about Y-axis parting,” Schelske said. “And I thought to myself, ‘That’s weird. I wonder if it really works like they say it does.’ Then at the same time, I started thinking about our twin-spindle lathes. You’re always trying to balance the cycle time on one side to the other so as to achieve the greatest productivity. But when you’re cutting off, both spindles are occupied and any improvement is an immediate overall gain. I quite literally called our local tooling distributor about two minutes after seeing the video.”

The video was about the CoroCut QD for Y-axis parting. Compared with conventional parting tools, whose X-axis movement directs the bulk of cutting forces downward against a relatively weak, unsupported blade, Y-axis parting drives most of the cutting forces along the long axis of the blade and toward the tool block. Results are longer tool life, finer surface finishes and significantly higher feed rates.

Days after Schelske viewed the video, he and Tooling Engineer Lyle Schneider headed to the shop floor to work with the parting blade. They encountered a few hurdles, however. The lathe was a Doosan Puma TT2500SY with a 3” bar capacity, an LNS Sprint 12’ bar feeder and a 1,000-psi MP Systems high-pressure

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coolant unit—one of two such machines at VMC. Schelske removed his old cutoff blade and mounted the new one in an extended-length WTO tool block. But he realized he would have to modify the arrangement to utilize the through-the-tool coolant, a must for the parting tool to be applied at anywhere near the advertised feed rates.

Although that problem was not a big deal, another problem was almost disastrous. “We did some light parting to test things out,” Schelske said. “And then I said, ‘OK, everything looks good. Let’s give it a whirl.’ The second I hit cycle start, the blade slammed into the workpiece at 3,000 rpm. I’d forgotten that with G96 constant surface speed engaged, the control is normally looking at the X-axis position to calculate the correct rpm value. But with Y-axis parting, the tool is positioned on the X-axis centerline, so of course it shot up to the maximum rpm.”

Fortunately, the tool survived. Schelske then tried programming the cutoff operation in multiple steps, gradually increasing the rpm as the Y-axis approached center. Results were not satisfactory. After searching the machine manual for a parameter that would tell the control to recognize the Y-axis rather than the X-axis for rpm calculations, he called his machine distributor for help.

“The guy didn’t get it at first,” Schelske said. “‘Why on earth would you want to do that?’ he asked. I wasn’t sure how to explain it, so I sent him the link to the Y-axis video. He did some digging and found the correct value to change. After that, it was seamless.”

In low-carbon steel, such as 12L14 and cold-drawn (CD) 1018, the CoroCut QD achieves a feed rate of 0.016 ipr at 600 sfm. In 4140 alloy steel, the tool is routinely fed at 0.012 ipr and 500 sfm. By comparison, Schelske typically ran his old cutoff tool at only 0.004 to 0.005 ipr at 400 sfm, depending on the material.

“I used the mean spindle speed...
in relation to the feed rate when determining rough estimates for the gains we’ve made,” Schelske said. “With low-carbon steels, we’re hovering around a 500 to 600 percent improvement. Resulfurized steels, such as CD 1144, see a 300 to 400 percent gain. And we’re in the same ballpark with A36 structural steel. The smallest gain we’ve seen ranges from 200 to 300 percent, and that’s with CD 1045 material.”

Considering that VMC produces 70,000 parts per year from 2.75”-dia. 4140 bar stock, the ability to triple feed rates is a big win. Another win is tool life. The team consistently gets upward of 500 pieces per insert on that high-volume work, with equally impressive results elsewhere.

“I think Sandvik Coromant hits the nail on the head when they talk about redirecting the vector forces to be in line with the blade,” Schelske said. “I love trying new products and new ways of doing things, but this has been easily the most substantial improvement that I’ve seen from any single cutting tool. I’m constantly dragging people over to show them the Y-axis parting. The response is always, ‘Wow!’”

The only downside Schelske sees with the new technology is that—because Y-axis parting uses such a high feed rate—there is little chance of saving the blade if something goes awry.

“You have to pay attention to your tool life,” Schelske said. “With traditional parting operations, you can push a tool that’s borderline. But wait too long before changing the insert with Y-axis parting and you’ll end up with a melted blob. We went through our fair share of blades at first, but everything has calmed down by this point.”

Valley Machining experiences up to 600 percent improvement in cutoff efficiency with Sandvik Coromant’s Y-axis parting tool, according to Process Improvement Engineer Brent Schelske.
People & Companies

**PEOPLE**

- Ramsey, New Jersey-based Glebar Co. Inc., which builds grinding machines, added Mark Kraus as medical business development executive and Anthony Pickering as Midwest regional sales manager.
- Haimer USA LLC, Villa Park, Illinois, promoted Steven Baier to vice president of sales. The company manufactures cutting tools, shrinking and balancing equipment and other metalcutting products.
- Toolmaker LMT Onsrud LP, Waukegan, Illinois, hired Rex Trammell as field sales and application specialist for Tennessee and the Gulf Coast states and promoted Mark Ware to milling and tapping application specialist.
- Machine tool builder Methods Machine Tools Inc., Sudbury, Massachusetts, appointed Jon Dobosenski general manager of the new Memphis Technology Center in Tennessee. In other company news, Methods Machine Tools recently hosted a ribbon-cutting and tours at the center.
- MRO distributor Motion Industries Inc., Birmingham, Alabama, promoted Randall “Randy” P. Breaux to president and N. Joe Limbaugh to senior vice president of supply chain, operations support and marketing.
- Souderton, Pennsylvania-based Solar Atmospheres Inc., which provides vacuum heat treating services, appointed Timothy C. Fish regional sales manager, named Roger A. Jones CEO emeritus and promoted Mike Paponetti to Southeast sales manager.
- Distributor Stellar Industrial Supply Inc., Tacoma, Washington, promoted John Baker to vice president of sales and business development for the Northwest, Colin Brown to national vice president of sales, Alfie Gallegos to vice president of sales and business development for the Southwest and Michael Skramstad to director of supply chain solutions. Also, Brian Bassett is vice president of strategic accounts, Phil Canipe is vice president of strategic accounts, and Mitch Davis is vice president of sales for aerospace manufacturer Boeing Co., Chicago. In other company news, Stellar Industrial Supply gave its 2018 Supplier of the Year award to toolmaker Fullerton Tool Co. Inc., Saginaw, Michigan.

**COMPANIES**

- Steffisburg, Switzerland-based Fritz Studer AG, which builds grinding machines, sold its 1,000th S31 universal cylindrical grinder to Hangda Aero Science & Technology Development Co. Ltd. in China.
Metrology equipment manufacturer Hexagon Manufacturing Intelligence, North Kingstown, Rhode Island, opened an office in Calgary, Alberta.

Scappoose, Oregon-based Oregon Manufacturing Innovation Center Research and Development, a metals manufacturing R&D facility, added its 22nd member: Ann Arbor, Michigan-based Zoller Inc., which makes equipment for tool presetting and measuring.

St. Louis-based Sunnen Products Co., which builds honing and lapping machines, established direct sales in Canada.
When Profilator GmbH & Co. KG introduced Hard Scudding a few years ago, the company called the gear-making process “ground changing.” Now, the Wuppertal, Germany-based developer and manufacturer has followed up with its microfinishing process, which is designed to further improve gear making.

Microfinishing occurs after Hard Scudding and intends to make a high-quality gear even better by reducing surface roughness.

Like other finishing processes, microfinishing reduces friction. By increasing pitting resistance and thereby reducing fatigue on gear teeth, microfinishing after scudding extends gear life.

“Microfinishing is a dry process,” said Scott Knoy, president of Profilator’s U.S. subsidiary, German Machine Tools of America Inc., Ann Arbor, Michigan. “It runs without cutting fluids and does not rely on minimum quantity lubrication technology.”

A diamond-plated tool developed by Profilator is central to microfinishing. The tool allows a user to remove about 20µm of stock per flank. This amount does not substantially affect the gear geometry yet improves the quality of the surface finish.

Among the benefits is noise reduction. Knoy said increased use of hybrid and electric vehicle technology has led to gears rotating at higher velocities.

“Smother surface finishes lead to quieter gears, significantly reducing the audible noise levels associated,” he said.

To demonstrate the effect of Hard Scudding alone versus Hard Scudding followed by microfinishing, GMTA provided Rz and Ra measurements of surface finish on sample gears. When Hard Scudding alone was applied, Rz measures—which compare the tallest peak and lowest valley in the surface—were 2.0µm and 1.7µm for the right and left profiles, respectively, and 1.6µm and 1.3µm for the right and left leads, respectively. In turn, when both Hard Scudding and microfinishing were applied, measures decreased to 0.8µm for both the right and left profiles and 0.7µm and 0.6µm for the right and left leads, respectively.

These results are comparable to abrasive gear finishing processes that are considerably more expensive and require machining fluids and fluid filtration systems, unlike the dry microfinishing process, Knoy said.

He noted GMTA’s data about cycle times. For example, working with a standard 125mm to 140mm ID automotive ring gear, Hard Scudding requires about 25 to 40 seconds for cutting and about 12 seconds for loading and unloading stock. Microfinishing requires about 20 seconds more, meaning an average cycle time of about 64 seconds for the two processes. As microfinishing is developed further, the company anticipates a 10 percent reduction in the combined process, bringing the average expected time to under a minute for an automotive ring gear.

Users have several choices for how to incorporate the new technology with existing Profilator equipment. One option is to use microfinishing as a stand-alone process on a scudding machine. A second method involves using the two technologies in sequence: first Hard Scudding, then microfinishing. A third way would be to simultaneously apply the two processes using a double-spindle Scudding machine. Knoy said part geometry ultimately should determine the optimal path.

For more information about German Machine Tools of America, call 734-973-7800 or visit www.gmtamerica.com.

Look-Ahead

MICROFINISHING SHIFTS GEARS

By Robert Weinstein

Robert Weinstein is a contributing editor for CTE. Contact him at 732-583-7171 or gersonpub@aol.com.
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