

Modern Machine Shop

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Use AI to Support Human Judgment

As AI changes industry, better decision-making matters more **pg. 30**

Choosing Tech With Automation in Mind

Top Shop asks: 'How can this integrate into an automated cell?' **pg. 70**

Programming Process Defaults

Getting your shop aligned on best practices beyond the basics **pg. 22**

Modern Machine Shop

TOP SHOPS

2026 HONOREES



HUMAN RESOURCES

ASTRO MACHINE WORKS

Charissa Gift,
Head of HR



MACHINING TECHNOLOGY

HEI PRECISION

Mark Holz,
Owner



SHOPFLOOR PRACTICES

PRECISION PROFILES

Matthew Lucco,
President & CEO



BUSINESS STRATEGIES

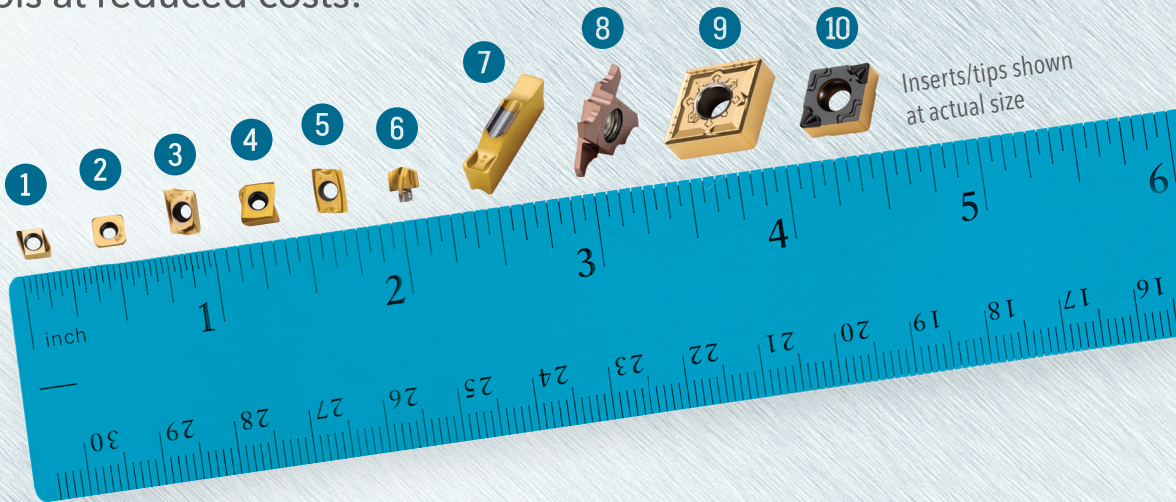
HILL MANUFACTURING AND FABRICATION

Mike Payne, CEO

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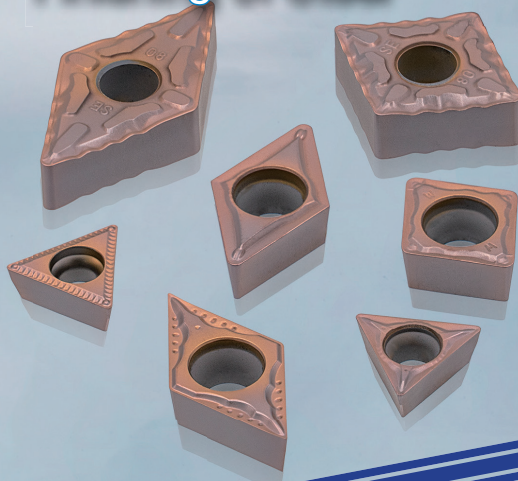
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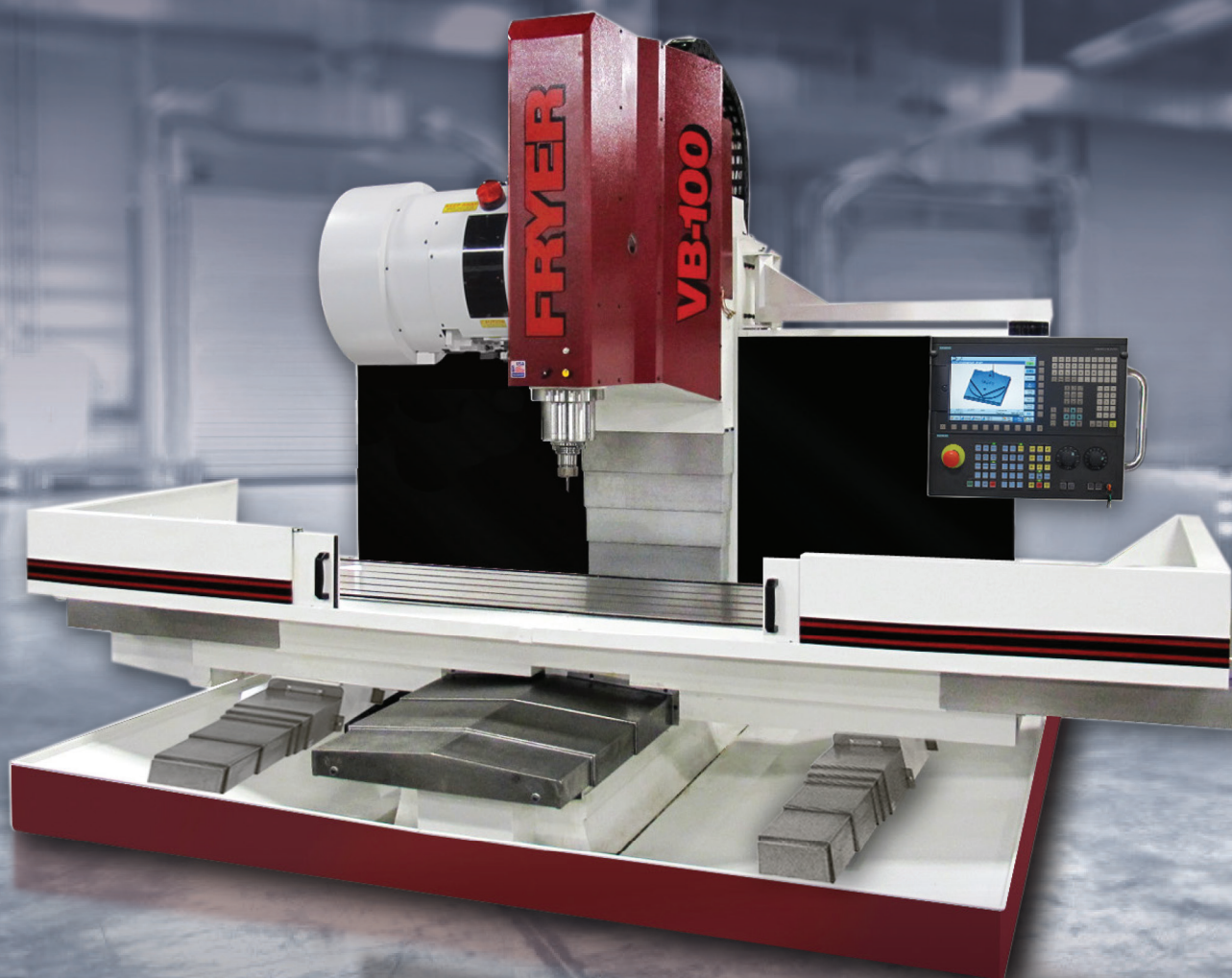


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44 TOP SHOPS

2026 Top Shops: Full Roster of Honorees and Top Performers



What separates the top-performing machine shops from the rest? The 2026 Top Shops data points to productivity, workforce performance and speed in winning new work. Meet this year's 36 Top Shops and four Honorees.

BY BRENT DONALDSON

SHOPFLOOR PRACTICES



Nothing Left to Memory

This 34-person manufacturer has built its operation around process control, knowledge transfer and customer reliability — qualities in short supply across a Navy supply chain struggling to keep pace with its own shipbuilding targets.

BY BRENT DONALDSON

HUMAN RESOURCES



Employee-Driven, Employee-Owned

A successful human resources program requires multiple strategies. Astro Machine Works doesn't rest on its ESOP, deploying a range of other programs that have earned it recognition as the 2026 Top Shops Honoree for Human Resources.

BY JULIA HIDER

BUSINESS STRATEGIES



Comparison Steals Downtime, Not Joy, From Top Shop

Hill Manufacturing and Fabrication has found success through diligent use of machine monitoring software and benchmarking surveys, including *MMS'* own Top Shops.

BY EVAN DORAN



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Also in This Issue

70



MACHINING TECHNOLOGY

Where Machine Tools are Chosen With Automation in Mind

For Top Shops Machining Technology Honoree HEI Precision, every machine tool purchasing decision starts with one question: “How can it be automated?”

BY DEREK KORN

From the MMS Editors

- 14** The Setup | Brent Donaldson

Technical Perspectives

- 18** Quality Gaging Tips
Probe presetting in inductive metrology
- 22** Miller's Edge
Programming process defaults
- 26** Cutting-Edge Perspectives
Reducing chatter in turning operations
- 30** The Margin Line
Using AI tools to support business decisions
- 96** How I Made It: Gisbert Ledvon

The Metalworking Industry

- 12** Digital Extras
- 34** GBI: Metalworking
- 36** Events & Webinars

- 38** AMT – The Association For Manufacturing Technology Update

Products

- 76** Tooling and Workholding
- 82** Systems and Software
- 84** Modern Equipment Review SPOTLIGHT: AUTOMATION



| ABOUT OUR COVER | 2026 Top Shops Honorees

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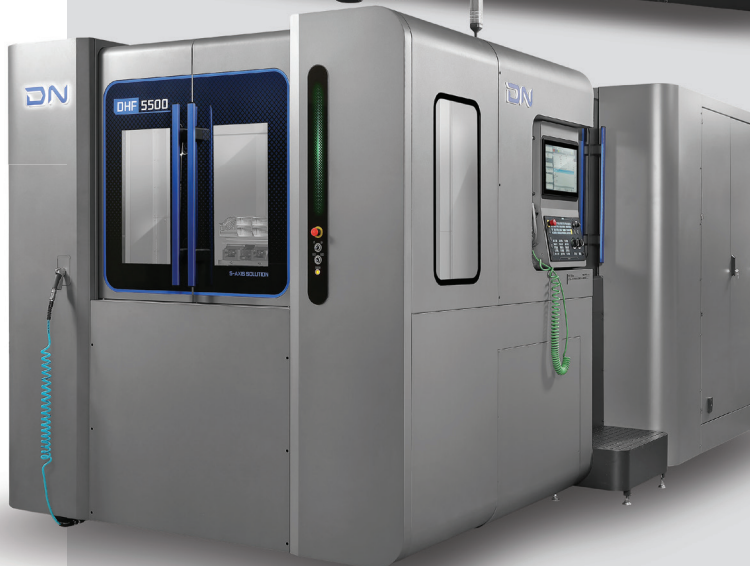
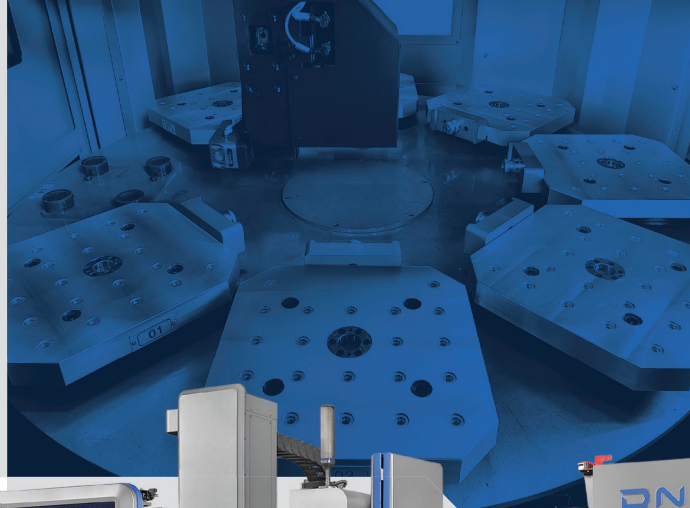
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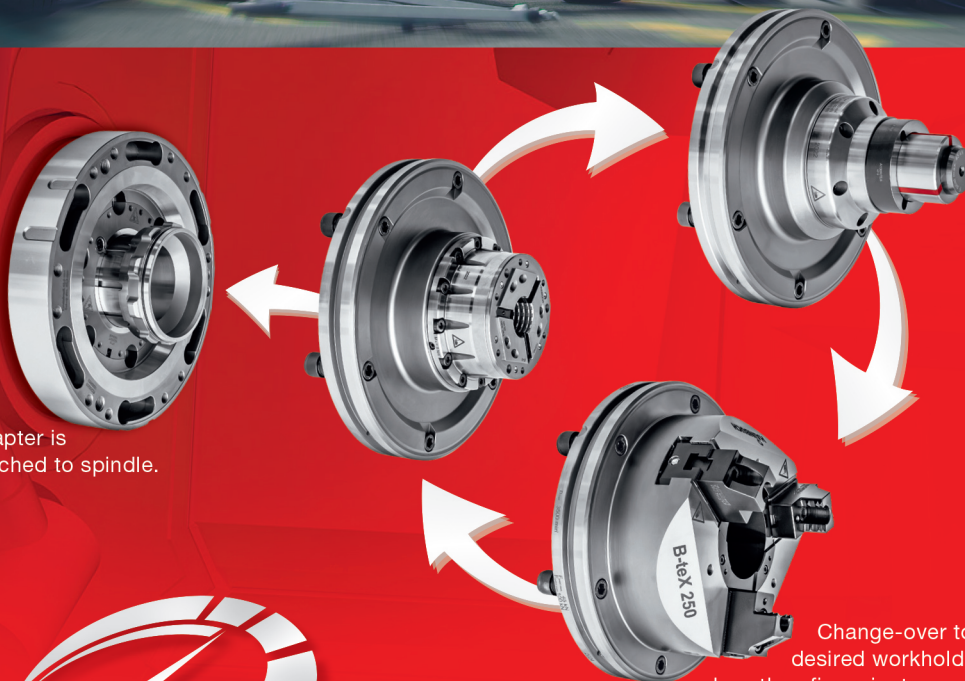
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MIN.**ARTICLE | Top Shops 2025 Takeaways**

The Top Shops 2026 Conference features this year's four Honorees and many other shops. Discover the *MMS* team's takeaways from last year's event.

READ: gbm.media/TSTakeaways1026

10
MIN.**ARTICLE | A Custom-Made Shop for Custom Parts**

On page 54, Executive Editor Julia Hider investigates how Astro Machine Works' ESOP has played a key role in the shop's recruitment and retention success, leading to it becoming this year's Top Shops Honoree in HR. For more about the company's manufacturing capabilities, check out Senior Associate Editor Evan Doran's 2023 article about the shop.

READ: gbm.media/Astro1026

8
MIN.**ARTICLE | Old and New Tech Restore WWII Submarine**

On page 46, Editor in Chief Brent Donaldson discusses how 2026 Shopfloor Practices Top Shops Honoree Precision Profiles uses vintage trepanning machines and streamlines part and fixture retrieval. For more about vintage machines in modern contexts, read Hider's article about how San Francisco's Maritime Park Association combines a Bridgeport, a 1954 Wohlhaupter boring head and new boring bars to maintain the USS Pampanito.

READ: gbm.media/USSPampanito1026

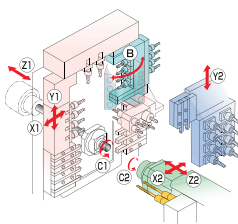


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How Top Shops Build Around Their Constraints

The 2026 Top Shops honorees show how deliberate decisions about technology, processes, information and people can address the factors that limit shop performance.



bdonaldson@gardner.media

Brent Donaldson
EDITOR-IN-CHIEF

When Mike Payne bought Hill Manufacturing and Fabrication in 2018, he had a strong business background but almost no experience running a machine shop. It was his first Top Shops survey that gave him a useful starting point.

"I don't think there was a single category that we were in the Top Shops column," Payne remembers. The fact that the shop he'd just acquired wasn't already a strong performer wasn't necessarily discouraging, because the Top Shops benchmarking report gave him a list of places to look.

Payne compared Hill's performance with that of Top Shops, identified the largest gaps and began addressing them. Tooling investment was low, so Hill changed vendors, added a tool vending machine and created a dedicated toolroom. Revenue per employee was low, so the shop reorganized its machines into cells. Setup delays were traced to tooling and information access, leading to changes that put setup notes, tooling lists and prints right at the machine.

Three years later, Hill qualified as a Top Shop.

That progression gets at something I find interesting about this year's four Top Shops Honorees: They operate in very different ways, and yet each were recognized in one of four different categories — Machining Technologies, Shopfloor Practices, Human Resources and Business Strategies. And each has developed a habit that is useful to any shop: Identify what is constraining your operation, then build a system around it.

The Top Shops program has accumulated benchmarking data from thousands of shops over the years. The value of that data is partly in identifying where a shop stands relative to its peers. But the more useful question might be what a shop does with the information once it identifies a gap, constraint or weakness.

Hill provides one answer. Precision Profiles provides another.

When Matthew Lucco acquired Precision Profiles in 2018, much of the shop's manufacturing knowledge existed in employees' heads or in handwritten notes. (Stop me if you've heard this one before.) The company has since put jobs, drawings, programs, setup information, production requirements and quality data into its ERP system.

"The idea is to remove as much tribal knowledge as needed because it facilitates training and it facilitates coverage," Lucco says.

That system has consequences beyond documentation. A machinist's absence doesn't have to jeopardize an order. New employees can be trained against an established process. The shop can retrieve historical cycle times when quoting repeat work. And fixtures can make previously time-consuming setups routine.

The takeaway isn't to buy a particular ERP system or build 150 custom fixtures. It is to look for places where performance depends on someone remembering something or knowing some specific technology or process, and then finding a way to remove that dependency from your process.

In another example from this year's Top Shops honorees, HEI Precision has attacked a different constraint: labor.

President Mark Holz says every equipment decision at HEI starts with a question about how the machine can integrate into an automated cell.

HEI has invested heavily in automation, but its biggest return has come from one of the simplest forms. "We have invested heavily in all kinds of automation," Holz says, "but the biggest ROI has come from the most basic — the pallet changers." Machining one pallet while another is being loaded or inspected keeps the spindle running and gives the shop flexibility to introduce new work without interrupting established production.

Again, the lesson here isn't a suggestion for a particular piece of equipment. It is the discipline ➤

Methods

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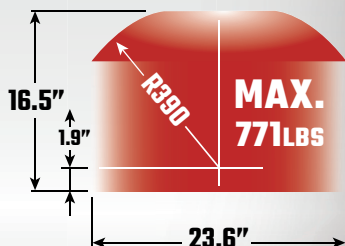
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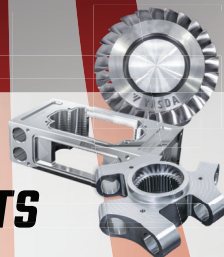
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of identifying what is actually limiting production before deciding how to invest capital.

Astro Machine Works identified a different constraint: developing and retaining the people needed to operate a high-mix business.

Its ESOP deserves the positive attention it's received, but the employee-ownership transition in 2018 followed a decade of open-book management. Employees receive monthly financial information, participate in establishing departmental goals and have access to career coaching. Astro also maintains an apprenticeship program that has

graduated 27 people and uses employee collaboration to bring ideas back into the organization.

"We want everybody to be involved, because if they're involved in creating the goals, then they're more apt to be engaged in achieving them," says HR head Charissa Gift. The company's flexible scheduling means that employees can take advantage of a 45-hour week and leave early on Friday, an arrangement that Astro says added five hours of production time for employees who previously worked closer to 40.

The common thread among these companies is

how each takes the time and effort to look carefully and honestly at its operations.

Consider this: Hill found lost time and labor utilization problems in its benchmarking data. Precision Profiles found that too much capability existed in individual employees' memories. HEI found that loading and unloading could limit the value of its machining equipment. Astro built systems to give employees more capability, information and incentive to contribute to the business.

Those are four very different problems. The response in each case was to make the solution part of the operation. That may be the most useful thing to take from the 2026 Honorees as the Top Shops Conference meets in Cleveland this month. Don't look only at what another shop has bought or a process they have copied. Look for the constraint that shop has identified, and how it has engineered its way around it. That's how benchmarking becomes a way to find the next problem worth solving. ■



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Understanding Probe Preset in Inductive Metrology

Properly implementing mechanical probe presetting is essential to optimize measurement accuracy, ensure repeatability and prevent costly spindle damage.

PAUL MAILLOUX | COLUMNIST

Inductive probes remain the standard workhorse for high-precision shopfloor dimensional gaging, automated multisensor fixtures and comparator stands. However, the term “preset” used in the context of inductive metrology carries different meanings depending on whether it refers to the display interface or the transducer itself.

This distinction is a constant point of confusion for many quality technicians:

- **Display / Readout Preset:** An electronic offset value entered into a digital display to show absolute part dimensions rather than relative comparative deviation
- **Inductive Probe Mechanical Preset:** The physical adjustment of an inductive probe spindle's internal travel positioning relative to its mounting fixture

Properly understanding and implementing mechanical probe presetting is essential to optimize measurement accuracy, ensure repeatability and prevent costly spindle damage.

Anatomy of Probe Travel

Every mechanical spindle, whether in a dial indicator, digital comparator or inductive probe, has a fixed total range of travel made up of three elements: pre-travel, measuring travel and over-travel.

Historically, all three elements were fixed components of the spindle assembly by design. On modern inductive probes, however, the pre-travel element has been made mechanically adjustable. This was not without a purpose.

The standard factory setting for pre-travel is typically a few thousandths of an inch. This ensures the probe tip maintains continuous contact with the workpiece, eliminating two primary sources of measurement error. First, calibration

may not be repeatable if the endpoint collected is not consistent. Second, the data may be incorrect due to a spiked reading caused by the probe coming on-scale mid-cycle or readings that do not change because the probe tip fails to make physical contact with the part.

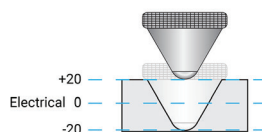
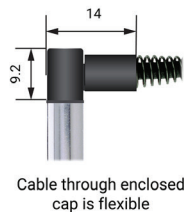
On adjustable inductive probes, pre-travel can be mechanically set prior to installation. When a probe is “preset,” it means that the pre-travel and/or measuring portion of the spindle has been mechanically adjusted to a certain position required for the application. The amount of pre-travel adjustment will vary by manufacturer and should never exceed past the null or zero position of the probe.

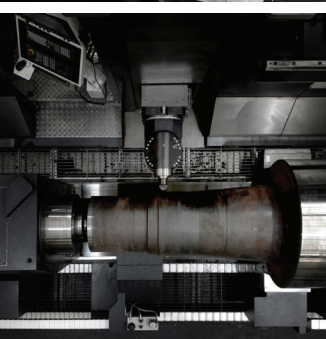


Why Preset a Probe?

There are two primary reasons to preset a probe: maximizing accuracy and reducing mechanical damage. Side-load forces and probe tip crashes are among the leading causes

Source: Mahr Inc.





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of gage downtime and ruined transducers in production environments.

Accuracy at Null: Inductive probes are center-based metrology systems. Their highest degree of linearity, sensitivity and accuracy occurs at or near the electrical null (center of travel). Presetting allows you to position the spindle so that part measurements occur precisely at this null point rather than near the extreme ends of the stroke, eliminating linear error and minimizing variation from internal spring pressure.

Preventing Probe Crashes and Side-Load Errors: A

classic example is a flatness gage where the probe is mounted underneath a reference plate. Flatness checks typically require very little measuring range. To ensure reliable data, readings should be captured at or near the probe's null position.

But what happens when an unadjusted probe is mounted beneath the plate and set to zero while a gage block rests over the surface? Remove the gage block, and the full positive travel of the probe now protrudes past the reference plane. Depending on the probe range, it could be 0.040 inch (1 mm) or more.

Now try to slide a part across the plate to measure it. Crash! This results in a side-play error and potential damage to the probe spindle, bushing and contact point, depending on the amount of force applied.

One may think the workaround is to simply place the part on top of the plate instead of sliding it across. But did we mention hysteresis? How about operator training, fatigue or error? This holds true for both single- and dual-probe fixtures.

Best Practices

As a rule of thumb, any probe that protrudes past a reference plate or plane and requires minimal measuring range should be mechanically preset. Mechanical presetting protects the probe assembly from destructive lateral impact while ensuring the measurement is captured at the probe's sweet spot, maximizing gage uptime, extending transducer lifespan and ensuring true, repeatable data collection. 

I AUTHOR | Paul Mailloux
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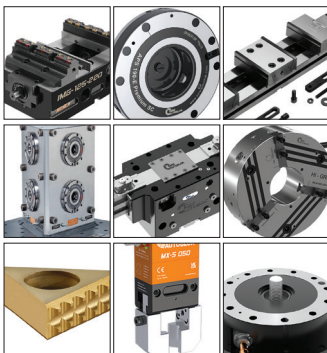


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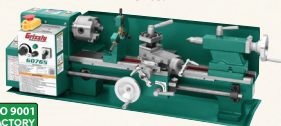
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Process Defaults Every Shop Should Set Once

Process default decisions should be easy and not overthought, so they get made once for the shop instead of fresh on every job. Then, when a part calls for something different, deviate deliberately and visibly.

JOHN MILLER | COLUMNIST

READER QUESTION: *We've grown our programming department, and with that we've picked up some new habits. What are some ways we can get the team aligned on best practices and promote consistency?*

Most shops have the basics settled. Program format, offset handling, safe starts at every tool and a well-tuned postprocessor doing most of that work automatically. If yours doesn't, that's the first place to look. But the consistency problem usually lives one layer up, in the small decisions a programmer makes on ordinary features without much thought. Leave 0.020 inch for the finish pass or 0.015 inch? Spot the hole or let the carbide drill find its own center? Turn comp on for a wall at ± 0.005 inch or leave it off? Any one of those, taken alone, barely changes the part.

What they do change is the week on the floor. Three programmers making those decisions independently means the same feature on similar parts shows up handled three ways, sometimes on the same machine, sometimes on consecutive days. The setup person can't tell whether the difference was a decision or an accident, so every first part turns into a small investigation, and every debugging session starts by ruling out the programmer. None of it is wrong. The shop just has three answers where it needs one.

I think of these as process defaults. They are decisions that should be easy and not overthought, so they get made once for the shop instead of fresh on every job.

Two questions qualify a decision. Does the choice, on its own, barely matter to the part? And does disagreement over it cost real time at the machine? If both are true, pick one and document it. If the choice matters a great deal, that's engineering judgment, not a default, and it stays with the programmer and the part. Here are the ones I'd settle first:

- **Cutter Comp:** There are three common ways to handle diameter compensation: Run the path at nominal tool size and comp at the control, cut the path to size in CAM and use wear offsets only, or skip comp entirely and repost when a size needs to move. Shops argue over which is best, and I'd suggest that's the least useful conversation you can have about it. What matters is that everyone does it the same way, so the operator knows before opening a program which features can be adjusted at the control and which need to go back to the programmer.

- **Stock Allowance:** How much to leave for a finish pass is a decision programmers make dozens of times a day and almost never discuss. Face milling, side walls and the stock ahead of a bore or ream all have different needs, and material changes the answer again. The shop should have simple standards by cut type and material family, and they should be documented. When the finish tool arrives at a wall, it should find the same amount of material no matter who programmed the part.

- **Tool Roles:** Some tools have a nominal purpose, and that purpose should be the same across the shop. A long-edge end mill owns perimeter walls; a shorter tool stepping down the same wall is a different process and shouldn't happen by accident. A rougher doesn't finish. Some shops assign a dedicated tool to floors or reserve certain tools for critical features. Each tool's purpose should be knowable from its place in the program, so a setup person seeing a tool number already knows what it's there to do.

- **Tolerance Thresholds:** There is a tolerance at which a hole stops being interpolated and gets reamed or bored. There is a tolerance, or a feature type, that earns a probe cycle by default. In most shops those lines exist, but they exist as instinct, so they move depending on who's pro-

»

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gramming. Set them. The numbers will be specific to your work, but once they're set, a tight hole is handled the same way in every file, and the operator isn't guessing whether the probe cycle they don't see was a decision or an omission.

- **Spot Drilling:** This one has a real answer. A carbide drill with a self-centering point entering a flat face does not need a spot, and adding one can hurt. The common mistake is a 90-degree chamfer tool pressed into service ahead of a 140-degree drill. The drill's outer corners meet the cone wall before the point does, which is

the opposite of what a spot is for. Spot when the entry surface is angled, rough or cast; when the drill is long or high-speed steel; or when position is tight enough to justify it. If you do spot, the spot angle should be equal to or wider than the drill point angle. Make that a shop rule and the argument will go away.

None of this means stop questioning things. A default is a starting point, not a law. When a part calls for something different, deviate, and do it deliberately and visibly, with a note in the

file so the next person knows it was a choice. What you're banning is the silent version, where a programmer drifts from the default because they prefer something else and the floor finds out at the machine. The defaults themselves should be questioned too, out loud and for everyone. If somebody has a better way to handle stock allowance, the shop should change its rule rather than one programmer quietly change theirs.

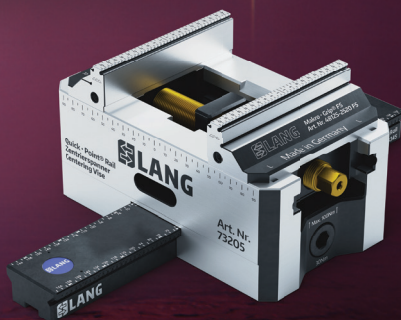
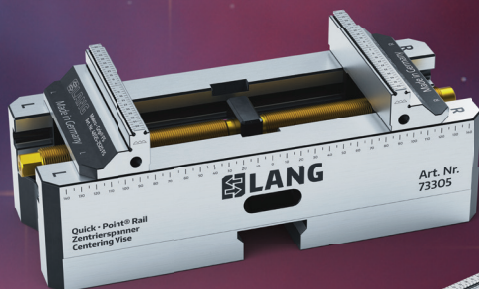
Creativity needs a baseline to push from. Settle the mundane decisions once, and your programmers have more room for the ones that matter. The payoff shows up on the shop floor. 

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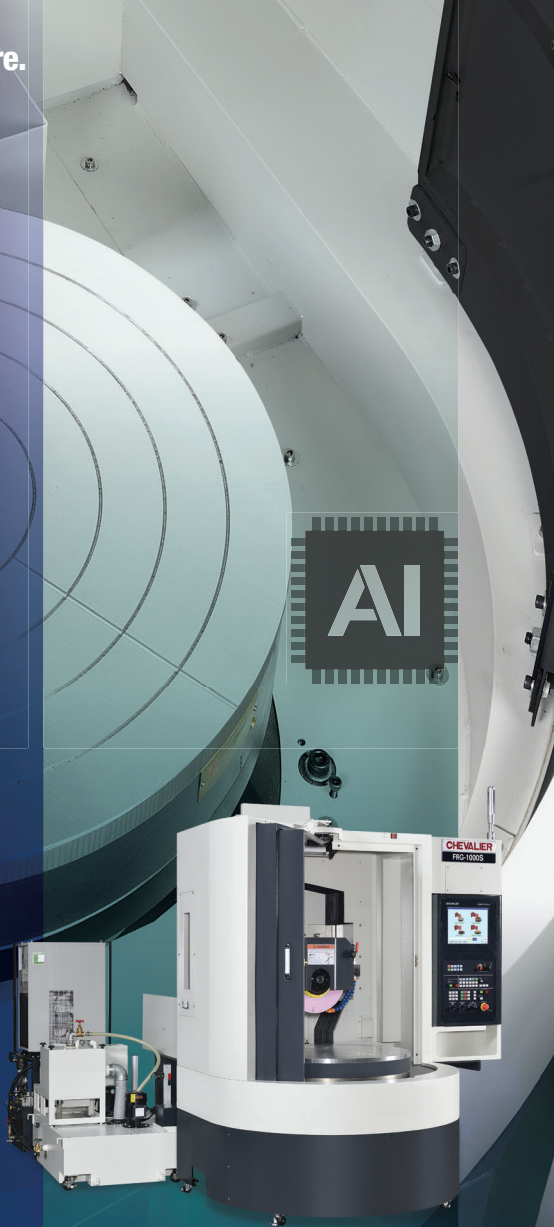
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Why Milling Force Isn't Constant — And How to Predict It

A geometric model of chip thickness variation, from entry angle to chatter-free parameters.

TONY SCHMITZ | COLUMNIST

The cutting force in milling can be modeled using the process geometry. The milling force varies because the chip thickness varies, even in the absence of tool or workpiece vibrations. Figure 1 shows this variation for both conventional (up) and climb (down) milling operations. Note that the chip thickness increases with tool rotation during up milling and decreases during down milling. For the latter, we refer to this as chip thinning.

The entry, or start, angle for up milling is $\phi_s = 0$, while the exit angle, ϕ_e , depends on the radial depth of cut, a , and tool radius, r , as shown in Equation 1.

For down milling, the exit angle is $\phi_e = 180$ degrees. Like up milling, the start angle is calculated using the radial depth and tool radius. See Equation 2.

Consider the up milling cut shown in Figure 2, where the radial depth of cut is 1.9 mm. For a 19 mm diameter (9.5 mm radius) tool, this is a 10% radial immersion cut. Because it is up milling, the start angle is $\phi_s = 0$. The exit angle is 37 degrees, and the instantaneous chip thickness, h , between the start and exit angles is defined by Equation 3, where f_t is the feed per tooth. The chip thickness starts at zero and ends at 0.09 mm if the feed per tooth is 0.15 mm. Because the exit angle is less than 90 degrees, the chip thickness never reaches the commanded feed per tooth value.

Because the chip thickness is not constant in milling, the cutting force is not constant. Like the chip thickness in Equation 3, the cutting force also depends >>

Eq. 1:

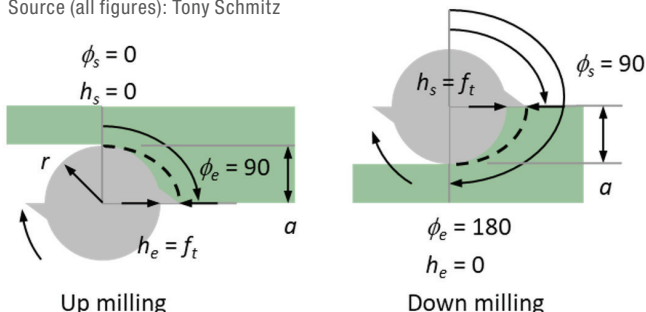
$$\phi_e = \cos^{-1} \left(\frac{r-a}{r} \right)$$

Eq. 2:

$$\phi_s = 180 - \cos^{-1} \left(\frac{r-a}{r} \right)$$

FIG. 1: Start and exit angles and corresponding chip thickness, h , variation for up and down milling ($a=r$, or 50% radial immersion).

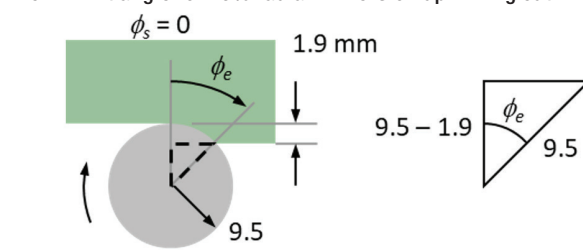
Source (all figures): Tony Schmitz



Eq. 3:

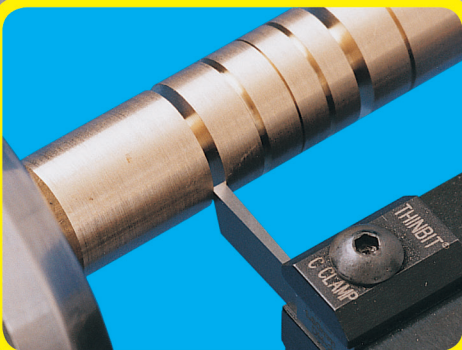
$$h = f_t \sin \phi$$

FIG. 2: Exit angle for 10% radial immersion up milling cut.



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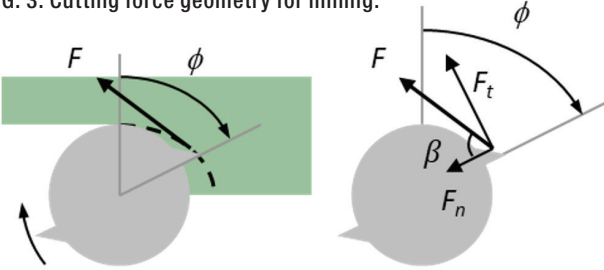
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Eq. 4:

$$F = K_s A = K_s b h$$

FIG. 3: Cutting force geometry for milling.



Eqs. 5 and 6:

$$F_n = \cos(\beta) F = \cos(\beta) K_s b h = k_n b h$$

$$F_t = \sin(\beta) F = \sin(\beta) K_s b h = k_t b h$$

Eqs. 7 and 8:

$$F_x = F_t \cos(\phi) + F_n \sin(\phi)$$

$$F_y = F_t \sin(\phi) - F_n \cos(\phi)$$

on the tool angle. The complete cutting force model includes the chip thickness variation with tool angle, the number of teeth simultaneously engaged in the cut at any instant and the projection of the cutting force into the machine tool coordinate frame.

We express the cutting force on any tooth as a function of the chip area, A , and specific force, K_s ; see Equation 4, where b is the axial depth in milling and K_s depends on the workpiece material and tooth geometry (for example, rake angle).

The normal, n , and tangential, t , components of the cutting force are written using Equations 5 and 6 and are displayed in Figure 3, where β is the cutting force angle relative to the normal direction.

The single tooth force shown in Figure 3 is described in a coordinate frame that rotates with the tool. For measurement purposes, however, it is convenient to express the force in the machine tool's coordinate frame. For example, the workpiece may be mounted on a cutting force dynamometer and the x , y and z direction force components recorded during milling; see Figure 4. To model these forces, we must project the normal and tangential components into the x

FIG. 4: Geometry for projecting the tangential and normal cutting force components into the x and y machine tool coordinate directions.

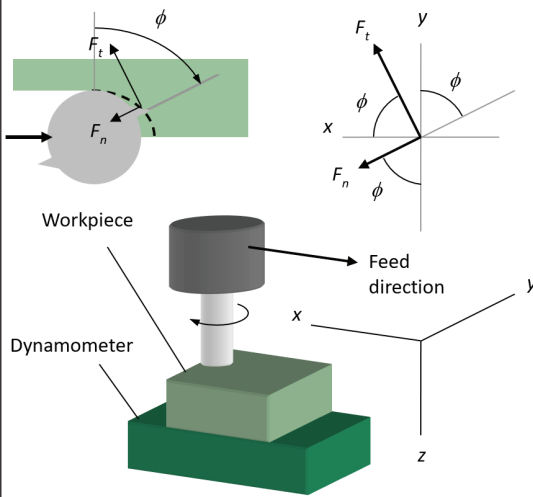
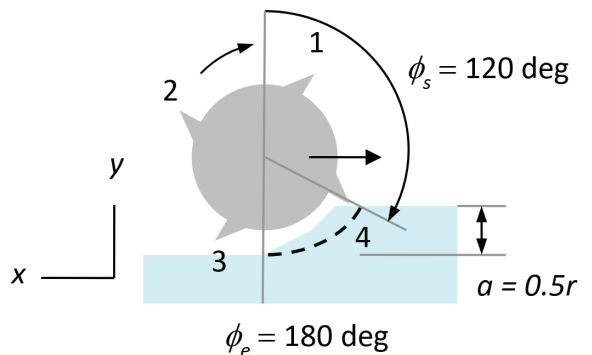


FIG. 5: 25% radial immersion down milling geometry.



and y directions using the tool angle. Generally, we can neglect the z direction component along the tool axis because the tool stiffness is much larger in this direction than x and y . See Equations 7 and 8.

Let's conclude with an example calculation of cutting force components for down milling. Figure 5 shows the geometry for a 25% radial immersion down milling cut. The starting angle is 120 degrees, and the exit angle is $\phi_e = 180$ degrees. We see that tooth 4 enters the cut first (assuming a start angle of $\phi = 0$ when tooth 1 is vertical).

This entry occurs after a 30-degree delay where no cutting occurs (that is, the 90-degree lead of tooth 4 relative to tooth 1 plus 30 degrees gives the 120-degree cut starting angle). The maximum force level is encountered at 30 degrees and then decreases with the chip thickness to an angle of 90 degrees; this trend of force reduction as the final surface is being created explains why down milling is often selected for finishing passes when surface finish is most critical. After $\phi = 90$ degrees is reached, the force is again zero until tooth 1 enters the cut at 120 degrees and the cycle is repeated. The negative x direction force means that it is acting to the right in Figure 5.

Finally, the periodic, impulsive nature of the cutting force in is effective at exciting the tool-holder-spindle-machine structural dynamics. The outcome is vibration that can either be stable or unstable (chatter). Given the force model and the

tool tip vibration response (described using the frequency response function, or FRF), we can generate a stability map that enables us to select chatter-free milling parameters without the need for trial-and-error testing. ■

AUTHOR | Tony Schmitz

Distinguished Technical Fellow, MSC Industrial Supply Co.



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As AI Changes Manufacturing, Better Decision-Making Will Matter More

The manufacturers that benefit most from AI will be the ones that understand where it can create meaningful improvements and where human judgment remains essential.

MIKE SIBLEY | COLUMNIST

Across the industry, companies are evaluating how AI can improve forecasting, automate processes, strengthen analytics and create more efficient operations. Nearly every technology platform today promises smarter decision-making and greater visibility.

But as manufacturers explore what AI can do, many are focusing on the wrong question. The goal is not simply adopting AI because it is the latest technology trend. Technology only creates value when it helps leaders improve profitability, strengthen operations, reduce risk and respond faster to an increasingly complex business environment. AI is a powerful tool, but it is still only a tool. The manufacturers that benefit most will be the ones that understand where AI can create meaningful improvements and where human judgment remains essential.

One of the challenges manufacturers face today is not a lack of information — it is having more information than they know how to use effectively. Most organizations collect significant amounts of data through ERP systems, production software, financial reporting platforms, inventory management tools and supply chain systems.

The real challenge is turning that data into actionable insights.

AI can process and analyze information faster than traditional methods, helping leaders identify trends, potential issues and opportunities for improvement. However, technology cannot determine which challenges are most important for the business. Leadership still has to ask the right questions, understand the operational environment and decide what actions will have the greatest impact.

The manufacturers seeing the greatest success with AI are not necessarily the ones generating

more dashboards or collecting more data. They are the companies identifying the insights that directly influence decisions around production efficiency, margins, inventory, labor and long-term growth.

AI also should not be viewed as a replacement for experience. Manufacturing has always relied on the knowledge of people who understand their operations, customers, suppliers and markets. AI can identify patterns and highlight potential problems, but it does not understand the full context behind those findings.

For example, a system may identify declining margins, rising inventory levels or changes in efficiency. But experienced leaders still need to determine why those changes are happening and what response makes sense. Is the issue related to pricing? Material costs? Labor challenges? Customer demand? Supplier performance?

Where AI is already creating significant value is by giving employees and leaders back valuable time. Many manufacturing teams spend countless hours collecting data, building reports and completing repetitive administrative tasks. AI can help automate those processes and allow employees to focus on higher-value activities.

Finance teams can spend less time preparing monthly reports and more time analyzing profitability and identifying opportunities for improvement. Operations leaders can gain faster visibility into production challenges and respond before small issues become larger problems. Supply chain teams can better anticipate disruptions and evaluate potential risks earlier.

The goal is not replacing people. The goal is helping people work more effectively.

However, before manufacturers accelerate AI adoption, they must also consider governance, »

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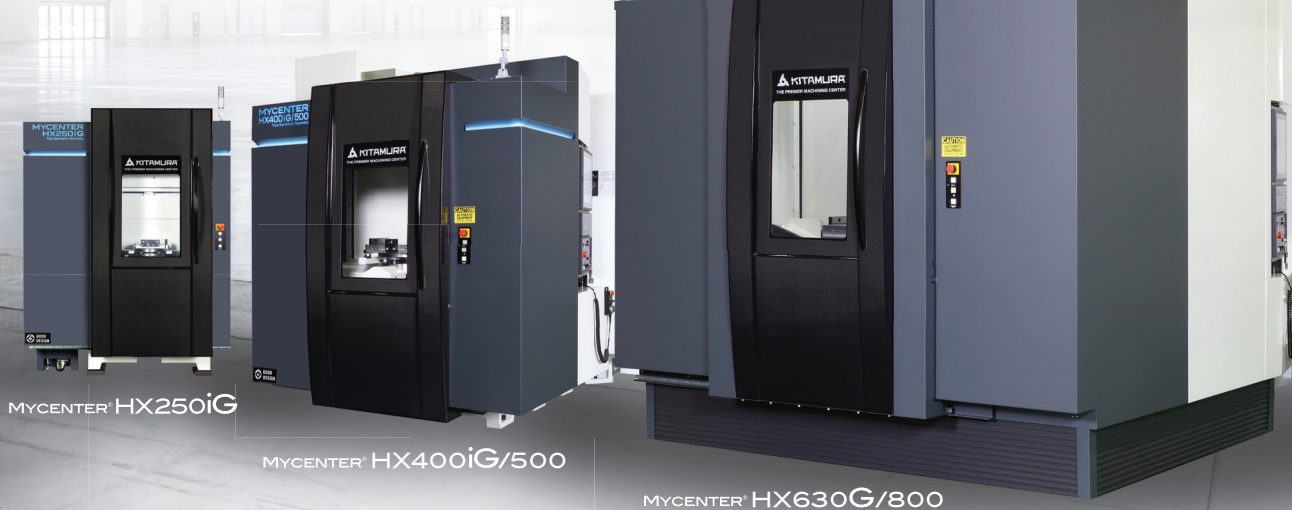
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security and implementation strategy. Many organizations are experimenting with AI tools without fully understanding how those systems handle sensitive information or how employees should use them responsibly.

Manufacturers manage valuable financial data, intellectual property, customer information and proprietary processes. Protecting that information must be a priority. Clear policies around data security, employee training and appropriate AI usage will become increasingly important as these technologies become more common.

Successful AI adoption also requires a clear understanding of business objectives. Companies should begin by identifying specific challenges where AI can provide measurable value rather than attempting to automate everything at once.

For some manufacturers, the opportunity may be improving financial reporting. For others, it may be strengthening forecasting, managing inventory levels, improving scheduling or identifying operational inefficiencies. Starting with targeted improvements allows organizations to measure results, refine their approach and expand AI use over time.

The most successful manufacturers will not be the ones that adopt the most technology. They will be the ones that understand how to use technology strategically.

Manufacturing leaders have always had to make decisions in uncertain environments. Today's challenges — including supply chain volatility, changing customer expectations, labor pressures and rising costs — require faster and more informed decision-making.

The manufacturers that outperform in the coming years will be those that combine technology with strong decision-making. They will use AI to ask better questions, uncover valuable insights and make smarter choices that improve their businesses.

Technology will continue to evolve. Strong leadership will always be the competitive advantage. ■

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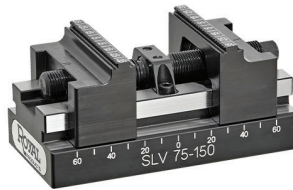
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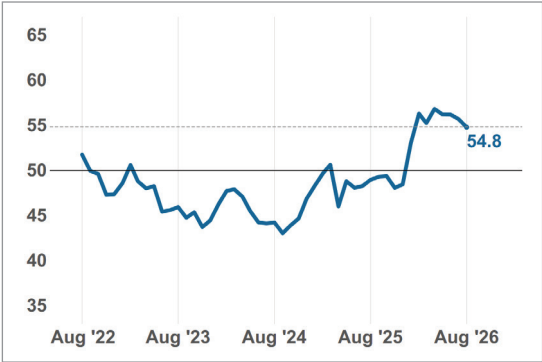
Metalworking Index Softens in August, But Production Strengthens

New orders and hiring pulled back, trimming the reading to 54.8, but a stronger production pace and easing costs kept the market’s eighth straight month of expansion intact.



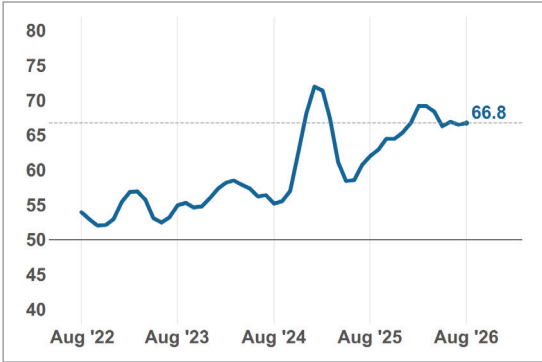
Mike Shirk
SENIOR MARKET
RESEARCH ANALYST

METALWORKING INDEX



The Gardner Business Index (GBI): Metalworking measures the current state of metalworking and machining activity through survey responses covering new orders, production, backlog, employment, exports and supplier deliveries. A reading above 50 indicates expansion, and a reading below 50 indicates contraction.

FUTURE BUSINESS INDEX



The GBI Future Business Index is an indicator of the future state of the metalworking market from industry respondents regarding their opinion of future business conditions for the next 12 months. A reading above 50 indicates expansion, and a reading under 50 indicates contraction.

GBI COMPONENTS SCORECARD

	Change vs	
	Month Ago	Year Ago
Supplier Deliveries	▲	▲
Production	▲	▲
New Orders	▼	▲
Employment	▼	▲
Backlog	▼	▲
Exports	—	▲

Source (all figures): Gardner Intelligence

The GBI Components Scorecard reports the monthly change rate of primary metalworking market factors contributing to the overall monthly index reading.

Reading the Scorecard:

- **Color** indicates *where* a component value falls relative to 50 for the current month. Green indicates expansion, and red indicates contraction.
- **Shade** indicates a value’s distance from 50. The darker the shade, the further from 50.
- **Direction** indicates a value’s change versus the previous period. Pointing up is always better. ➡



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PRESENTER: Marc Bissell, Senior Applications Specialist, HCL



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Must-See Manufacturing TV

Travis Egan

CHIEF REVENUE OFFICER

AMT – The Association For Manufacturing Technology, which owns and operates IMTS – The International Manufacturing Technology Show

IMTS+, the digital home of IMTS – The International Manufacturing Technology Show, features international award-winning original programming. IMTS+ spotlights the people, processes and ideas driving manufacturing forward.

Building a Foundation

Now in its second season, “The Architect,” brought to you by Hexagon, celebrates the ingenuity, partnerships and problem-solving powering the industry. The season kicks off on the moon — sort of — as viewers rocket off to Paragon Space Development Co. to explore the manufactured environments that will make lunar life possible. For the second episode, the team tours Hexagon’s state-of-the-art facility in Rhode Island. The theme of innovation-powered exploration continues in the final episode, with a special visit to SpaceX.



Travis Egan, host of the IMTS+ “The Architect,” brought to you by Hexagon, visits Paragon Space Development Co. to explore the manufactured environments that will make lunar life possible.

Learning New Ways in the Old World

“Road Trippin’ with Steve” gives the old van a rest and racks up some air miles for its fifth season — this time in Europe. Powered by SMW Autoblok, this season starts at the historic home of SMW in Turin, Italy. After exploring the town that helped build the industry icon, the crew ventures to Germany to glimpse the future of SMW and see a mechatronic gripper that can hold a 900-pound part. The tour de force ends in Switzerland with Swiss-made manufacturing, world-class watches and, of course, a gondola ride.

Getting Smart(er), One Shop at a Time

Brought to you by Toolpath, “Smart(er) Shop” Season 3 explores the real-world tools, strategies, and technologies helping small and midsize manufacturers compete and grow. Join hosts Al Whatmough, founder of G28.io, and AMT’s Mary Cecile “MC” Neville as they visit several shops that have found creative solutions to their challenges. First up is CJ Abraham, the former owner of Precision Product Development. Now with Hadrian, Abraham used automation to meet overwhelming demand, transforming his entire operation in the process. Next, they introduce viewers to Michael Gimbel, who turned a custom solution collecting dust in the back of the shop into a high-demand product line, launching Gimbel Automation, a new automated CNC business. The final episode follows entrepreneur and car enthusiast Jim Belosic, founder of SendCutSend, which navigates unusual angles and visionary ideas to deliver custom parts for clients ranging from hobbyists to aerospace engineers.

New shows will be released and available throughout fall 2026. Check [IMTS.com/Watch](https://www.imts.com/watch) to catch all the seasons of “The Architect,” “Road Trippin’ with Steve” and “Smart(er) Shop.”



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From Photo to Digital Twin

I took the motorcycle to work one morning and, a few moments after reaching my destination, found myself ogling a 3D version of it on my computer.

The bike hadn't been scanned with specialized equipment. There was no point cloud, no expensive hardware and no lengthy setup. I simply took a picture, uploaded it into a prototype application developed by Chloe Radigan, AMT's applied research engineer, clicked a few buttons, and watched a single image become a 3D object.

That's the kind of work happening every day inside AMT's Technology Department and, more specifically, within the AMT Testbed.

The project is still an early proof of concept. The system can take a single photograph and generate a 3D representation of it. Radigan accomplished this by implementing an open-source Trellis model and is now testing multiple images to create more accurate models. The graphics may currently resemble something from a PlayStation 2 game, but that's beside the point. The workflow works.



The model's detail might be reminiscent of Playstation 2 graphics, but remember: This came from a photo.

Stephen LaMarca

SENIOR TECHNOLOGY ANALYST

AMT – The Association For Manufacturing Technology, which owns and operates

IMTS – The International Manufacturing Technology Show

Take a photo. Upload it. Inspect the result. Make adjustments if needed. Generate a 3D object. That's it.

What makes this project particularly exciting is what it could enable for manufacturers.

Imagine photographing equipment on your shop floor and quickly generating assets for simulation, training, facility planning or digital twins and turning them into interactive digital content. During the demo, the technology team discussed how these workflows could eventually connect with MTConnect, simulation platforms such as Nvidia Isaac Sim, and other tools being explored in the testbed.

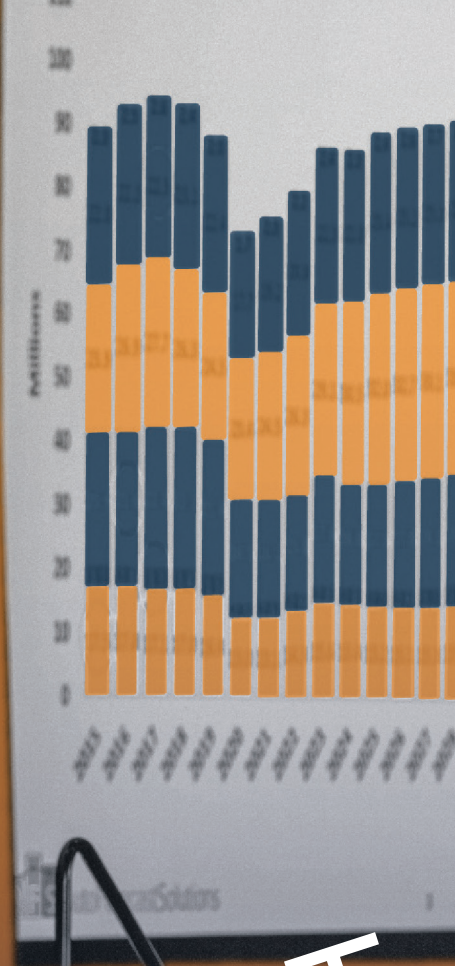
The reaction inside the department was telling. During a recent tech demo, several team members expressed surprise at how far the technology has progressed. When Will Sobel, chief architect of the MTConnect standard, said "Wow, that's impressive," Russ Waddell, tech contractor for the MTConnect Institute, joked that he couldn't remember hearing Will say that in the last 15 years.

The response highlights a larger point: Technologies that manufacturers assume are years away are rapidly becoming practical, accessible and affordable. The AMT Testbed exists to give us a place to ask a simple but important question: What could manufacturers do with this technology?

Today, it turned a photo of my motorcycle into a 3D model. Tomorrow, the same type of workflow could help manufacturers build digital twins, simulate production environments, train employees or interact with machine data in entirely new ways.

Want to explore what emerging technology could do for your operation? Reach out to Technology@AMTonline.org.

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Industrial AI: The Next Manufacturing Revolution

Robert Schoenberger

EDITORIAL DIRECTOR

AMT – The Association For Manufacturing Technology, which owns and operates IMTS – The International Manufacturing Technology Show

Manufacturing adopted artificial intelligence (AI) early, winning solid gains from inspection systems, toolpath planning and scheduling systems. But the current wave of generative AI products promises massive disruption to how factories operate.

In his “Industrial AI and the Factory of the Future” report, Ryan Kelly, vice president of technology at AMT – The Association For Manufacturing Technology, argues that generative AI will be at least as transformative as connectivity (Industry 4.0), computer controls (CNC) and electrification have been for manufacturing.

“The AI-native factory is one where machines, software, and human operators share a continuously updated model of what is happening — sensors feeding data into models, models informing decisions, decisions producing new data,” Kelly writes in the report. “The loop tightens until the coordination overhead that once required armies of planners, expeditors, and analysts becomes something the factory manages largely on its own.”

It’s a transition that will take decades, he argues, and one that will have clear winners and losers. Success will likely go to the manufacturers

that can best make sense of the massive amounts of data coming from every piece of shop equipment.

The current tech stack in most factories is very noisy, with each tool, machine

or software system focused on an independent task. Getting those systems to work together at the level needed to achieve AI breakthroughs requires a common understanding, Kelly says. Each component must agree on things like what a “part” is, what a “downtime event” means, what constitutes a “work order.”

For companies that can get their data in order, the potential benefits are massive. Each major technological revolution in manufacturing has done more than just increase production. Steam and water power did more than just replace human muscle; they moved manufacturing out of homes and into centralized factories. Electrification gave factories the flexibility to move machines within facilities, leading to optimization and modern management practices. Computerized controls boosted repeatability and made it easier to compare performance across multiple locations. Connectivity has created instant visibility into operations.

Kelly says AI, in addition to boosting individual operations, will drastically reduce the time between identifying a change in connected data and acting on it. Machines will react more quickly to changing conditions and fully optimize operations.

“AI doesn’t replace human decision-making. However, the coordination cost of human decision-making collapses because everyone and everything is working from the same picture,” Kelly explains. “The plant manager, the process engineer, the scheduler, the machine tool and the quality system all access the same operational ground truth. Each can act on it without waiting for translation projects, reconciliation meetings and time-consuming data-cleaning exercises.”

To read the full “Industrial AI and the Factory of the Future” report, go to bit.ly/3Topwn0.



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2026 TOP SHOPS

Full Roster of Honorees and Top Performers

What separates the top-performing machine shops from the rest? The 2026 Top Shops data points to productivity, workforce performance and speed in winning new work. Meet this year's 36 Top Shops and four Honorees.

BRENT DONALDSON | EDITOR-IN-CHIEF



Fun fact: A Top Shop's machines generate almost twice the revenue of those at an average shop.

This year's Top Shops report a median \$342,000 in revenue per machine, compared with \$180,000 for other shops. They also generate \$241,000 in revenue per employee versus \$191,000 at typical shops. Speed also matters when it comes to winning work: Shops that turn quotes around within a day report a 51% win rate on new business, compared with 41% for shops that take longer.

These 36 shops represent this year's top-performing machine shops, selected from hundreds of companies that completed the 2026 Top Shops Benchmarking Survey. Four additional 2026 Top Shops earned individual Honoree distinctions — one each for Machining Technology, Shopfloor Practices, Business Strategies and Human Resources — and are profiled elsewhere in this issue.

2026 TOP SHOPS

A-1 Lapping	Rockford, IL	Revolution Precision Machining LLC	Claremore, OK
Advanced Precision Engineering	Ipswich, MA	Rhine Machining	Kiel, WI
Apollo Tool Co.	Westfield, WI	Rocket Machining & Design	Springfield, MI
Aviva Metals Inc.	Lorain, OH	Rosenberger North America Pennsauken LLC	Pennsauken, NJ
Barsplice Products Inc.	Dayton, OH	Solomon Engineering dba SEI Technologies	Hickory, NC
Blossom Aerospace	Blossom, TX	Spectrum Machine and Design LLC	Windsor Locks, CT
Burkert US Corp	Huntersville, NC	Stecker Machine Co.	Manitowoc, WI
Chemring Energetic Devices	Downers Grove, IL	Topper Machine LLC	Spooner, WI
Demirjian Automotive Ent. Inc.	Oceanside, CA	Tuffaloy Products Inc.	Greer, SC
Dura Products	Swift Current, SK, Canada	Vineburg Machining Inc.	Carson City, NV
Faircloth Machine Shop	Winston-Salem, NC	Xcelicut	Latrobe, PA
Ferro Ceramic Grinding	Wilmington, MA		
Focused on Machining	Louviers, CO		
GAF	Burgaw, NC		
General Machine Works Inc.	York, PA		
Golden West Machine Inc.	Santa Fe Springs, CA		
Haumiller Engineering	Elgin, IL		
IMS Inc.	Decatur, AL		
JD Machine Corp.	Ogden, UT		
Manitowoc Pattern & Machine	Manitowoc, WI		
Midway Swiss Turn Inc.	Wooster, OH		
Precision Innovations	Germantown, WI		
Proto Technologies Inc.	Liberty Lake, WA		
Prowse Manufacturing Group Inc.	Marysville, WA		
Rayson Co.	Houston, TX		

2026 TOP SHOPS HONOREES

MACHINING TECHNOLOGY (page 70):

HEI Precision

SHOPFLOOR PRACTICES (page 46):

Precision Profiles LLC

BUSINESS STRATEGIES (page 62):

Hill Manufacturing
& Fabrication

HUMAN RESOURCES (page 54):

Astro Machine Works

The 2026 class of Top Shops will be recognized at the Top Shops Conference, Oct. 6–7, in Cleveland, Ohio, where attendees can meet this year's honorees, learn how they run their shops and have some fun along the way.

2026 HONOREE

SHOPFLOOR PRACTICES

PRECISION PROFILES

Nothing Left to Memory

A 2026 Top Shops Honoree, this 34-person Titusville, Pennsylvania, manufacturer has built its operation around process control, knowledge transfer and customer reliability — qualities in short supply across a Navy supply chain struggling to keep pace with its own shipbuilding targets.

BRENT DONALDSON | EDITOR-IN-CHIEF

An 18,000-pound bar of Monel 400 arrives at Precision Profiles' hollow machining department that needs a 16-inch hole cut through its center. At roughly \$65 per pound, this massive cylindrical workpiece — made from a nickel-copper alloy resistant to harsh marine environments — is worth about \$1.17 million. Drilling the hole would turn the material removed from the center into very expensive chips.

Instead, Precision Profiles trepanns the bar, leaving a 14.5-inch solid core that the customer can recover and reuse after testing. To do this, the company deploys six large trepanning machines, most of which date back to WWII. Newer trepanning equipment can remove more material at a faster rate, but only at a great disadvantage when the customer's priority is recovering as much of an expensive alloy as possible.

These machines are just one example of the way Precision Profiles approaches manufacturing. Strategically, the company has built processes around equipment, fixtures, documentation and employee training so it can consistently perform specialized work without depending on one person's memory or a particular machine.



A Precision Profiles machinist works a large-diameter bar at the company's Titusville, Pennsylvania, facility. The shop keeps decades-old machines like this one in production because newer equipment removes more material than its customers can afford to lose.

Source (all images): *MMS*

That matters a lot for a 34-person shop in Titusville, Pennsylvania, where some of the work involves turbine components for submarines, aircraft carriers and power-generation equipment. It's part of the reason

why *Modern Machine Shop* has named Precision Profiles our 2026 Top Shops Honoree for Shopfloor Practices. And it's part of the reason the shop is in a different condition today from just four years earlier, when a sudden falloff in orders from its submarine and aircraft carrier customers had put Precision Profiles' future in question.

A Business Worth Saving

Titusville's manufacturing history dates to the oil boom that followed Edwin Drake's first commercial

oil well near the town in 1859. A new chapter of the town's industrial history would certainly include Precision Profiles, which operates a 70,000-square-foot facility that combines CNC machining and proprietary profile grinding with manual machining, trepanning, boring and honing.

CEO and President Matthew Lucco first learned about the company in 2005, back when he was working in investment banking and helped the company's second owner line up financing to acquire it. His firm's financing wasn't ultimately used, but 13 years later when that owner decided to retire, Lucco bought the company himself.

While Lucco didn't have a manufacturing background, his logic behind the purchase was clear-eyed: "I wanted to see if I could run and improve an operation, start from point A, and see if we can get it to point B," he says.

When Lucco bought the shop in 2018, just two customers accounted for about 85% of its business, a percentage that had concerned other potential buyers. But Lucco had important





A finished heavy-wall tube in Precision Profiles' hollow machining department. Customers who supply solid round bar and need a bored ID rather than the solid core recovered from a job like the Monel forging above get same-day quotes from the shop.

context that other buyers didn't: Those same two customers had been there when he evaluated the company in 2005, supplying turbine work for aircraft carrier and

submarine applications.

As majority shareholder in the company, the first changes Lucco made were basic — cleaning up operations and reorganizing workflow. Growth continued through a 2021 acquisition that added a hollow-machining division, and both operations were ISO certified and eventually consolidated under one roof. The more consequential change came from what happened to the business in 2022.

Precision Profiles was used to waiting patiently on its defense customers to place orders. That cadence was steady enough until its major submarine and aircraft carrier customers began

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Precision Profiles turbine vanes for marine propulsion, shown by stage — vane geometry changes at each stage as pressure and temperature drop through the turbine. In the foreground, a stage-10 turbine vane shows the difference in scale across programs.

a rear admiral at a conference in Washington, D.C., he asked customers to work with his company toward continuous production rather than large, irregular orders. For submarine

work, the company now receives orders on a more predictable schedule tied to production.

That change addressed an immediate cash problem. It also set a pattern that echoes across the shop floor: Repeatability reduces how much depends on circumstances outside the company’s control.

Putting the Knowledge in the System

When Lucco took over, manufacturing knowledge existed in roughly equal parts in employees’



purchasing more material than they needed for the ships under construction in 2022. The resulting gap in orders left the shop in a financial predicament. “We were months away from having to shut down,” Lucco says.

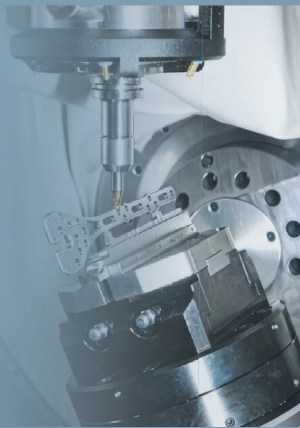
Lucco responded by changing the way he managed customer demand. After speaking with

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Precision Profiles bought this Mazak Integrex i-200S in 2020 to bid on a rotating-blade job and lost it. The multitasking mill-turn machine sat largely idle for two years, aside from training runs, until a customer redesigned a turbine vane in 2023 with a twist along its length — a geometry the shop's standard profile-grinding process can't produce. The Integrex has run that job (among others) monthly since 2024.

provides access to scheduled jobs, drawings, program numbers and production requirements. Operators use these devices to access setups and individual operations, record production quantities and enter quality data. The system also identifies which program should be loaded and what that program is expected to do. "The idea is to remove as much tribal knowledge as needed because it facilitates training and it facilitates coverage," Lucco says. An employee taking time off should not put an order at risk just because no one else knows how to run it.

The ERP has changed the quoting process as well. For a repeat turbine vane, Precision

heads and on paper notes. "That knowledge was 50% in the minds of the shop-floor people, and 50% in notes that were written on tablets on the shop floor: paper tablets, yellow legal tabs, or graph paper," Lucco says.

Precision Profiles now uses Fulcrum Pro ERP throughout the shop. Each employee has an iPad that

training newer hires as well as teaching one employee to maintain the machines.

In 2025, cross-training expanded to honing, trepanning, saw cutting, large grinders and EDM, and the shop is now systematically capturing knowledge from its experienced employees, including one with 54 years under his belt.

Ten-Minute Setups

The result of these efforts was visible in Precision Profiles' Top Shops data. The company reported an average CNC setup time of 10 minutes in the 2026 survey, the lowest figure in the dataset and well below the median of about 90 minutes.

The primary reason is simple: fixtures. "You can drop the material into the fixture, indicate fairly quickly, and then touch off and go," Lucco says.

Precision Profiles has more than 150 custom fixtures, each associated with a specific profile. The fixtures are made in-house and identified by part number. Once a fixture has been developed and proven, an operator can install it and get the first piece into production without rebuilding the setup. The ERP separately records setup time and runtime per unit, allowing the company to measure the result.

Quick-change devices, tool presetting and probing are part of the operation, but Lucco gives credit to the fixtures more than anything. "We

Profiles can review the drawing revision, retrieve the previous cycle time and produce a quote in about 10 minutes. The company also now knows which jobs it previously underbid and which it can price more competitively. In one recent case, better cycle-time data allowed Lucco to reduce a customer's price by 15%.

The same idea applies to equipment that is unique to the shop. Precision Profiles has five proprietary profile grinders — conventional horizontal surface grinders modified in-house to produce profiles as long as six feet. Long-tenured employees are tasked with

don't really look at the tool setting as something innovative, it's just something that needs to be done for the job to make sure we're getting the right results," he says.

The shop doesn't optimize every process for speed. In 2025, it reported 99.2% on-time delivery and 98.9% first-pass quality. Lucco says those figures are representative of the company's performance, and its internal target for on-time delivery is 95% or better. First articles are sent to a third party for validation before they go to the customer — a process that has produced 100% first-article approval.

Old Machines, New Value

The six trepanning machines in the hollow machining department are an entirely different kind of process advantage. They're mostly 1940s-vintage, WWII-era equipment that Precision Profiles has kept in production and updated over the years (when something breaks, the company sometimes has to make its own replacement parts). Titanium trepanning work

produces cylinders that become missile-program components before another supplier performs the finished machining.

The machines remain in service because newer equipment removes too much material. A 16-inch hole through the Monel bar described at the beginning of this story leaves a 14.5-inch core. Lucco says a newer trepanning process could leave only a 9- or 10-inch core. "At \$65 a pound, to be able to give them a 14-and-a-half-inch solid bar back is huge," Lucco says.

A Supplier the Navy Needs

Defense-related work makes up roughly 55% of Precision Profiles' business, primarily CNC machining of turbine components for submarines and aircraft carriers. The remaining 45% is commercial and industrial work, including gas turbine components for data centers and other power-generation customers.

Precision Profiles operates within the Navy submarine industrial base, supplying components that support programs built around prime



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Matthew Lucco, president and CEO of Precision Profiles (white shirt), with much of the shop's 34-person team at the company's Titusville, Pennsylvania, facility. Lucco says the company's five-year target is 50 employees and a fully built-out third bay.

contractors including General Dynamics Electric Boat and HII's Newport News Shipbuilding. But that position has become more consequential as the defense industry works to expand capacity. For example, Virginia-class submarine deliveries have remained at roughly 1.2 to 1.3 boats a year since 2022 (the same year Precision Profiles nearly shut down) and the Navy's goal of reaching two Virginia-class boats annually, previously targeted for 2028, is now expected around 2032, according to Chief of Naval Operations Adm. Daryl Caudle. The Naval Sea Systems Command has said submarine construction capacity needs to nearly double, a goal complicated by a maritime industrial base that has shrunk to roughly a third of its size compared with 30 years ago.

The Pentagon has run into versions of the same problem. In July 2026, the Pentagon suspended the next phase of its Cybersecurity Maturity Model Certification (CMMC) program, amid concerns that compliance burdens could drive small companies out of the Defense Industrial Base. Precision Profiles' benchmarking performance reflects the same capabilities the broader defense supply chain needs: reliable delivery, documented processes and the ability to produce complex components consistently.

Building the Next Stage

Precision Profiles has grown from nine employees in 2018 to 34 today, and Lucco attributes part of that growth to changing how the company hires. The company now primarily looks for people who are willing to learn and then trains them for the work. Three employees have come through a student-run manufacturing enterprise established with a local high school. Students in the program learn quoting, sales, marketing, machine programming, production and machine operation.

Lucco says changing to a "hire for fit, train for skill" model has been one of the most consequential changes the company has made. Two of the company's three most productive employees had no machining experience when they were hired, he says. This does not eliminate the broader workforce problem, of course. The hardest positions to fill are those requiring experience troubleshooting complex equipment and programming around unusual machining challenges.

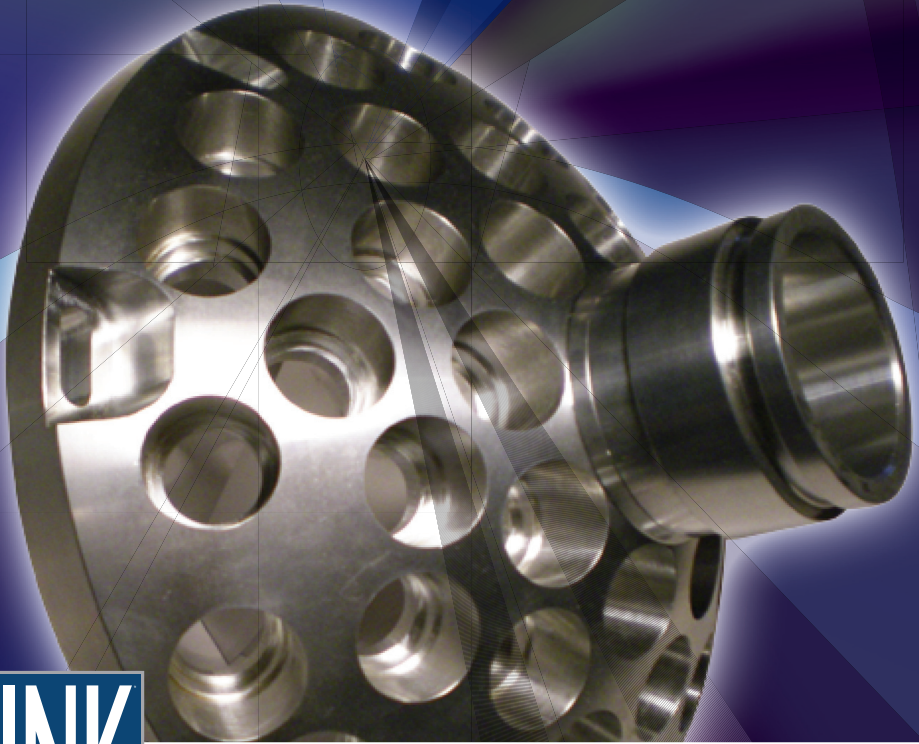
Lucco's five-year target is 50 employees and a full Bay 3, which would leave room for roughly four additional conventional CNC machines. He also wants more commercial contracts to balance the company's defense work, and to keep improving shopfloor operations to reduce inefficiencies. "Machining isn't a dirty business. It can be clean, fun and exciting, and you're making stuff that matters." ■

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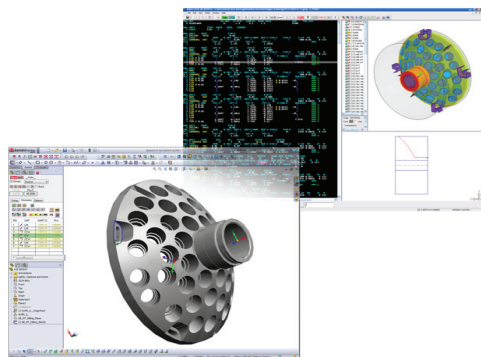


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HUMAN RESOURCES

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A successful human resources program requires multiple strategies. Astro Machine Works doesn't rest on its ESOP, deploying a range of other programs that have earned it recognition as the 2026 Top Shops Honoree for Human Resources.

JULIA HIDER | EXECUTIVE EDITOR

In 2018, Astro Machine Works was at a crossroads. The president was planning his retirement and considering succession planning options for the shop, including selling to private equity. Although the company had a successful experience with private equity, finding another firm that fit the business equally well seemed like a long shot. But when company ownership came across the idea of transferring the company to an employee stock ownership plan (ESOP), they saw how this plan would complement the management style and culture the business had cultivated over the years.

The company completed its ESOP transition in 2018, and in less than 10 years the share price has skyrocketed from zero at onset to more than \$200. This success is in no small part due to its workforce strategies, which have earned Astro Machine Works the title of 2026 Top Shops Honoree for Human Resources.

Open-Book Management

Founded in 1984, Astro Machine Works has nearly 80,000 square feet across four buildings in Ephrata, Pennsylvania. Out of 130 employees, about 100 work on the shop floor across two shifts running a variety of machines including four- and five-axis mills, lathes, wire EDMs and surface grinders in a range of sizes, though Sales Manager Brian Hess says most parts are smaller than two



Astro Machine Works is manufacturer in Ephrata, Pennsylvania, that makes custom machinery and automation systems for a variety of end markets. Thanks to an ESOP, its 130 employees are also company owners. Source: *MMS*

feet in length. Astro also acquired a fabrication shop in 2021 that does plasma cutting, welding and light assembly work. Customers operate in a variety of industries, including defense and nuclear power. Astro has earned a number of certifications to perform this work, including AS9100, ISO 9001 and CMMC Level 2, while maintaining a compliant quality program in accordance with ASME NQA-1 for work related to nuclear safety. The customer base is intentionally diverse to protect the business from downturns. Astro focuses on making custom machines and automation systems, meaning much of its work falls into the “high-mix, low-volume” category.

The groundwork for the ESOP was laid 10 years prior, when the company adopted an open-book management system that continues to this day. “We share financial information with all of our workforce,” notes Astro’s Head of HR, Charissa Gift. “We’ve done a lot around our culture and values, and all of those things were a really great recipe to become an ESOP.” An ESOP requires openness about company performance, and at Astro, the culture and infrastructure for that communication was already in place.

Astro shares its company financials with employees every month through bulletin boards, email and other communications. “Anybody can look to see where we’re at according to our goals,

what our backlog is at any given time,” Gift says. This includes information on the company’s profit-sharing bonuses. “Our free cash flow is put into a bonus, and you can see where the bonus pool is,” she explains. Twice per year, half of the free cash flow is paid out in a bonus to employees, and the other half is invested back into the business.

Another aspect of the open-book management system

is developing a yearly roadmap for the company. Astro works to ensure all employees are included in the creation process. In October, each department meets and sets goals for the next year. “We want everybody to be involved because if they’re involved in creating the goals, then they’re more apt to be engaged in achieving them,” Gift says. With departmental goals established, the financial team and senior leadership teams set the budget and put everything together. “We give a copy of the roadmap to every employee. It has all the charts, the information, department goals,” she adds. The company also creates and distributes a communications plan for the year, so employees know when they will receive certain information through newsletters, meetings and more.

Value-Based Culture

The ESOP also pairs well with the value-based culture Astro has developed. The shop worked with a consultant in 2014 to define its culture, values, vision and mission. “We had everybody involved in that, the whole company,” Gift says. The company landed on “Creating relationships that improve and protect our world. It’s basically why we come to work each day. Why do we want to work at Astro Machine Works? Because we’re doing things that protect our world, that make it a better place,” she explains. “There’s people



making parts, there's people putting machines together, but then there is the support, the HR, the IT, the quality, so we're all in this together for that one mission."

The process also helped the company uncover "how we want to do business: respect, compassion, innovation — they are the drivers of how we want to do business and how we want our workforce to experience their work," Gift adds.

These values have stuck around because they "came directly from the people on the shop floor," Hess notes. The ESOP enables the employees to protect the values they chose. "We've maintained control of how we want to do business," Gift says, as opposed to if the company had been acquired.

Communication

When the ESOP was established, the business put a lot of effort into ensuring its employees understood what it meant. "There was a lot of excitement around it," Gift says, "but there was also a lot of unknowns because it was a very new concept to most of the workforce, so we did a



Before pursuing an ESOP, Astro instituted open-book management, which provided a solid foundation for the ESOP. The company shares its financials with employees monthly through bulletin boards and emails. Source: *MMS*

lot of communication." Astro continues to regularly disseminate information about the ESOP.



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The company's employee-driven, values-based culture also provided a strong basis and motivation for the ESOP. It enables employees to protect the values and culture they helped establish, as opposed to other succession planning options. Photo by MMS

"We still do a lot of communication around what the ESOP is, what it means," she adds. Astro also has a plan for bringing new employees on board with the ESOP. Gift and company President Eric Blow conduct an in-depth training within a new hire's first 90 days. "We go over exactly what the open-book management is, how to read the financial statements and the metrics and all of the communications, and then we go in-depth about what the ESOP is and how that works and how that's going to work for them," Gift explains.

Even with the employees on board with the plan, it took some time for the company's valuation to grow enough for employees to take notice.

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“It did take a couple of years to really have people understand that what I am doing here is actually being shown through my financial statement, and it’s growing and increasing wealth for my retirement,” she says.

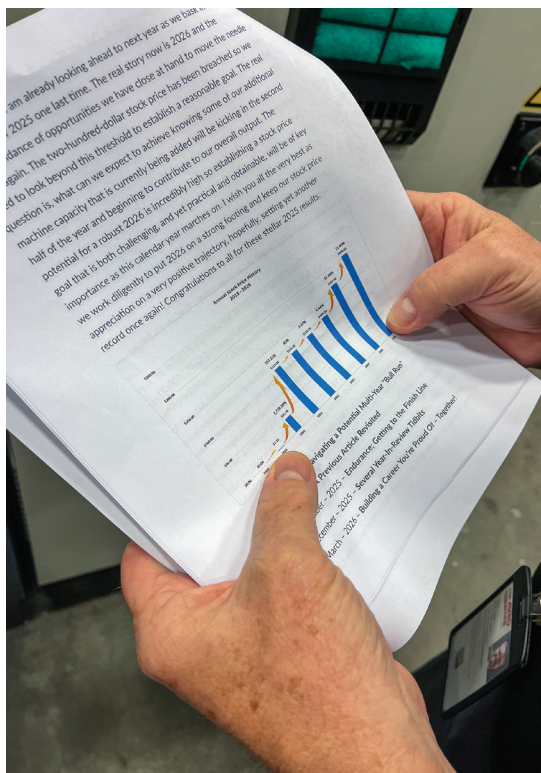
Since the ESOP transition, the company’s share value has been on an upward trajectory. “Our share price has gone up every single year since we’ve started,” Gift says. After starting at zero, it went up to \$1.12 by the end of the first year and continued to climb to \$204.01 at the time of my visit.

The share price also provides an opportunity for team bonding. The company celebrates when shares reach a milestone value, such as when it hit \$200. “We have a stock picking contest where employees guess the share price every year, so people get involved and try to guess what it’s going to be based on different metrics,” she adds.

Recruiting and Retention

When it comes to the company’s approach to personnel, “Having a couple different strategies” makes a difference, Gift says. For example, the ESOP has proved to be a useful tool in recruiting and retention. “We advertise ourselves as an employee-owned company, and during the interviewing process, we do talk about that,” she

Share value started near zero, but has grown steadily since, reaching \$204.01 when I visited. As share value grew, employees began to take more interest in the ESOP. Source: MMS



Astro also worked with an external partner to develop a one-on-one coaching program. Managers go through training and have a one-on-one coaching session once per year with every employee, along with informal coaching throughout. These are separate from perfor-

mance reviews, which focus on where the employee is now. Coaching sessions are intended to look at the employee’s career goals and develop a plan to achieve them. “We say that we don’t just offer a job here;

we offer a career,” Gift says.

Another benefit Astro offers is flexible schedules. Each shift has a two-and-a-half-hour window during which each employee can start working (so first shift can arrive anywhere between 5 a.m. and 7:30 a.m. and leave between 3:30 p.m. and 5 p.m.). It also allows employees who have worked 45 hours by 9 a.m. on Friday to leave early. “It really worked because we had some people that were not doing much more than a 40-hour regimen, but they started taking

“Recently, we’ve started contributing more effort as a company to benefits, so we can keep the costs down for our workforce.” —CHARISSA GIFT, Astro’s head of HR

says, “and it’s definitely something that many people are intrigued by.” But this is far from the only way the shop sells itself to new hires and keeps current employees happy. “We also look at our wages and do wage studies to keep very competitive with what we’re paying,” she adds. “We also strive to keep competitive with benefits. Recently, we’ve started contributing more effort as a company to benefits, so we can keep the costs down for our workforce. We are constantly looking at those things.”



Astro strives to give its employees careers, not just jobs. To that end, managers have one-on-one coaching sessions with all employees aimed at career progression and planning. Source: Astro Machine Works

advantage of the 45-and-out, so we gained five hours of production time on the floor,” Hess notes, which benefits both the employee and the company.

Creative scheduling was an initiative suggested by the Astro Collaboration Team. This is a group of employees who serve for two years on a committee consisting of a representative from every department, which gets in-depth information on the ESOP. They act as ESOP ambassadors, bringing that information to their teams and bringing ideas about reducing costs or improving efficiency from their teams to the committee.

Apprenticeship Program

Astro also makes efforts to recruit not only experienced machinists, but also early-career employees. The company has had a registered apprenticeship program since the 1990s, which it updated a few years ago to give apprentices



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Astro's apprenticeship program has graduated 27 apprentices since it was established in the 1990s, with two currently working their way through. ToolingU, funded by grants, provides the education portion, and apprentices rotate through different departments to get shopfloor experience.

Source: MMS

ated 27 total apprentices, with two currently in the program.

Apprentices are paid for their time on the shop floor. "We start them at an entry-level machinist rate," Gift says. "They are fully compensated while they are going through the training program." Astro receives grants from Workforce and Economic Development Network of Pennsylvania (WEDnetPA), an alliance of Pennsylvania educational providers focused on workforce training within the state, to fund the ToolingU portion of the program. It also receives funding through an incumbent worker training program through WEDnetPA for upskilling.

Astro uses multiple channels to recruit apprentices and other early-stage manufacturing employees. It works with local high schools and CTCs to hire students for co-ops. It also offers

more options. It works with ToolingU for the education portion, which Gift says everyone appreciates for its flexibility. For the shopfloor training component, apprentices rotate through all departments. The program has gradu-

internships for students in the two-year machinist program at its local technical college, Thaddeus Stevens College of Technology. Members of Astro's workforce development collaboration team attend occupational advisory committee meetings at several area CTCs and technical colleges; work with different partners in the community, such as the workforce development board; and attend open houses and career fairs. Additionally, the committee organizes tours for more than 200 students each year. "We've had several people come here either through CTC or even later in their career, saying, 'Oh, I came to Astro 10 years ago on a tour, and I've always kept you guys in mind,'" Gift says. "So sometimes it comes full circle. The stuff that we did 10 years ago is helping us move forward."

The ESOP, like Astro's recruiting efforts, took time to show results. But the change is more than just monetary. "People have more ownership and pride in what they're doing. They had that before ESOP too. But it really hits home when you have a stake in the company and what you're doing is really making a difference, not only in the world, but in your own financial situation," Gift says. "It's just a different level of pride and ownership and being a part of a company." ■

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HILL MANUFACTURING AND FABRICATION

Comparison Steals Downtime, Not Joy, From Top Shop

Hill Manufacturing and Fabrication has found success through diligent use of machine monitoring software and benchmarking surveys, including *MMS'* own Top Shops.

EVAN DORAN | SENIOR ASSOCIATE EDITOR

What's the most effective path to improvement? Mike Payne, CEO of Hill Manufacturing and Fabrication, began asking this question in early 2018 when he acquired the shop. He started answering that question quickly, relying on benchmarking for the shop and conversations with peers for himself, using the feedback to determine where he would invest in the shop.

Now, Hill Manufacturing stands as a successful business across four locations, with a central building making use of process monitoring, benchmarking and smart cell design to improve its productivity and increase revenue by an average of 20% year over year. The success of its methods has earned it a spot as the 2026 *Modern Machine Shop* Top Shops Honoree in Business Strategies.

The Benefits of Benchmarking

Payne filled out his first Top Shops survey in the spring of 2018, not long after buying Hill Manufacturing. At that time, "I don't think there was a single category that we were in the Top Shops column," Payne says, but he didn't let this discourage him. Instead, he dug deeper into the survey, looking for the categories where Top Shops (the top 20% of respondents) and other shops diverged in the results. From there, he focused on the categories where his shop most



diverged from the Top Shops, looking for ways to improve these metrics in the aim of improving his shop performance.

In practice, Hill made three major changes. Payne realized the shop was spending only half the percentage of revenue Top Shops would spend on tooling, and lost time tracking tooling across the shop. As such, he initiated a reevaluation of Hill's tooling vendors, and the shop bought a tool vending machine, set up a dedicated toolroom and hired a toolroom attendant.

The survey also informed Payne that Hill's revenue per full-time employee was well below the Top Shops' average, leading him to reconfigure the shop's process and workflow. When he first came to the shop, each machinist ran one specific machine, limiting their usefulness while their machine was running. To improve productivity, the Hill team rearranged their shop floor into cells of three machines, with two people assigned to each, increasing productivity considerably, especially as the shop has added machines. Recently, Hill has also started to add fourth, automated machines to its cells to further improve productivity.

Payne also noticed oddities in Hill's setup times, discovering that this often came down to staff members needing to track down managers for questions or make multiple trips to the tooling station as they inevitably forgot a few tools. While the tool vending machine helped with this, Payne says the greatest change occurred when Hill

adopted ProShop and used it to make prints, setup notes and tooling lists available from stations at the machines.

Three years after Payne and Hill

Manufacturing

first participated in the Top Shops program, its performance had improved enough to qualify as a Top Shop. Payne says he could look around and feel the improvement in the shop's operations, and as such, he continues to fill out the survey year to year and use it as a lodestar in Hill's continuous improvement journey.

Monitoring Improvements

Software capturing machining and quality data has also played a major role in the shop's continuous improvement efforts. Hill adopted ProShop in 2019, and the shop has since become a power user of the software, employing it as a total quality management system that is fully integrated into every job. Payne says it captures former tribal knowledge like tooling lists, tool settings and machine settings, and that with proper notes and pictures, he can ask any machinist in the shop to set up a part that previously only one specific, skilled machinist could

Hill Manufacturing's 2018 Top Shops results showed their one operator, one machine standard resulted in below-average revenue per employee. Since then, Hill has reorganized the shop floor to assign two staff members to three-machine cells, and is in the process of adding fourth, automated machines to its cells. Source (all photos): MMS



have completed. He adds that the software helped speed visibility into job performance from weeks after a job completed to the same day the shop started making parts, enabling it to adjust and pivot if parts come out incorrectly.

This reactivity improved further with the shop's adoption of Datanomix in 2022, which enables real-time machine monitoring. Payne says this has shown discrepancies between performance expectations and reality from the very first part, while also helping determine when a tool is starting to go bad. He also notes that it helped Hill detect break bleed around lunch time, where people going on break would lead to downtime on spindles. Beyond setting up the shop to fix this and regain that lost spindle time, Payne says the software enabled the shop to track the time it lost at the



Hill has used Datanomix since 2022 and ProShop since 2019. The combination of these software suites has helped Hill catch and reduce significant areas of spindle downtime across the shop.

start of the morning shift, when every spindle in the shop would need to warm up and every person would need to gather tooling. Now, he pays one staff member to come in early, set the

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machines to their warm-up cycles and check ProShop to match each station with the proper tooling before the start of the first shift.

Hill also set up a Datanomix station at each cell so cell leads can take in the status of each connected machine at a glance. The shop uses Datanomix's alert escalation systems when

Hill's logo includes references to each of the shops under its umbrella. While these shops tackle different kinds of jobs, each shop quotes jobs that could run at any of Hill's locations. From there, they use an internal billing system to keep paperwork in-network and Autodesk Fusion to securely transfer part data.

needed, ensuring the right department lead gets notified when a problem arises, and that if the problem goes unresolved, the alert automatically escalates to full shop leads or Payne himself. When the shop needs a new report, view or dashboard, Payne says his team is quick to request them, and they often arrive in the software soon after.

Setting Up Connections

Part of this, Payne acknowledges, is the idea that "if Mike wants it, then probably everybody else does too." This is because, as many readers probably know, Payne has been one of the cohosts of the MakingChips podcast since 2023 and launched the platform's Buy the Numbers podcast in 2024, making him a visible face in



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the industry. While his visibility tends to give him access to OEM leaders and job shop floors, his strategies for learning about new opportunities and technologies only differ in scale from the five years before he officially joined the podcasts.

Payne recommends paying attention to multiple sources, whether in the form of podcasters (he listened to all of MakingChips well before his first guest appearance), YouTube influencers or magazines. The best method for him, however, has been speaking directly to peers and touring job shops. He says he goes in knowing that he doesn't want to take pictures of parts, but rather of the little oddball signs and details that suggest process improvements. While he admits that the idea of touring nearby job shops and inviting fellow shop owners to your facility may seem like it gives away a competitive edge, he counters that it helps everyone involved improve and make connections. For his part, Payne has been able to borrow gages and taps from nearby ostensible competitors as a result of these connections, and returns the favor when he can.

The management of Hill's flagship shop does its best to make the facility a welcoming environment, with a saloon-themed breakroom that includes a pool table for after-shift games and a beer fridge for after-shift conversation.

Payne also recommends attending conferences where possible, and gave a shout out to the 2025 Top Shops conference, which he said was useful because it was a chance to talk about "the good, the bad, the ugly, and how different people are handling some of those things" with shop owners dedicated to improving their processes. He points to the visit to Roush Yates Manufacturing's facility as a highlight, as he got to ask questions about their pain points and the everyday simple solutions that addressed long-running issues.

Taking part in the production of MakingChips enables Payne to do this on a larger scale, giving him an inside look at upcoming technologies and strategies, as well as how he could bring them to the Hill Manufacturing shop floor. For example, Hill adopted Toolpath's AI-driven CAM software following a conversation with the CEO on the podcast. MakingChips' creation of HireMFGLeaders has also helped Hill



Payne says he started trying to figure out the retention puzzle early, as he was one of the youngest folks at the shop when he bought it, and the shop had a much higher average employee age compared to other Top Shops. Now, after eight years and several retirements, he's the third-oldest employee in Hill's flagship shop.

Manufacturing find experienced people who want to work as part of a shop known for being on the front edge of the industry.

Creating the Target

Of course, the industry visibility from the podcast would mean nothing if Hill Manufacturing did not have the customer service and internal culture to back it up. Payne says the shop works hard to reach on-time delivery and quality expectations. When a part goes wrong, the team will stay late to finish it, and Payne has been known to personally deliver parts when needed. Though the ideal is for production to be seamless, if Hill needs to pivot and recover, Payne wants the shop to be agile enough to do so. »

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The shop also wins more quotes than it loses, even with higher prices than the competition on paper. Payne credits this to the shop's identification of its ideal customer and its focus on repeat business. While the shop's normal win rate for quotes is around 55%, Payne estimates that this increases with established customers to around 70%. The shop's focus on on-time delivery can outweigh small differences in price for these customers, as can its ability to perform turnkey work and condense operations that would otherwise require multiple vendors.

Payne says his goal for the shop is to double its revenue every five years, and though revenue was flat in 2024, Hill is still on target thanks to a 47% YoY revenue increase. He attributes half of this to internal shop development, and half to an acquisition that added another shop to Hill's growing network.

Cross-Discipline Stability

Hill Manufacturing and Fabrication includes four shops in the Tulsa area, with an executive management team headed by Payne overseeing all of them. The facilities share a common software workflow, even as the individual machine tools, skillsets and cultures of the shops differ. For example, satellite facility QMI handles higher-volume production work, while the main facility handles smaller-run, high-precision parts. Payne says each shop in Hill's portfolio would have no-quoted about 80% of the work mix the other shops take on, but when combined, they are able to handle all of these work mixes for any client of each of the four shops. Management maintains the unique culture of these shops and respects their retention efforts: One shop grills out on Fridays, and another operates on a four-day, 10-hour workweek rather than a traditional five-day, eight-hour schedule.

This trust and respect extends to the shopfloor level as well. Payne says he trusts his staff to do their part, and the regular introduction of new technology means staff can grow and see a long-term career pathway. The shop's combination of



As part of its efforts to build up the culture among its employees, Hill began its Hill's Hounds program fostering shop dogs and finding forever homes for them. "You can just feel the difference in the building," when a foster is in the building versus when they're not, Payne says. I was greeted by Abigail, the shop's 102nd foster, when I visited Hill's flagship shop in July.

machine shop work and fabrication also creates this sense of long-term stability. Payne says when he first bought Hill, its ratio of fabrication work to machining could swing wildly, with 70/30 ratios in either direction month-to-month. Now, with the improved productivity of the machining cells, the balance leans toward machining, which stays between 60-65% of the shop's workload. Hill's staff also cross-trains between machining and fabrication, meaning they can stay flexible when one area or the other has a downturn. Hill has also diversified from the region's traditional focus on oil and gas, adding customers from other markets to mitigate the impacts of booms and dips in any one industry. The cross-training and customer diversity help Hill keep employment levels stable and build a loyal, skilled bench of machinists for the shop to rely on as it expands and tackles new and more challenging work. ■

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DEREK KORN | EDITOR-IN-CHIEF, *PRODUCTION MACHINING*

“Our first parts ran on a CNC lathe with a bar feeder,” Mark Holz explains. “When we added milling capacity, we created robotic cells. Since then, every equipment decision we make starts with one question: ‘How can this integrate into an automated cell?’”

Holz is president of HEI Precision, located in Bellingham, Washington. He says he built the now AS9100-certified, ITAR-registered CNC machine shop with high-volume production in mind. Its focus is producing parts with estimated annual usage (EAU) ranging from 200 to 200,000 pieces.

The business began as a fab and design engineering shop producing motorsports components. It still produces parts for that market, but has expanded to others including aerospace, defense, electronics, optics and commercial while continuing to explore new markets and opportunities.

Thanks in part to machining automation, HEI Precision commonly produces 40,000 to 50,000 parts per month despite having only 10 people on staff. The shop currently has three different automation setups: bar-fed lathes; robot-loaded, dual-pallet VMCs; and palletized multiaxis machines.



Recognizing the value of palletized machining in terms of production and flexibility, HEI Precision has added one Matsuura HMC with 15-pallet capacity and two Matsuura five-axis machining centers with 32-pallet capacity. Source (all photos except where noted): *MMS*

Today, the shop has six DN Solutions multiaxis turning centers, all with twin spindles, twin turrets and Y-axis milling capability. These machines enable the machining of complex round parts with

“Between the three of those automated machining concepts, we’re able to keep volume up without adding headcount,” Holz explains. “And what we end up with is dedicated capacity for customer forecasts, clearer capacity planning and the ability to scale production without proportionally scaling labor.”

Automation Started with Bar-Fed Lathes

Early on, the first bar-fed lathes the shop added were conventional three-axis models making

Each of these dual-pallet R-450X2 Brother VMCs are integrated with a RoboJob Mill-Assist robot loader with reconfigurable workpiece storage table.

simple parts, as Holz describes them. As part complexity increased, HEI Precision added twin-spindle lathes with live tooling.

milled features in a single operation. With the addition of twin turrets, HEI Precision is able to split the cycle time between the main and the sub-spindles to reduce overall part production time.

During my recent visit, I saw two such machines producing end caps for shock absorber reservoirs. Each machine can produce 1,000 parts unattended per day. And because of the twin-spindle/twin-turret design, the cycle time per part is effectively cut in half because the machines can perform op. 10 and op. 20 work simultaneously.

Completed parts are dropped onto a conveyor for collection and then moved to racks HEI Precision created to store and enable them to essentially drip-dry prior to packaging. The shop also made sloped racks which present bar stock to the bar feeders above them to simplify stock addition while freeing up floor space as the material is not staged on the floor.

Adding Robots to Dual-Pallet VMCs

Some years ago, HEI Precision added three dual-pallet, Brother R650X2 three-axis VMCs from Yamazen to perform second-op milling of shock absorber piston blanks that were first turned on a lathe. The big advantage of the dual-pallet rotary table system is that it enables operators to load parts on one pallet outside the machine while the spindle cuts parts on the other.

Holz says those served the shop well for a time, but it got to the point in which the operators couldn’t keep up with loading



them. Turned blanks would need to be loaded every 30 minutes, meaning operators were bouncing from machine to machine to keep the mills stocked.

So, HEI Precision added two smaller, dual-pallet R-450X2 Brother models, each with a RoboJob Mill-Assist robot loader with reconfigurable workpiece storage table. Now, instead of first creating piston blanks on a lathe, the parts are milled from rectangular bar (three pistons per bar) held in pneumatic vises. Once bar material is manually loaded on the RoboJob Mill-Assist tables, the machines can run unattended for 12 hours. And this setup also enables the two machines to produce more parts than the previous three non-automated machines.

For the piston application, robot speed is a non-factor. That's because when the robot is loading blanks, unloading completed parts or flipping parts for op. 20 work, the machine is still in the cut on the other pallet. The robot can perform all those duties while the machine is cutting, and that also affords extra time for operations such as blowing chips off vise jaws.



When HEI Precision added an HMC, it chose not a standalone machine, but instead, a compact, four-axis Matsuura H-Plus 300 with 15-pallet automation and 330-tool ATC magazine.

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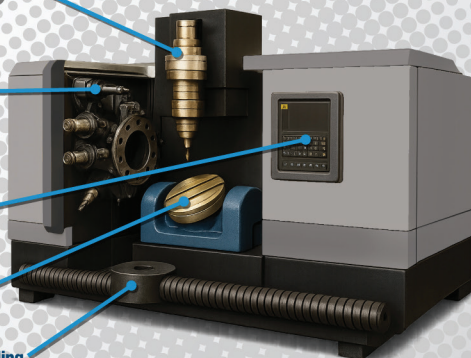
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The cells also can accommodate multiple piston sizes. Holz says changing to a different size takes approximately 20 minutes to swap out vise jaws and reconfigure the pins that hold and locate the stock on the robot table. Changing the robot program is essentially performed by entering the number of parts to be machined and stock size, and the controller outputs where to install the pins on the table to load the material.

The RoboJob Mill-Assist uses an area scanner to ensure operator safety. If a person were to enter a defined outer zone around the cell, the robot slows its motion. If a person enters an inner zone closer to the robot, the robot stops its motion, which would then require it to be reset to continue.

Realizing the ROI of Pallet-Pool Machines

In 2022, high-production requirements for a family of shock absorber bridges led HEI Precision to add an HMC. It chose not a stand-alone machine, but instead, a compact, four-axis Matsuura H-Plus 300 with 15-pallet automation and 330-tool ATC magazine.



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Mark Holz (left) and his son, Ryan, appreciate that prismatic parts such as manifolds can be machined complete or nearly complete while also enabling the drilling of holes at odd angles using the shop's five-axis machine tools.

"We considered many pallet systems and settled on Matsuura primarily because everything is integrated," Holz explains. "There's one machine, one warranty, one service tech and one training program. And if something were to go wrong, there's no finger-pointing between vendors about whose system caused the issue. That integration matters more than people think, especially when you're running production volumes."

It was also attractive as the shop didn't have a lot of floor space to devote to a linear pallet pool. "The amount of production you can get out of that small footprint is impressive," Holz says.

Of course, tombstones enable the fixturing of multiple parts to present to the machine. For the H-Plus 300, HEI Precision purchased raw tombstone castings in which only the bottom surface was machined. Each was then loaded into the HMC that then machined the tombstone faces and drilled and tapped holes in a pattern to enable vises to be oriented in multiple ways. "In doing so, everything lines up perfectly," Holz says.

For some high-precision jobs, a Renishaw touch probe is used for in-process measurement of critical machined features. If a feature is found to be out of specification, the machine shuts down. These types of jobs — often aerospace or defense — are typically run during the day when an operator is present, whereas more open-tolerance parts run overnight.

This HMC also features Matsuura's Automatic Acceleration and Deceleration Control (ADC) function, which tunes acceleration/deceleration according to loaded part weight to shorten indexing time. "The machine sort of 'shakes' the pallet every time it changes a tool," Holz says. "It's weighing the pallet and determining its inertia so as material is removed, the machine can be adjusted to make safe, faster movements."

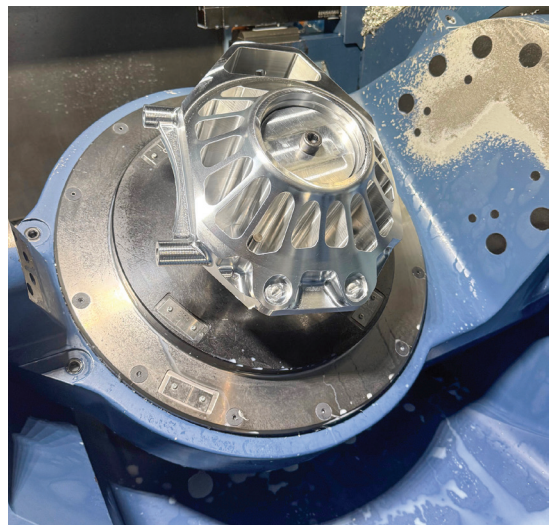
Recognizing the value of palletized machining, HEI Precision has since added two Matsuura MAM 72-35V five-axis machining centers with 32-pallet automation and 330-tool ATC magazines as it has been taking on more complex work that could benefit from a five-axis platform.

Much of this work is positioning in five axes, aka 3+2 machining. Prismatic parts such as manifolds can be machined complete or nearly complete while also enabling the drilling of holes at odd angles. In terms of workholding, the shop uses single vises, double vises, pyramid vises and even miniature tombstones that accommodate four vises to accommodate a range of jobs.

Pallets Offer Production and Flexibility Advantages

Holz says that while the shop has invested heavily in various forms of automation, the biggest ROI has come from pallet changing capability. While the machines are in the cut, other pallets can be loaded with material and staged/scheduled. A part program is already created

Much of the work performed on the five-axis machines is positioning in five axes, aka 3+2 machining, rather than full contouring operations. Source: HEI Precision



and assigned to a pallet and ready to be pulled up, and the tools are already installed in the machine. Having redundant tooling can enable the same jobs to be run over and over again, which is helpful for long stretches of unattended machining. But it offers flexibility to work in new jobs as well.

For those, they can be set up and run and then be pulled for first-article inspection or program tweaking. While that happens, another pallet can be pulled in for part machining so the spindle is not idle during that time.

Therein lies the value of leaving a few pallets open for prototyping work for new customers and emerging markets, Holz notes. Testing and tweaks can happen without majorly disrupting production work for existing customers.

Next Possible Automation Additions

Holz has been eyeing CNC Swiss-type lathes for a while, but hasn't as yet landed on a job well suited for it. There are also considerations relative to programming and tooling with what would be a new machining platform for the

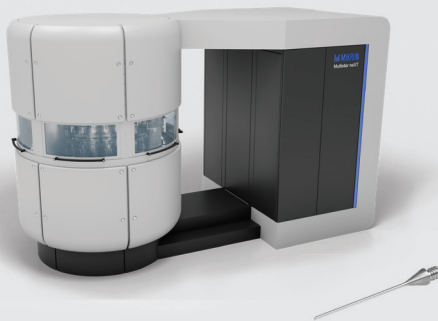
shop. But he feels it's just a matter of time before he adds that technology. A gantry-load turning center might also make sense for an automotive application the shop is currently running, although the volume is not sufficiently high at the moment. Holz notes that the gantry setup would take up less floor space than a conventional robot in front of a machine and likely would be faster. Unlike the Brother VMCs with the RoboJob Mill-Assists, robot speed would be essential because machining would stop during part load/unload.

But he's also considering the addition of a second CMM, and is examining ways to automate inspection. This is largely driven by aerospace and defense work, which could require 100% inspection on all parts. "We're very automated when it comes to machining parts, but inspection seems to be harder to automate," Holz says. "I'd like to identify technology that can offer some efficiencies in that process." ■

HEI Precision | heiprecision.com

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Tooling and Workholding

CHRIS PASION | MANAGING EDITOR | cpasion@gardner.media

Kyocera SGS End Mill Promotes Effective Chip Evacuation During Aggressive Cuts

Kyocera SGS Precision Tools' Hi-Per Feed MS high-performance end mill series is engineered for high-feed machining of stainless steels and high-temperature alloys. Combining advanced geometry, premium carbide and the company's Ti-Namite-A coating technology, the Hi-Per Feed MS is designed to maximize metal removal while maintaining process stability, helping manufacturers achieve shorter cycle times, extended tool life and reliable performance in demanding applications.

At the center of the Hi-Per Feed MS design is a dual-axial radius cutting edge that creates an axial chip thinning effect and redirects cutting forces into the spindle. This improves machining stability and reduces tool deflection while allowing shallow depths of cut to be paired with high feed rates for efficient material removal. Optimized end gashing promotes effective chip evacuation during aggressive high-feed milling, while select sizes feature internal coolant delivery directly to the cutting zone for improved chip evacuation and heat control.

The Hi-Per Feed MS features Kyocera

SGS Precision Tools' Ti-Namite-A physical vapor deposition (PVD) coating to reduce friction, improve wear resistance and minimize built-up edge when machining stainless steels and high-temperature alloys. Available in metric and imperial sizes with 2×D, 4×D and 6×D reach lengths and four- or six-flute configurations based on diameter, the series provides a comprehensive offering for a wide range of demanding high-feed applications.

| Kyocera SGS Precision Tools | kyocera-sgstool.com



Kennametal Turning Geometry Expands Capabilities for Steel, Cast Iron and General Machining

Kennametal's Widia -MU geometry universal turning insert is engineered for applications ranging from finishing to semi-roughing. Its chipbreaker design is intended to promote high-process reliability through chip shape control and optimized edge stability. The inserts are said

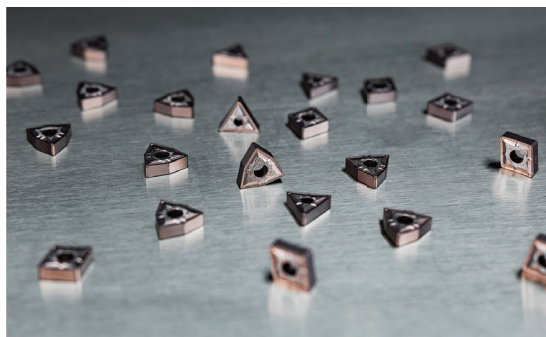
to be well-suited for streamlining inventory and increasing shopfloor productivity.

The -MU geometry inserts are designed to:

- Withstand higher cutting forces for deeper cuts and higher feed rates
- Handle light depths of cut without sacrificing chip formation
- Reduce cutting forces through a chip groove profile engineered for a smoother cut
- Provide balanced edge strength and low cutting forces through a reinforced nose and open geometry for stable and efficient machining

The inserts are available in CNMG, DNMG, TNMG, VNMG, VNMG and SNMG styles. Widia Victory grades include WP05CT, WP15CT, WP25CT, WM15CT, WM25CT, WK05CT, WK20CT, WU10PT and WU25PT.

| Kennametal Inc. | kennametal.com



Iscar Grooving, Parting Insert System Reduces Downtime, Improves Machining Stability

Iscar USA's Quickpenta 24 insert system for grooving, parting and light turning applications is designed to simplify insert indexing, reduce downtime and improve machining stability. The Quickpenta 24 combines a multifunctional cutting platform with a clamping mechanism that enables faster insert changes and increased shopfloor productivity.

At the core of the system is the Quickpenta 24's Safe-Lock clamping mechanism, engineered to provide secure insert retention and stability during machining. The locking design allows operators to release the insert with two turns of a screw, enabling quick and easy replacement while minimizing machine downtime.

Inserts can be rotated by hand to the next cutting edge, allowing for fast indexing without complicated setup procedures. This streamlined process is designed to help reduce interruptions and improve machine utilization in high-production environments.

The Quickpenta 24 is available in a range of cutting widths, including 1.5 mm (0.059"), 2.0 mm (0.078"), 2.4 mm (0.094") and 3.0 mm (0.118"), with a maximum depth of cut of 12.7 mm (0.5"). Pinpointed coolant delivery directs coolant precisely into the cutting zone for improved heat management, chip control and tool performance.

The same Quickpenta 24 insert can be used in both right- and left-hand tools, supporting parting, grooving and side-turning applications. The Quickpenta line is compatible with traditional Penta holders, providing shops with an easy transition path while expanding machining flexibility.

Iscar | iscarmetals.com



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Big Daishowa Fine Boring Tools Feature Streamlined Operation

Big Daishowa's EWR series of fine boring tools are designed to provide improved usability and readability while streamlining operation.



Built on the EWN and EWE platforms, the EWR series features a simplified design with only essential onboard electronics. All advanced functions — including energy management, data processing and visual feedback — are managed through a high-resolution, full-color external reader.

The reader connects to the EWR boring head via a magnet and displays readout in any orientation. The reader communicates using near-field communication (NFC), promoting stable and reliable data transmission. Operators can easily switch between inch and metric modes depending on application requirements. The system offers 1- μ m (0.00005") diameter resolution and a rechargeable battery that supports up to 250 adjustments or up to two months in standby mode.

A single reader can be used across multiple EWR boring heads, which the company says makes it a cost-effective solution compared to digital boring heads.

Big Daishowa | bigdaishowa.com

Air Turbine Tools' Live Tool Boosts Swiss-Type Lathe Output at High Speeds

Air Turbine Tools Inc.'s 822CX Air Turbine live tool is engineered to add governed 60,000 or 80,000 rpm on Swiss-type lathes. According to the company, the 822CX outperforms conventional live tools by providing reliable, ultra-high-speed cutting at a significantly lower cost with only a connection to 90 psi required.

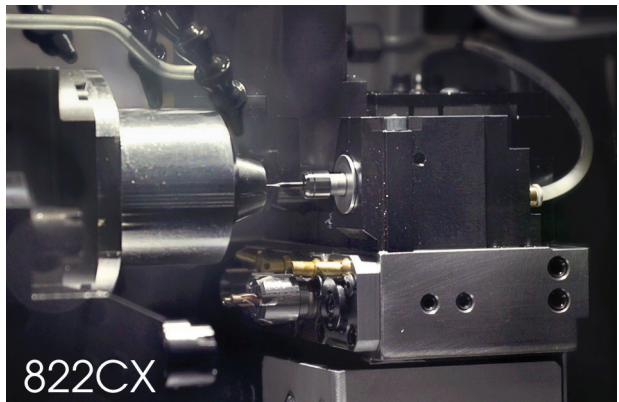
A key feature of the 822CX is its custom double turbine-driven mechanism, which automatically increases airflow cfm volume to match cutting load. This design is intended to keep the tool running at its rated speed in-cut, maintaining the sfm specified for small tools. The company says production cycle times can be reduced by six to 10 times across a wide range of lathe applications. This contrasts with traditional nominal high-speed tools, which lack power and bog down on the tool path. The 822CX's governed speed is designed to prevent tool breakage and promote consistent finishes, optimizing small-diameter tool performance to improve surface quality and tool life while shortening cycle time.

The 822CX is a direct drive with only two moving components: a custom turbine and air-cooled precision bearings. Unlike electro-spindles that generate heat and risk burnout, this mechanism generates no heat and runs cool in continuous

24/7 micro-machining operations. With zero thermal growth and 2- μ m accuracy, the 822CX is designed to support tight-tolerance work where dimensional stability is critical.

Setup is intentionally simple. The user mounts the 822CX in the toolholder, connects dry 90-psi compressed air and starts the tool using an M code or solenoid, avoiding the complex, time-consuming installation associated with traditional systems that require control boxes, wiring circuits and lubrication.

Air Turbine Tools | airturbinetools.com



Pascal Engineering Vise Improves Milling Accuracy

Pascal Engineering Inc.'s CVH centering vise is designed for milling applications after turning. The double-acting vise holds the workpiece with high accuracy and repeatability while saving time through automatic operation.

The CVH features a pressure range of 1-7 MPa and a proof pressure of 10.5 MPa. It is available in standard or long stroke configurations as well as with a jaw.

The centering vise minimizes tool interference and promotes a stable cutting process with optimum tool length. It helps maintain a constant workpiece center by using both jaws to stroke. Center datum processing remains possible even when the external shape of the workpiece varies.

The same soft jaw used for the lathe turning process mounts on the centering vise, eliminating the need to fabricate a new soft jaw for use with a machining center. One-chuck machining is possible for a variety of workpiece shapes using a self-cut soft jaw.

| Pascal Engineering Inc. | pascalenginc.com



Engis Bore Honing Tools Enable Simultaneous Finishing of Dual Diameters

Engis Corp.'s bore honing division has developed advanced tooling and processes for precision finishing

of dual diameters (step bores) in parts. These tooling and processes now enable step bores to be finished simultaneously while holding



diametrical tolerances under one micron (0.00004") in production.

Engis precision diamond tooling is manufactured to quality standards designed to produce bore cylindricity, surface finish and concentricity between each bore. With the Engis design, separate size compensation for each diameter can be performed within seconds, and the long-lasting diamond tooling is said to help produce a low cost per finished piece.

Single-pass dual-diameter bore finishing advantages:

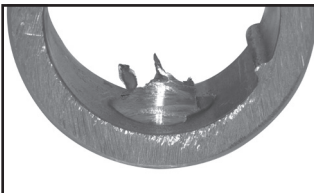
- Split-sleeve design for independent size adjustment
- Size control within one micron
- Separate adjusting nuts
- Two sleeves on the same mandrel
- Improved concentricity of the bores
- Reduced number of spindles
- Adjustable sizing of each bore to within one micron
- Improved coaxiality of bores down to one micron
- Cylindricity of each bore under two microns
- High production rates (typically 150 to 300 parts per hour).

| Engis Corp. | engis.com



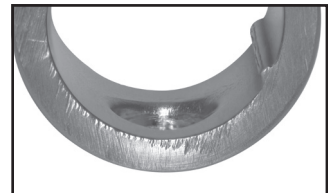
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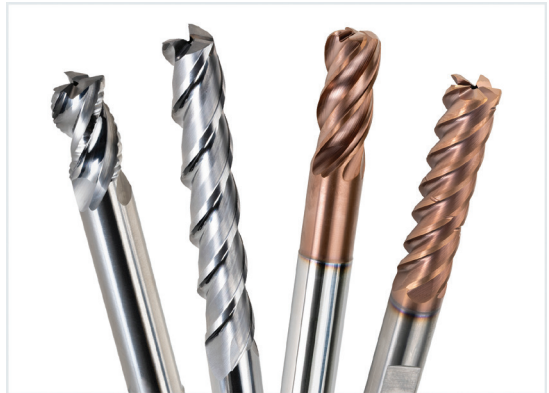
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Ingersoll Solid Carbide End Mills Target Aluminum, Stainless Steel Applications

Ingersoll Cutting Tools' PrimoLine solid carbide end mills are designed for manufacturers seeking measurable performance gains in demanding applications. Advanced geometries, premium substrates and application-specific designs enable machinists to push speeds and feeds while maintaining stability and tool life.

The PrimoAlu-R and PrimoAlu-F are three-flute, 90-degree solid carbide end mills designed for extreme material removal in long-reach aluminum applications. Both utilize variable pitch and variable helix geometries intended to virtually eliminate vibration and chatter, promoting smooth cutting — including passes where the part corner radius on the wall matches the tool's radius. Through-coolant capability on diameters 0.250" and larger supports efficient chip evacuation and thermal control. The PrimoAlu-R supports aggressive roughing with lengths up to 6×D, while the PrimoAlu-F extends to 7×D for long wall finishing and vibration-free milling into corners. The company says users can obtain excellent surface finishes even at extended lengths.

The PrimoSS-V and PrimoSS-H are designed for versatility and high-efficiency machining of stainless steel. Both feature variable pitch and variable helix geometries that detune vibrations, promoting smooth cutting.

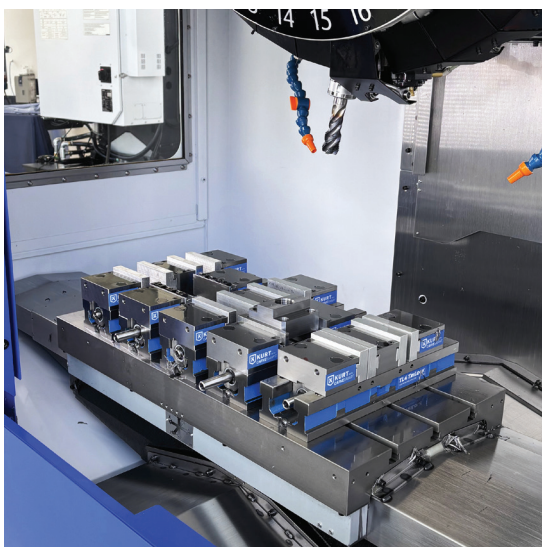


Through-coolant designs are also available to improve cutting performance. The PrimoSS-V is a four-flute end mill designed for slotting, shoulder and finish milling. The PrimoSS-H, offered in five- and six-flute options, is optimized for high-efficiency and trochoidal milling. The combination of chip splitters, advanced geometries and deep-reach capability is said to maximize productivity in stainless steels.

| Ingersoll Cutting Tools | ingersoll-imc.com

Kurt Workholding Short-Body Vises Provide High-Density Workholding in Compact Applications

Kurt Workholding showcases the TL4SCS and TL6SCS TriLock short-body vises with Carvesmart quick-change jaws, providing high-density workholding and flexibility for compact CNC machining environments.



Designed for smaller machining centers, the 4" TL4SCS and 6" TL6SCS combine Kurt's 3-in-1 TriLock vise technology with a quick-change dovetailed jaw system. The compact designs allow shops to maximize machine table capacity.

The TL4SCS is 14.192" long, while the TL6SCS measures 18.961" long. Both models feature 100-mm and 125-mm through-body mounting patterns compatible with common machine tables from Haas, Brother, FANUC Robodrill, Mazak and others.

The short-body TriLock models convert between double-station, single-station and large-capacity single-station configurations, providing versatility from a single workholding platform. The custom Carvesmart dovetailed jaw system eliminates traditional jaw cap screws, enabling jaw changes in seconds.

Each TriLock short vise ships with machinable aluminum jaw sets and is compatible with a growing lineup of pre-cut 4", 6" and 8" Carvesmart jaw options, including hardened jaws, steel and aluminum soft jaws and edge-gripping styles. Bulk steel jaw stock and aluminum extrusions are also available.

| Kurt Workholding | kurtworkholding.com



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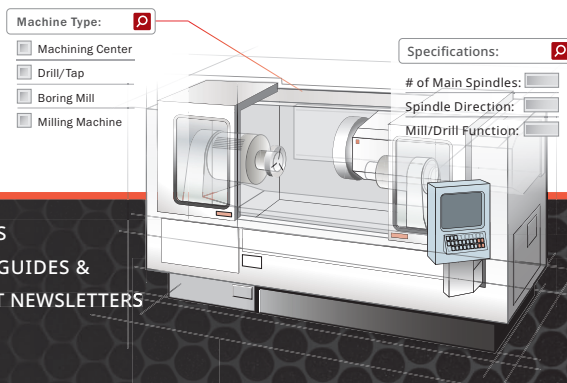
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Verisurf Software Update Advances Model-Based Metrology

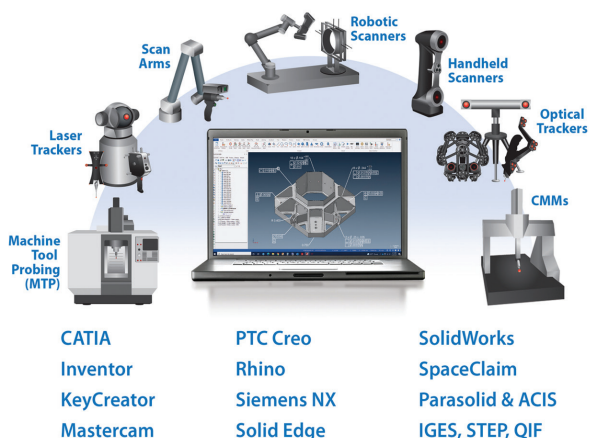
Verisurf Software introduces Verisurf 2027, which features the company's latest advancements in model-based metrology, open connectivity and automated inspection programming. These advancements are meant to be part practical workflows designed to help manufacturers improve productivity, increase quality and streamline inspection processes.

Verisurf's latest model-based inspection, 3D scanning, reverse engineering, automated CMM programming and QIF-enabled features are designed to help quality teams move faster, improve consistency and bring measurement closer to production.

Verisurf 2027's capabilities include automatic inspection plan creation from QIF and enhanced Persistent IDs (PIDs) that preserve engineering intent from the STEP AP242 engineering model throughout the manufacturing process. Built on an open CAD platform, the software is designed to help users eliminate manual processes while maintaining complete alignment with the original product definition.

"Customers want to automate inspection without losing the connection to the engineering STEP model," says Ernie Husted, president of Verisurf Software. "Verisurf 2027 strengthens that connection through model-based workflows, QIF interoperability and Persistent IDs that preserve engineering intent throughout the manufacturing process."

Verisurf Software | [verisurf.com](https://www.verisurf.com)



Cimatron Software Features AI-Powered Toolpath Programming

Cimatron's CAM Agent uses agentic AI to help manufacturers make better use of existing resources. Developed in collaboration with Limitless Labs, the fully integrated machining strategy agent analyzes part geometry and available tool libraries to generate complete three-axis tool paths.

By automatically recognizing machining requirements, recommending strategies and handling repetitive programming tasks, Cimatron's CAM Agent helps manufacturers create reliable CNC programs more efficiently.

Cimatron 2027 provides features and improvements for mold and die design, CNC programming, machine simulation, electrode design and production, wire EDM operations and other core manufacturing workflows.

Cimatron also provides other technology such as Cimatron SuperFinish and Cimatron FeedOptimizer.

Cimatron SuperFinish is a finishing technology developed in conjunction with ModuleWorks to calculate tool paths directly from exact surface geometry rather than relying on a mesh approximation.

Cimatron FeedOptimizer uses tool, machine and material data to determine the optimal feed rate throughout a tool path. The technology is designed to adjust feed rates according to actual cutting conditions.

Cimatron | [cimatron.com](https://www.cimatron.com)



High QA Quality Platform Connects Inspection Planning and Traceability From Design to Delivery

High QA's design-driven manufacturing quality platform is designed for manufacturers and OEMs in need of faster inspections, automated reporting and complete traceability from design to delivery.

High QA makes the 2D drawing or 3D model the single source of truth, keeping every requirement, inspection result and quality report connected to the original design intent. This is designed to help manufacturers reduce manual interpretation, eliminate disconnected workflows and minimize rework, delays and risk across internal teams and suppliers.

High QA's platform is designed to automatically balloon 2D drawings and 3D models, extract GD&T and PMI, generate inspection plans, collect measurement data and produce critical quality documentation such as AS9102 FAIRs and PPAPs in minutes instead of weeks. Inspection results, SPC, non-conformance reporting and quality documentation are managed in one connected system, replacing spreadsheets, manual entry and fragmented tools.

High QA also integrates with existing

manufacturing technology stacks, including CMMs and metrology systems such as PolyWorks, as well as ERP and PLM systems. By connecting engineering, inspection, reporting and supplier quality, High QA is designed to enable manufacturers to build a scalable digital quality process that supports compliance, improves efficiency and keeps quality linked from design through delivery.

The platform serves manufacturers across the aerospace, defense, automotive, energy, oil and gas and medical industries.

High QA Inc. | highqa.com



Bossard Factory Solutions Streamline Fastener Management, Assembly

Bossard's Smart Factory Solutions are designed for OEMs and suppliers seeking scalable, connected manufacturing. This integrated solution combines Smart Factory Assembly and Smart Factory Logistics to simplify fastener management while improving production efficiency, quality and process traceability across production operations.

Bossard integrates AI-assisted inventory management, fastening expertise, digital work instructions, smart tools and traceability into a connected manufacturing ecosystem designed to reduce downtime, improve quality and accelerate production.

The Smart Factory Solution connects digital work instructions with automated inventory control to create a seamless flow from material replenishment to final assembly. Operators are guided through digitally enabled, error-proofed processes using smart tools and real-time monitoring, helping standardize assembly steps, reduce rework and promote consistent quality.

Automated replenishment systems — including smart bins, sensors and connected inventory management — provide real-time visibility into inventory levels, helping eliminate stockouts, reduce excess inventory and minimize manual material handling.

Together, these capabilities provide full-process transparency and digital traceability, enabling manufacturers to meet stringent quality standards while improving consistency and compliance. By connecting inventory and assembly data, Bossard helps teams improve production control, reduce disruptions and make more informed decisions on the shop floor. Bossard says its Smart Factory Solutions deliver measurable productivity gains and greater confidence on the shop floor.

Bossard | bossard.com



Modern Equipment Review

CHRIS PASION | MANAGING EDITOR | cpasion@gardner.media

SPOTLIGHT | Automation

FANUC Cobot Enables Portable Automation for High-Mix Tasks

FANUC America expands its CRX cobot series with the introduction of the CRX-3iA, a lightweight cobot designed for fast redeployment across small, high-mix tasks. Weighing only 11 kg (24 lbs), the CRX-3iA can be carried and set up in minutes, giving manufacturers a portable way to automate jobs such as welding, part handling, small assembly, screw driving, tool positioning and inspection — especially in tight spaces or temporary work areas where permanent fixtures are not feasible. The cobot features a 3-kg payload and 692-mm reach.

The CRX-3iA's key feature include:

- **Lightweight design:** Can be carried by a single person and quickly moved to workstations, temporary setups or field environments
- **Flexible installation:** Supports magnetic bases and offers simple wall or ceiling mounting with automatic angle detection and no manual input
- **High-mix task support:** Well-suited for welding, part handling, small assembly, screw driving, tool

positioning and inspection tasks

- **Portable welding capability:** Can be manually moved to the welding area for fast repositioning with support for touch sensing, eliminating the need for precise robot placement. Additionally, auto weld point detection and auto path generation accelerate welding setup

| FANUC America | fanucamerica.com



Lang Technik Automation System Boosts Productivity in Compact Footprint

Lang Technik's RoboTrex Compact Automation System is a robotic automation solution designed to help manufacturers maximize machine utilization, increase productivity and reduce labor dependency within a compact footprint.

Developed for small-part manufacturing environments, the RoboTrex Compact combines robotic workpiece handling with high-density storage to support extended unattended machining operations. The system features an integrated FANUC

industrial robot capable of automatically loading and unloading workpieces weighing up to 7 kg (15.4 lbs), helping manufacturers increase spindle uptime and improve overall equipment efficiency.

Despite occupying only approximately 2 m² of floor space, the RoboTrex Compact offers substantial storage capacity, accommodating up to 100 Makro-Grip 46 Micro vises or 50 Makro-Grip 77 vises. This capacity enables longer production runs and supports lights-out manufacturing strategies without requiring additional floor space.

The system's control interface and pre-configured robot programming are designed to simplify implementation and daily operation. Flexible job management capabilities allow the system to automatically select the appropriate machining program for each workpiece, enabling unattended production of multiple part types within a single manufacturing cycle.

| Lang Technik USA | lang-technik-usa.com



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Mitsubishi Electric Automation Robotic Solutions Automate CNC Machine Tending

Mitsubishi Electric Automation Inc.'s LoadMate Plus and ARIA preengineered robotic machine tending solutions are designed to help manufacturers automate CNC mills and lathes with confidence, flexibility and scalability.

Automated machine tending enables longer spindle uptime, improved process consistency and redeployment of skilled workers to higher-value tasks. Robotic tending also reduces unplanned downtime and supports

lights-out or extended-hours production.

"For many manufacturers, robotic machine tending is one of the most practical and financially justifiable entry points into automation," says David Simak, product manager (service) at Mitsubishi Electric Automation. "When implemented correctly, it provides productivity improvements that can be measured quickly on the shop floor."

LoadMate Plus is designed for quick setup and long-term deployment at a single machine. It can be customized for different machine layouts, part sizes and safety requirements while integrating directly with Mitsubishi Electric CNCs and robots.

ARIA (Automated Robotic Industrial Assistant) is a compact, configurable solution for mill and lathe tending in space-constrained environments. It supports multiple robot types and can be relocated within a facility, making it well-suited for shared or expanding automation strategies.

■ Mitsubishi Electric US Inc.
us.mitsubishielectric.com



Caron Engineering Process Control Systems Streamline Automation

Caron Engineering's connected automation and real-time process control technologies help address the challenges of reducing scrap, improving process consistency, shortening cycle times and automating production — all while machining more complex parts with tighter tolerances and fewer experienced operators.

MiConnect, Caron Engineering's low-code manufacturing automation platform, is designed to simplify communication and orchestration across machines, robots, sensors, gaging systems and software platforms. According to the company, MiConnect enables manufacturers to rapidly build and deploy automation workflows that streamline production and coordinate entire machining cells without complex custom programming.

Caron Engineering's complete process control ecosystem includes:

- Tool Monitoring Adaptive Control (TMAC) for real-time cutting optimization, adaptive feed control and tool breakage detection
- AutoComp closed-loop dimensional feedback with automatic CNC offset compensation

- ToolConnect RFID and barcode-based tool data management and transfer
- DTect-It advanced sensor analysis for machine health, vibration monitoring and predictive process intelligence

Together, these technologies are designed to create a connected manufacturing environment capable of making intelligent, real-time process decisions while reducing scrap, shortening cycle times, extending tool life, improving quality and enabling more reliable unattended machining.

■ Caron Engineering Inc. | caroneng.com



Fastems Automation System Enables Scalable Entry-Level Manufacturing

Fastems' Flexible Pallet System – Stationary (FPS-S) is a compact, flexible and scalable pallet automation solution designed to help manufacturers take their first step into automation. The modular FPS-S makes efficient use of available floor space while providing a clear growth path from a single-machine automation solution to a full-scale Flexible Manufacturing System (FMS).



In its base configuration, the FPS-S combines a stationary stacker crane with a four- or five-axis CNC machine tool to increase spindle utilization through automated pallet handling and lights-out manufacturing capabilities, while maintaining consistent production quality.

The system integrates with more than 90 machine tool brands and can also be connected to machine tools without an automatic pallet changer (APC), making it suitable for a wide range of manufacturing environments.

The FPS-S is available in payload classes of 500, 1,000 and 1,500 kg and supports pallet sizes up to 630 × 630 mm. Its modular architecture features a 360-degree layout concept, allowing machine tools, storage modules and loading stations to be positioned on any side of the system. The actual footprint depends entirely on the selected configuration.

One of the key advantages of the FPS-S is its scalability, the company says. Starting with one or two machine tools, manufacturers can gradually expand the system into a complete linear FMS. By adding additional FPS-S modules and a rail-guided stacker crane, the system can be extended over time to connect multiple machine tools within a flexible manufacturing environment.

At higher levels of automation, the concept also supports the integration of additional value-adding processes such as tool automation and robotic pallet loading.

The FPS-S is powered by the Manufacturing Management Software (MMS), designed for planning, controlling and monitoring high-mix manufacturing environments.

| Fastems | fastems.com

Marposs Integrated Solutions Support Lights-Out Machining

Marposs Corp. provides intelligent process control, measurement and machine protection technologies designed to help manufacturers run smarter, longer and with greater confidence to support lights-out manufacturing.

Marposs' touch probes and tool setters continuously verify workpiece dimensions and monitor tool condition directly on the machine tool. When process variation is detected, Marposs QuickSpC software automatically updates machine offsets in real time, compensating for tool wear and maintaining part quality throughout the production cycle. The result, according to the company, is a self-correcting manufacturing process that consistently produces parts within specification.

For unattended operation, Marposs' Collision Monitoring System (CMS) continuously monitors machine behavior and detects abnormal conditions that may indicate an impending crash. By responding instantly to unusual events, CMS is designed to help mitigate costly machine damage, reduce downtime and protect valuable production assets.

Together, these technologies are intended to transform conventional machine tools into intelligent manufacturing systems that can monitor, correct and protect themselves. Manufacturers can use the capability to extend production into nights, weekends and periods between shifts while reducing dependence on scarce skilled labor.

| Marposs | marposs.com



Star Cutter Centerless Grinder Features Expanded Automation Capabilities



Star Cutter's Tru Tech T93XM-A high-precision centerless profile grinder features expanded robotic automation and redesigned software to support longer unattended production runs and simplify operation.

Designed for manufacturers producing high-precision cylindrical components, the T93XM-A performs profile,

plunge, peel, in-feed and through-feed grinding. This enables manufacturers to process a wide range of part geometries and perform multiple grinding operations on a single machine platform.

The latest T93XM-A incorporates a six-axis FANUC 200iD robot and a five-pallet configuration, increasing capacity by 67% to support longer periods of unattended production, according to the company.

Star Cutter has also redesigned the automation software with an intuitive operator interface and integrated 3D simulation. Instead of programming individual pallet layouts, operators select the desired pallet array, load the parts and begin production. This streamlined workflow reduces setup requirements and makes automation more accessible across different production environments.

A redesigned gripper assembly enables rough and finish grinding to be completed within the same automated cycle. Keeping the part within one continuous process reduces handling between operations and supports more efficient production.

| Star Cutter Co. | starcutter.com

Heller Mill-Turn Increases Machining Flexibility

Heller Machine Tools debuts the HF 3500 APC mill-turn. The HF series five-axis machining centers are designed to meet the demands of modern production, combining five-sided and simultaneous five-axis machining to enable a wide range of operations on a single machine.

The mill-turn functionality — with up to 800 rpm and up to 472 foot-pounds of torque — enables combined milling and turning on a single machine. An optional

configuration provides additional capabilities with 1,140 rpm and 885 ft-lbs of torque. The design is intended to reduce setup requirements and increase flexibility for machining workpieces. The machine is equipped with a robot loading interface aimed at reducing downtime and maximizing production capacity.

HF 3500 APC mill-turn highlights:

- 500 × 500 mm table (×2)
- Swiveling NC rotary table with counter bearing
- Pro package — higher precision
- Rapid traverse X/Y/Z: 3,543/3,543/3,150 ipm
- Maximum workpiece height: 630 mm
- Increased feed force in the Z-axis
- Milling technology package (One Dynamics 5×) for path control and surface finish
- AutoSet function, which adjusts drive parameters to match the current clamping load and AutoCal function for calibration of axes
- High-performance Siemens Sinumerik One control

| Heller Machine Tools | us.heller.biz



Prima Power Laser Systems Tackle Complex 3D Manufacturing Challenges

Prima Power Laserdyne provides advanced 3D laser technologies designed to help manufacturers solve complex production challenges with greater precision, flexibility and automation. The portfolio of five-axis laser processing solutions is engineered for demanding applications across aerospace, defense, automotive, medical and precision manufacturing industries.

Laserdyne systems provide accuracy and process control in laser welding, drilling and cutting applications. Equipped with technologies that optimize beam delivery, motion control and process monitoring, Laserdyne solutions are designed to enable manufacturers to achieve repeatable results on intricate components where quality and consistency are critical.

Prima Power's 3D laser systems bring five-axis laser cutting to manufacturers seeking greater production flexibility and efficiency. From prototype development to high-volume manufacturing, Prima Power solutions are designed to help manufacturers bring complex processing in-house, reduce secondary operations and increase productivity while maintaining part quality.

Whether manufacturers are exploring automated laser processing for the first time or expanding advanced manufacturing capabilities, the combined expertise of Prima Power and Laserdyne is said to provide solutions tailored to a wide range of production requirements. Integrated automation, intelligent software and decades of laser application experience are intended to help manufacturers improve throughput, reduce operating costs and tackle increasingly complex components.

Prima Power Laserdyne LLC | primapower.com



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Takumi Bridge Mill Boosts Performance in Die/Mold Applications

Takumi's H12E bridge mill is well-suited for die/mold applications with demanding accuracy and surface finish requirements. The H12E incorporates a range of design features and technologies designed to boost performance.

To maximize stability and rigidity, the H12E's bed, column and cross-rail are created from a single-piece frame with no weldments. The cross-rail saddle carries a constant weight, enabling fast cutting speeds with no

compromise to surface finish. In addition to minimizing vibration, the machine's design maintains close positioning of the spindle to the bridge to reduce overhang.

A Big Plus CAT 40 direct drive spindle provides a maximum speed of 15,000 rpm via a 25-hp motor. Takumi's iSpinII intelligent thermal compensation system counters ambient temperature variations to promote consistently high levels of precision. Temperature-controlled, direct-coupled ballscrews further improve repeatability, while linear scales on all axes allow exact positioning.

Offering the largest Y-axis travel in its class, the H12E includes X-, Y- and Z-travels of 49.2" × 37.4" × 22.8". Capable of accommodating parts to a maximum weight of 4,400 lbs, the machine provides a solution for the production of large components.

The H12E offers extra-wide door openings to allow easy part loading and unloading, and large windows provide high visibility into the work envelope. The H12E features a FANUC Oi Plus or Heidenhain TNC7 control as standard, with a Siemens Sinumerik One control available as an option.

Takumi | takumiusa.com



Halocarbon Metalworking Fluids Improve Efficiency in Difficult-to-Machine Materials

Halocarbon's InfinX Series of metalworking fluids is engineered to improve machining performance and reduce maintenance demands in applications involving high-temperature nickel alloys, like Inconel, refractory metals and other difficult-to-machine materials.

The InfinX platform is designed to support consistent performance in high-value manufacturing environments where tool life, surface integrity and machining efficiency are critical. In controlled production trials conducted at a U.S.-based aerospace manufacturer, InfinX fluids were said to demonstrate measurable performance gains to tool life, machining efficiency and surface finish quality during machining of Inconel 718 components under real operating conditions.

In addition to performance improvements, InfinX fluids are designed to support extremely low-maintenance operation. Their non-aqueous formulation eliminates dilution requirements and prevents microbial growth, eliminating odor development and reducing routine coolant management tasks common in traditional water-based systems.

InfinX metalworking fluids can help manufacturers working with Inconel, molybdenum, tantalum and other refractory materials achieve improved productivity,

extended tool life and consistent machining results in demanding production environments.

Halocarbon | halocarbon.com



Junker Group Modular Machines Enhance Grinding Flexibility

Erwin Junker Machinery Inc. showcases high-precision grinding technology including the Platform 3 modular grinding machine series and the Junior corundum grinding solution.

The Platform 3 series of modular grinding machines is engineered for maximum flexibility and performance in applications with small lot sizes and increasing part variety.

Platform 3 features include:

- Modular design for tailored configurations
- High system flexibility to adapt quickly to changing production requirements
- Optimized cost-effectiveness through reduced

setup times and improved utilization

- Higher throughput through improved productivity and shortened lead times

Manufacturers can configure solutions from a wide range of machine types, including:

- **Jumat:** versatile cylindrical grinding
- **Jucam:** precision camshaft, cam grinding and non-round applications
- **Quickpoint:** efficient, high-speed single-point grinding
- **Jucrank:** advanced crankshaft grinding

The Junior is designed to combine the cost-effectiveness of corundum grinding with the flexibility and

performance of a high-precision grinding machine. According to the company, it provides high grinding performance with reduced heat generation and wear, providing consistent surface quality even when processing demanding materials. Corundum grinding wheels help lower tooling and operating costs while allowing fast adaptation to new parts, making the Junior well-suited for dynamic and evolving production environments.

Erwin Junker Machinery Inc.
junker-group.com



Hermle Five-Axis Mill-Turn Provides Precise Machining of Complex Parts

Hermle USA Inc.'s C 62 U MT Gen2 five-axis mill-turn center provides precision and productivity for demanding workpiece challenges.

The C 62 U MT Gen2 features traverse paths of 1,200 × 1,300 × 900 mm and accommodates workpieces weighing up to 2,500 kg on its 1,350-mm swiveling rotary table. Spindle speeds reach up to 18,000 rpm, combined with rapid traverse rates of 50 m/min, which support aggressive material removal rates and surface quality required by aerospace, energy and heavy-industry manufacturers. The machine's mineral casting construction and chip management system provide long-term accuracy and reliability in demanding production environments.

The machine supports both Heidenhain TNC7 and Siemens Sinumerik One control platforms, as well as integration into Hermle's PW 3000 pallet

changer and full HACs/HIMS automation suite. The C 62 U MT Gen2 can be transported without disassembly and installed without a foundation, simplifying deployment.

Hermle | hermlusa.net



LK Metrology Systems Provide Flexible Part Inspection

LK Metrology Inc. CMMs, metrology software and associated CMM accessory products include the ISF 04.04.04 shopfloor CMM with a Renishaw MH20i probe head; an ISF 07.06.05 shopfloor CMM with a Renishaw MH20i probe head; an Altera M 10.10.8 with PH10MQ, TP20, SP25, LC15DX, LC12DX and L100NX laser scanners in a multi-sensor setup; and an Altera M 15.12.10 with Scantec5 equipped with a Renishaw Revo-2 five-axis scanning system.

LK Metrology also offers PXR-CT Alpha 320KV CT system as well as its Camio measurement, programming simulation, analysis and reporting software.

LK Metrology Inc. | lkmetrology.com



DN Solutions Multitasking Center Expands Single-Setup Machining



DN Solutions' DNX 2100SB multitasking turn-mill center is designed to make single-setup machining accessible, allowing manufacturers to consolidate jobs from multiple turning and machining centers onto one machine.

The DNX 2100SB features twin turning spindles and a milling spindle with 0.0001-degree indexing for six-sided machining of complex parts in a single setup.

The indexing milling spindle also supports a reduction in tooling costs compared to traditional turning centers with live tooling turrets. One tool can be used for both the main and subspindle, and one tool handles radial and axial milling, allowing standard tools to be used for complex applications without the need for special angular toolholders.

With a maximum machining capacity of 520 × 1,100 mm (20.5" × 43.3"), the DNX 2100SB is well-suited for a range of parts across a variety of industries.

DN Solutions America | dn-solutions.us

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A

AMT - The Association For Manufacturing Technology
Digital Edition Sponsor, 39, 41, 43, 69

Atlas Bronze 65

AutomaTech Expo 2027. 85

B

BIG DAISHOWA Inc.. 48

C

Certus 35

Chevalier Machinery Inc. 25

CHIRON Group 49

CONTRAX Grand Rapids 61

D

DEUBLIN Company, LLC 72

DN Solutions 9

F

Fives Machining Systems, Inc. 67

Fryer Machine Systems. 3

G

Gardner Intelligence 93

GEMINIS 19

Greenleaf Corp. 56, 57

Griffo Brothers Inc.. 53

Grizzly Industrial, Inc. 21

H

HAINBUCH America Corp. 11

Harmoni Solutions, Inc.. . . . Inside Back Cover

Horn USA, Inc. 7

I

IMTS 2028 Digital Edition Sponsor, 69

IMTS+ 39

Ingersoll Cutting Tools Inside Front Cover, 1

J

J.W. Done Corp. 79

K

Kennametal Inc. 4, 5

Kitamura Machinery of USA Inc. 31

KYOCERA Precision Tools, Inc. 16

L

LANG Technik USA 24

Lyndex-Nikken Inc.. 23

M

Methods Machine Tools Inc. 15

Mikron Corp. - Machining Division 75

MTForecast 41

O

oelheld U.S., Inc. 51

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P

Platinum Tooling Technologies, Inc. 77

R

RayMack Machinery Co., Ltd. 89

Royal Products 33, 33a, 33b

S

Select Machining Technologies 17, 19

SGS Solid Carbide Tools 16

Shear-Loc Products 89

SMW Autoblok 20

SORALUCE. 17

Southwestern Industries, Inc. Back Cover

SPHINX TOOLS. 48

Star CNC Machine Tool Corp. 13

Sumitomo Electric Carbide Inc. 2

Summit Machine Tool LLC 29

T

TCI Precision Metals 73

Techspex. 81

The MFG Meeting 43

THINBIT 27

TRAK Machine Tools Back Cover

U

Uline Corp. 59

UNISIG. 64

W

Western Gage Corporation 92

Y

Yaskawa America, Inc. 32

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HOW I MADE IT

Gisbert Ledvon

Vice-President of Machine Tools at Heidenhain

Gisbert Ledvon started out as a tool and die apprentice in West Germany, leveraging that foundation to build a career in U.S. business development.

INTERVIEWED BY | EVAN DORAN

My dad worked in a shop for a construction company and was in charge of repairing heavy equipment. He was always dirty and oily, and he told me, when you get into your apprentice program or you find a job, I want you to become a tool-and-die maker, because those guys work in a clean environment.

Luckily, there was a company nearby where I could get into an apprentice program. I had to go through a lot of testing. Even in those days, they tested if you were qualified from a maths point of view, even to get into the apprentice program. I did my whole three-and-a-half-year apprentice program, school and hands-on work.

After my apprentice program, I went to Berlin, West Berlin at the time, and I worked there in a mold and tool shop. And I got exposed to EDM technology. It was totally fascinating that you could use electricity on the wire to cut through hard material. I said, “I want to get into that.” We were using — and I remind you, this is in the ’80s — we started to use computers. Most people hadn’t even seen them yet but you were able to program jobs.

I started to work at Charmilles Technologies, what is one of the first ones who developed EDM technology. And in ’93, the economy in Germany wasn’t so great. So they gave us the opportunity to move to another country and I came to the United States.

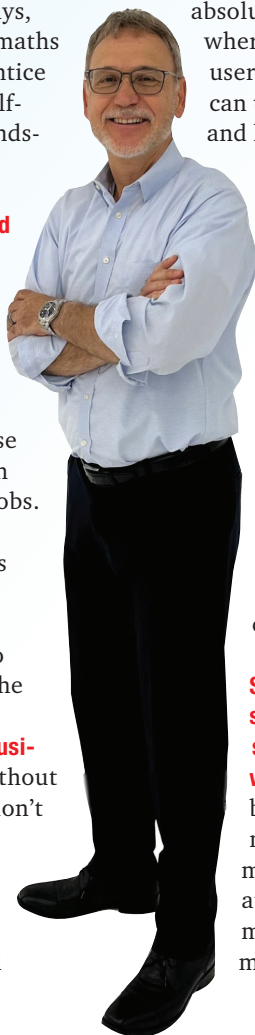
That’s where I saw a different drive in business, that you can make a career here without a paper necessarily. In Germany, if you don’t have a certain degree or a certain paper, you’re not going to get to a certain level in the organization. I learned very quickly in North America that when you work hard, you show an interest and

you are open-minded to learn new technologies, you can move into different positions.

I’ve got to thank Harry Moser because he introduced me to NTMA. And Harry was always going a little bit against the mainstream, what our competition would do. Our competition would go to events where the competition is. Harry said, “Let’s go where the end users are.” And that was really an eye-opener for me because he’s absolutely right. You want to go to an event where your customers are, where your end users are so you can listen to them. You can understand what their challenges are and help them with solutions and build relationships.

The adoption of automation is still not where it should be. I remember when I came here in the early ’90s, we put a robot on an EDM. In Germany, we already used robots for years to load and unload parts. Here, when our customers came into the showroom, they go, “We’re not going to put this on there. It cost me only 10 bucks to have a guy to change the electrode or the part in and out.” There was a mindset in ’95, ’96 and today, we’re finding out we can’t find people who want to put parts into machines. Now we’re talking cobots, now we’re talking robots.

I saw a statistic that in the United States, the proportion of CNC machines shipped with robots in 2024 was in the single digits, less than the 12% average worldwide. How can that be? We need to be a little bit more trusting of the technology. The machine tools can do much more, they can do good parts, so you can automate. And the first step into automation is five-axis machining, five-side machining in a single setup. ■





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