CUTTING TOOL ENGINEERING

May 2025 | Vol. 77 | Issue 4

ctemag.com

MANUFACTURING RISING

For reshoring and workforce development efforts to succeed, industry leaders say public perception must change

Also in this issue

- AI-driven automation takes the lead
- Aerospace raises the bar in manufacturing
- Tapping your shop's full threading potential

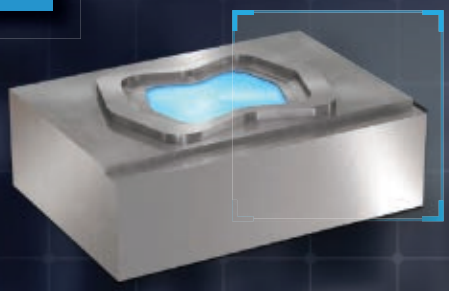
YOU

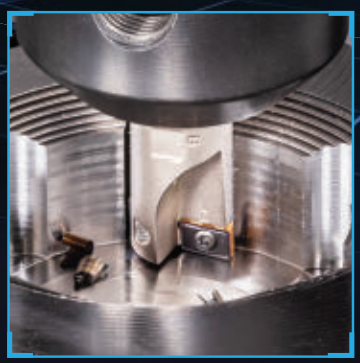
MILLING

INTELLIGENTLY?

QUICK D MILL

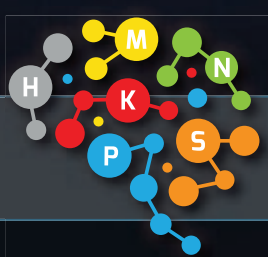
NEW Combined Functions for Milling and Drilling in One Single Cutter for Maximum Machining Efficiency.





QUICK-D-MILL Insert with 4 Cutting Edges. Two Outer Cutting Edges for Milling, 2 Center Cutting Edges for Drilling Applications. Incorporates Dovetail Clamping and Ensures High Process Reliability.

LOGIQUICK
MACHINING INTELLIGENTLY



Member IMC Group
ISCAR
www.iscar.com

SCAN ME

TAPMATIC SYNCHROFLEX®

- Longest Tap Life.
- Ultimate Thread Quality.
- With High Pressure, High Volume Internal Coolant or MQL.
- A full program available for all machines and tap sizes from M1 to M48.

The Best Choice for Rigid Tapping!

TAPMATIC

Please call us at 800-854-6019, e-mail info@tapmatic.com, or visit our website www.tapmatic.com.

Table of Contents

May 2025 Volume 77 Issue 4

COVER STORY

FEATURES

One machinist tends three robots that each tend two machines at Screwmatics of South Carolina Inc. To learn more, read **Next-Gen Automation on page 24**.

Absolute Machine Tools

DEPARTMENTS

Follow Us on

Looking for trusted suppliers of cutting and grinding products? The CTE Buyer's Guide is your go-to resource — searchable, user-friendly, and packed with over 38 years of trusted listings.

Find exactly what you need, fast: www.ctemag.com/buyers-guide

See this and more on CTE Social.

CUTTING TOOL ENGINEERING®

121 S. Wilke Rd. Ste. 200
Arlington Heights, IL 60005
847-498-9100
www.ctemag.com / www.cteguide.com

Publisher
Dennis Spaeth
dspaeth@ctemedia.com

Editorial
Gina Stehl, Creative Director
ginas@ctemedia.com
Alan Richter, Editor-at-Large
alanr@ctemedia.com

Contributors
Cutting Tool Engineering regularly features writing by numerous industry experts and practitioners, such as Jeffrey Badger, Christopher Tate and Brandt Taylor.

Advertising Sales
Kenneth Spaeth, East
847-714-0173
kspaeth@ctemedia.com
Tom Tobiason, Central/West
630-248-0686
ttobiason@ctemedia.com
Dave Jones, Central
708-442-5633
dmj_jonesmedia@yahoo.com
William Spaeth, Sales Assistant
847-714-0182
bspaeth@ctemedia.com

Corporate Staff
Chief Executive Officer
Dennis Spaeth
dspaeth@ctemedia.com
CFO/Director of Sales
Kenneth Spaeth
847-714-0173
kspaeth@ctemedia.com
Digital Developer
Tim Spaeth
tspaeth@ctemedia.com

Circulation
Innovation Network LLC
cte@circumatic.com
cte.circumatic.com

Member IMC Group

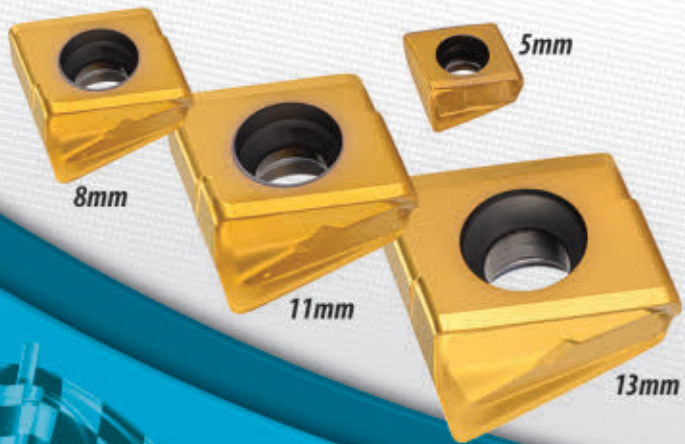
Ingersoll Cutting Tools

MAXSFEED™

Tangential Ramping

Straight or Helical – Unprecedented Versatility

- Comprehensive series of tangential milling cutters
- 90° standard and extended flute end mills
- 90° face mills and new 45° face mills for hi-feed machining
- Integrated wipers produce surface finishes in the single digits
- Secured dovetailed insert seating for increased edge-life and improved cutter reliability
- Four insert sizes; diameters from 0.5" to 6.0"
- Depth of cut range from .185" to .479"



WINSFEED™

ADVANCED MACHINING

Scan for profitability

845 South Lyford Rd • Rockford, Illinois 61108-2749 • 815/387-6600 • www.ingersoll-imc.com

VARYING THE WORKPIECE RPM

By Jeffrey Badger, Ph.D.

Dear Doc: Our cylindrical grinding machine has the option of varying the workpiece rpm. Is this legit? How does it work?

The Doc replies: Yes, it's definitely legit. Here are the two main reasons it's helpful.

Reason 1: When you begin to grind, the wheel/spindle assembly bounces up and down – ever so slightly – at its natural frequency. This can lead to self-excited workpiece-regenerative chatter. As the workpiece rotates, the slightly bouncing wheel creates small lobes on the workpiece. As these lobes come around again, they create force pulsations that excite the wheel/spindle, causing it to bounce slightly more, which creates bigger lobes. These bigger lobes come around again and excite the wheel/spindle even more, causing higher bouncing, which creates bigger lobes, which come around again and excite the wheel/spindle even more, which creates even bigger lobes. Next thing you know, the wheel/spindle is bouncing like crazy – i.e., chatter is out of control.

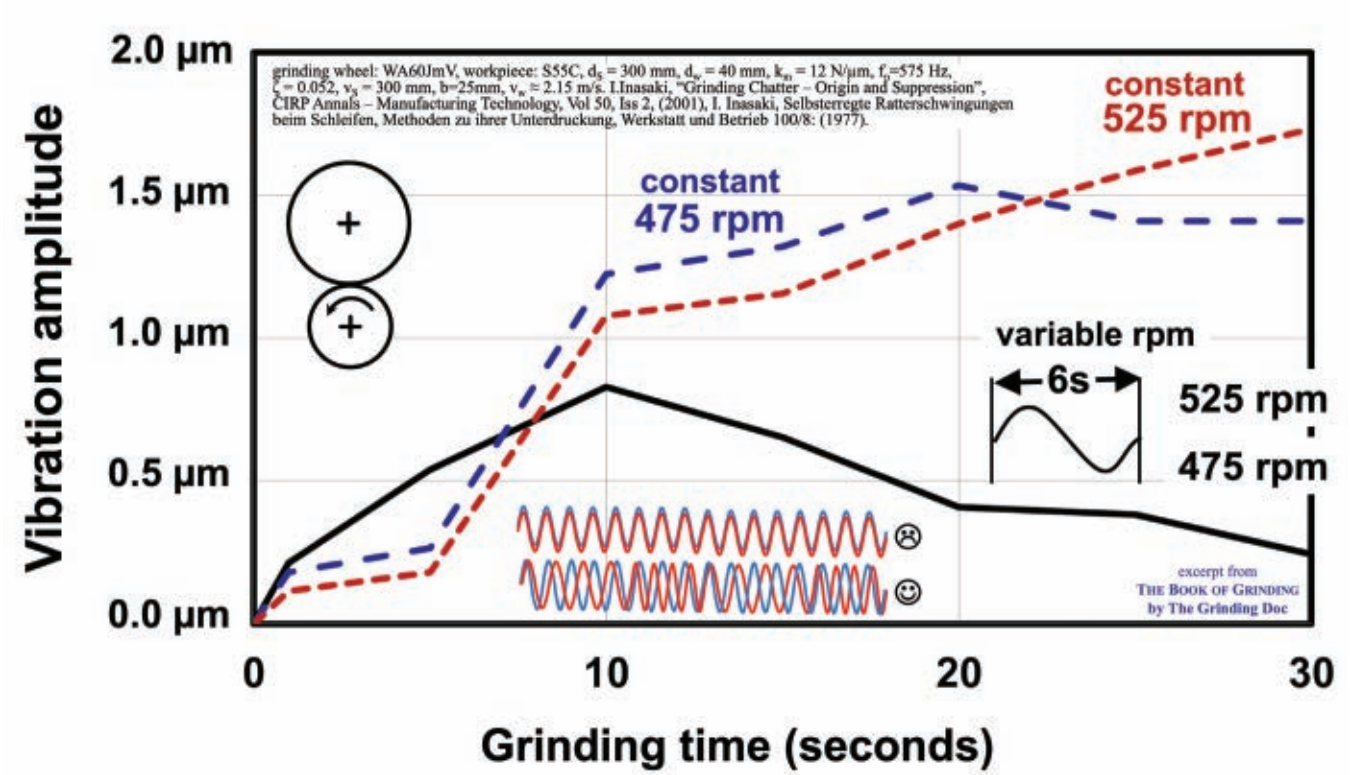
For the lobes to excite the bouncing of the wheel/spindle, the wheel/spindle bouncing and the workpiece lobes have to be in-sync, with no phase shift between the two. This depends on the ratio of wheel/spindle natural frequency and workpiece rpm. If the bouncing/lobes are in-sync, chatter gets worse. If the bouncing/lobes are out-of-sync, chatter is attenuated – i.e., it dies down.

Sometimes bouncing/lobes are in-sync, sometimes they're not. There's no good way to predict when that happens. It happens mostly by chance.

If you vary the workpiece rpm, the bouncing/lobes are going in-sync and out-of-sync. Chatter may build up for a second or two, but then a second or two later it is being attenuated.

The result? Chatter doesn't

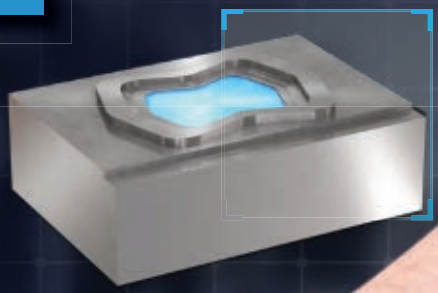
Varying the workpiece rpm causes the lobes to shift in and out of sync, which naturally builds and then dampens chatter. As shown in the figure, a ±5% rpm variation every six seconds effectively prevents chatter from escalating.

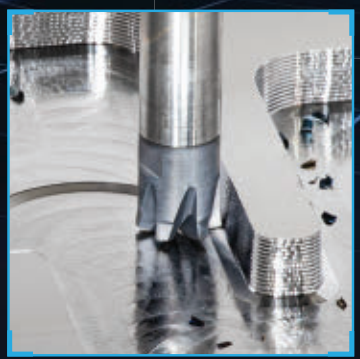


YOU MILLING INTELLIGENTLY?

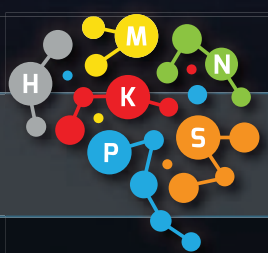
MULTI-MASTER

NEW High Feed Heads with
6 Effective Cutting Edge.





The new heads have ramping and slotting capability.
Diameter: .315, .394, .472, .500, .630, .787 & .984".



LOGIQUICK
MACHINING INTELLIGENTLY

Member IMC Group
ISCAR
www.iscar.com

SCAN ME

self-excite drastically.

The figure shows an example of the theory proven out by measurements. A workpiece rpm variation of ±5% every six seconds was enough to keep chatter from getting out of control.

Reason 2: No wheel is perfectly balanced, and no wheel is perfectly true. Even a wheel with auto-balancing is out of balance. It's just less out of balance.

Out-of-balance creates lobes on the workpiece. That's fine and normal and unavoidable. That's why we spark out, to obliterate those lobes.

But what happens when the ratio of wheel-rpm to workpiece-rpm is close to an "integer value" of 8.0000 or 9.013 or 8.9924? As we spark out, the same point on the wheel hits the same point on the workpiece, and we never obliterate those lobes. That's why we want a ratio like 9.36488 or 8.916742. During my grinding courses, I have attendees chant the Grinder's Mantra: "Round number bad, strange number good."

Sometimes bouncing/ lobes are in-sync, sometimes they're not. There's no good way to predict when that happens. It happens mostly by chance.

There's a remedy for avoiding those bad round numbers: Vary the workpiece rpm. That way, you're never in a round number for more than a split second. You're obliterating those lobes. The result? A round workpiece. CTE

about the author

Jeffrey Badger, Ph.D., is an independent grinding consultant. His popular three-day High Intensity Grinding Course has been helping grinders for almost 20 years. Visit www.TheGrindingDoc.com.

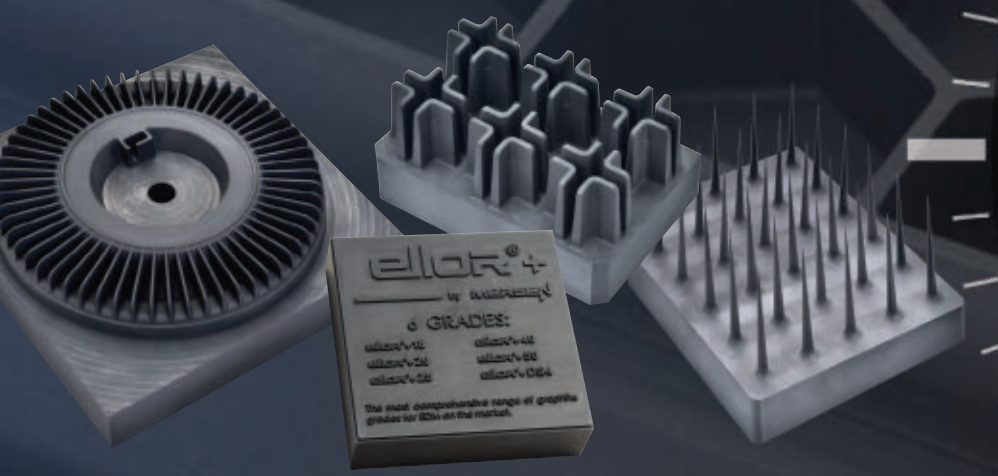
DS4 Ultra-Fine EDM Graphite

Proven to Handle EDM's Highest Degree of Difficulty

When your machining operation demands an EDM electrode that can provide intricate detail with an ideal surface finish you need Mersen's DS4. Over the last 15 years DS4 Ultra-Fine EDM Graphite has established a track record of handling the most challenging EDM burns while proving strong, durable and easy to machine. If you're ready to save money on ultra-fine EDM graphite, it's time to switch to DS4.

Ask your EDM distributor for DS4!

Precision Detail & Finishing



Graphite Grade	Density lbs/cubic ft	Density g/cc	Hardness Shore	Flexural Strength psi	Flexural Strength MPa	Electrical Resistivity Ω inch	Electrical Resistivity μ Ω cm	Average Grain Size inch	Average Grain Size μ m
ELLOR® DS4 Featuring DARKSTAR **Ultra fine grain graphite** Ultimate precision & EDM performance	117	1.88	72	13,500	93	.00050	1,320	<0.0002	4
ELLOR® DS4C Featuring DARKSTAR **Ultra fine grain copper impregnated graphite** Exceptional EDM performance & precision	187	3.00	75	19,000	131	.00015	381	<0.0002	4

Roughing

MERSEN

Shaping the future of EDM

edm.mersen.com

Made in U.S.A.

PATENT PRIMER – THE PROCESS

By Brandt Taylor

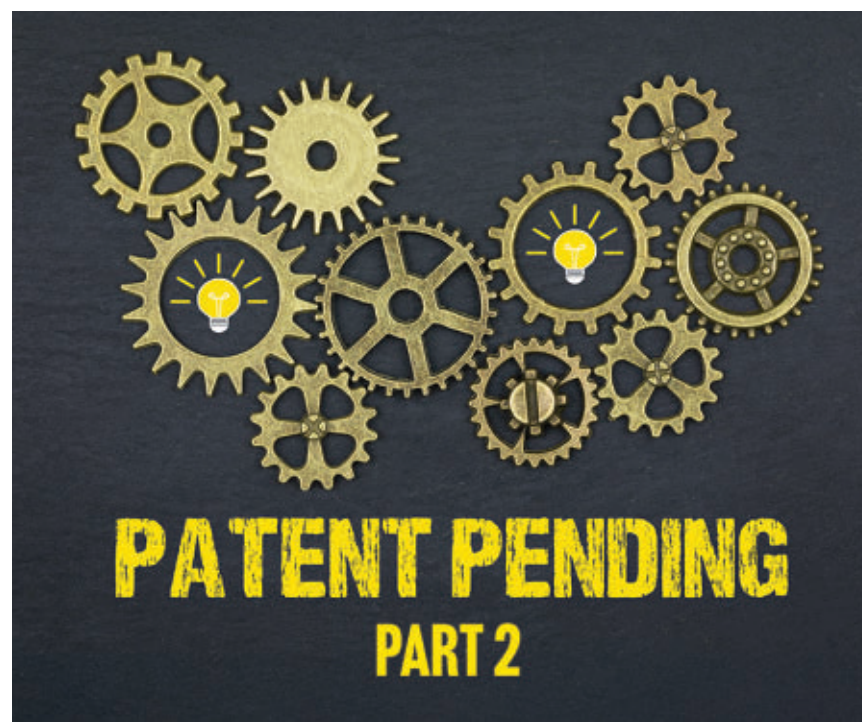
Last month I explained the different types of patents with an emphasis on utility patents. This month I will walk you through the key steps involved in applying for one.

The first step in getting a utility patent is to file a provisional application. The filing fee is small. The subsequent non-provisional application can either be a U.S. patent application or a PCT (Patent Cooperation Treaty) application. A U.S. patent will give protection in the United States only. A PCT application affords an inventor the ability to apply for the patent in foreign countries. The one-year period gives time to search the patent literature to see if the idea has been made public before, and also to find a patent agent. A good agent could also do the search. I personally liked doing the search. It can be done online using the U.S. Patent and Trademark Office database. It has every patent ever issued in the United States. Bear in mind, something that was first patented in a foreign country and had value was also likely patented in the United States because of the size of the U.S. economy. If you have an idea that you think might be patentable and valuable, doing a search can prevent wasted time.

When a non-provisional application is filed, the USPTO will do a thorough search of previously issued patents.

A non-provisional utility patent has:

1. **An abstract.** This is a short description of the patent.
2. **Background.** This is a description of the field of the invention before the subject invention came to be and why the subject invention is an advancement. It helps the patent agent argue for granting a patent.



3. **Specification.** A detailed explanation of the subject invention.
4. **Claims.** An explanation of what is legally covered by the patent. There are two types of claims: independent claims and dependent claims. An independent claim explains the core principle that is patented. The job of the applicant is to make this claim as broad as possible to cover as many embodiments of the idea as possible. The job of the examiner is to make this claim narrow. Utility patents often contain multiple independent claims to cover different categories of an invention, such as a service or apparatus claim, a method or process claim, a system claim, or a composition claim. Dependent claims describe narrow applications of the independent claims. A patent can have many dependent claims.
5. **Drawings.** Any drawing sheets.

The USPTO has specifications for content and format for a non-provisional patent application that you must follow. (See uspto.gov)

A patent may be applied for by the inventor, by a patent agent on behalf of the inventor or by a patent lawyer on behalf of the inventor. A patent agent must have passed the

Schutte sets you apart.

Truly superior tool and cutter grinding technology

Versatility, reliability, and productivity:

- 5-axis all-linear precision universal grinding
- Smart, easy to use software designed for tool and cutter grinding
- Automation for unmanned operation – pallet, chain magazine, or robot.
- Highest structural rigidity
- Rapid wheel change – 5, 12, or 24-wheel magazine
- High torque, high speed grinding spindle – up to 24000 rpm
- Multiple part clamping options

Result:

Less grind time, better surface quality, flexible operation. It's what sets us apart and lets you grind parts like this.

And you're supported by responsive factory-trained service, engineering, and parts inventory based in Michigan.

Step up to Schutte.

Multispindle CNC turning.
Tool and cutter grinding machines.

schutteusa.com | email info@schutteusa.com | 1-800-668-4035

Machinist's Corner

USPTO bar exam and have a bachelor's degree in science, engineering or technology. A patent lawyer must also have a law degree and be a practicing lawyer. In my case, I filed provisional applications myself and then got a patent agent or lawyer to carry the ball the rest of the way. Finding an agent that has background in the field of the invention is important. A primary job of an agent is to help write claims, and so having good language skills and being versed in the legalese of patents is also important. Only a patent lawyer can represent the patent in infringement cases.

When a non-provisional or PCT application is received by the USPTO, an examiner will be assigned to it by the patent office. The job of the examiner is to determine if a patent is justified. The material must be novel, advance the art, and not have been made public previous to the priority date. The job of the inventor or his representative is to convince the examiner to grant a patent. It is a back and forth negotiation that will usually last about three years.

If you have an idea that you think might be patentable and valuable, doing a search can prevent wasted time.

If a patent is granted, a fee must be paid to the patent office in each country where a patent is sought. After that, periodic annuities must be paid to each granting authority to keep the patent in force. A patent agent will keep track of all this stuff.

If a patent has great value, a third party may challenge the validity of the patent in court, claiming that the patent should not have been issued in the first place. Only a patent lawyer can litigate such a case on behalf of the patent holder.

Is owning a patent worth all this work? It is for me. Coming up with some world beating technology is what still gets this old boy out of bed in the morning. CTE

about the author

Brandt Taylor is owner of Berlin, Massachusetts-based Taylor Engineering, a machine shop and manufacturer of lathe chuck jaws. He can be reached via email at gbrandttaylor@gmail.com.

FACE MILLING

DoTriple-Mill

Highly versatile face milling with a unique triple-insert capability.

DoTriple-Mill features an enhanced dovetail clamping structure, allowing square, octagonal, and round inserts in the same pocket for maximum flexibility and performance.

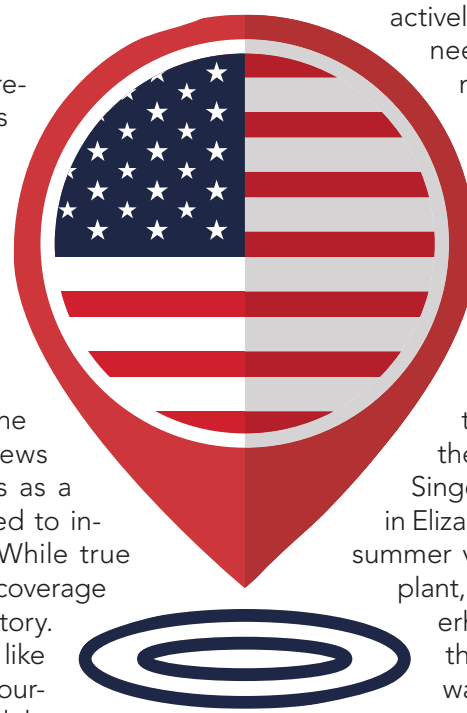
Member IMC Group Tungaloy

tungaloy.com/us

Workforce Reshoring

Urgency builds for workforce development solutions as manufacturing reshoring grabs headlines.

By Dennis Spaeth



Not that we needed to be reminded, but last month's news of the tariffs the U.S. announced on imports from all countries makes it painfully obvious that manufacturing in this country remains sorely misunderstood by the general public. And, that goes for much of the news media as well.

In the immediate aftermath of the announcement April 2, most news media outlets framed the tariffs as a political or economic tactic related to inflation or geopolitical motives. While true enough, generally speaking, such coverage gives short shrift to a complex story. A few business-oriented outlets, like Bloomberg and The Wall Street Journal, thankfully made the effort to delve into the stated goal of the tariffs — to spark a renaissance in U.S. manufacturing. Or, in less poetic terms, the goal is to encourage more manufacturers to locate jobs and facilities in this country, something widely known today as manufacturing reshoring.

The tariff news coverage not only underscores the need to update the public's perception of manufacturing, it pretty much establishes that need as a prerequisite for the success of workforce development and manufacturing reshoring efforts. To explore why, I turned to three industry leaders uniquely qualified and actively leading the charge for the changes needed to improve workforce development and manufacturing reshoring efforts in this country.

Harry Moser

Harry Moser, a 58-year industry veteran and founder of the Reshoring Initiative, grew up during an era when the U.S. still reigned as the world's industrial leader and his father and grandfather both worked at the Singer Sewing Machine Manufacturing Co. in Elizabeth, New Jersey. Moser himself spent summer vacations from school working at the plant, which is historically regarded as a powerhouse of the Industrial Revolution. By the time the plant closed in 1982, Moser was well on his way to forging his own manufacturing career. In 1985, he went to work for Charmilles Technologies, an EDM machine tool company in Lincolnshire, Illinois, where he served as president for nearly 25 years. By the time he retired from the company — now known as GF Machining Solutions — in 2007, Moser had grown tired of watching a long list of American manufacturing plants move offshore. So, in 2010, he founded the Reshoring Initiative to help bring manufacturing jobs back to the U.S. by providing free analytical tools, such as its Total Cost of Ownership Estimator. The tool helps American companies understand all the financial ramifications

Facts about manufacturing

As of February 2025, the average hourly earnings among U.S. manufacturing production and nonsupervisory workers was $28.68, according to the Bureau of Labor Statistics. For all manufacturing employees, average hourly earnings were $34.92.

Foreign direct investment jumped from $757 billion in 2010 to $2.22 trillion in 2023, according to the Bureau of Economic Analysis. In 2022, the manufacturing sector accounted for 42.4% of the total FDI position in the U.S.

As of March 2025, U.S. manufacturing employment remained above pre-pandemic levels at 12.764 million, according to the Bureau of Labor Statistics. That's about 12,000 more jobs than in February 2020.

The Industry Needs You

Scan the QR code to learn how you can get involved with a variety of industry efforts aimed at the future health of U.S. manufacturing.

associated with offshoring, such as inventory carrying costs, travel costs to check on suppliers, opportunity costs from product pipelines being too long, and risks to intellectual property.

Terry Iverson

Terry Iverson, a 45-year machine tool veteran, is the former owner and president of Iverson & Company, a machine tool sales, service and remanufacturing company in Des Plaines, Illinois, founded by his grandfather in 1931. Since selling the business in June 2023, Iverson has turned his focus to giving back to the industry that has been part of his family for three generations. Iverson, who first began speaking to high school students about manufacturing in the mid 1990s at Moser's encouragement, founded CHAMPION Now! in 2012 as a nonprofit organization focused on changing the public's outdated view of manufacturing careers. He's written two books supporting that mission: Finding America's Greatest Champion, published in 2018, and Inspiring Champions in Advanced Manufacturing, published in 2023. In addition, Iverson developed and launched Camp CHAMP, a traveling workshop that features two table-

top CNC machines — a mill and a lathe — and a curriculum designed to introduce middle school students to careers in manufacturing. Having received positive feedback from a dozen camps held throughout the Chicago metropolitan area in the past year, Iverson hopes to expand Camp CHAMP workshops nationwide.


Roy Sweatman

Roy Sweatman, a 60-year industry veteran, is the president and owner of Southern Manufacturing Technologies Inc. (SMT), an AS9100- and ISO9001-registered precision machine shop in Tampa, Florida, that specializes in complex precision machined components and assemblies for the aircraft, aerospace, defense and medical industries. Sweatman began his career as an apprentice machinist at General Electric in Erie, Pennsylvania. He spent 13 years with GE, working his way up to general manager of GE's Cleveland, Ohio, facility. He left GE and spent the next five years as general manager for a Cleveland-area precision machine shop. Then, in 1983, he moved to Tampa, Florida, to purchase a small machining company with five employees. That company was SMT, which now employs more than 100 people. Sweatman's industry involvement, however, goes even deeper than that. In addition to being a CHAMPION Now! board member, Sweatman serves or has served on the boards for a lengthy list of manufacturing trade associations, including the National Tooling and Machining Association (NTMA), the National Institute for Metalcutting Skills (NIMS), the Bay Area Manufacturers Association (BAMA), and Florida's State Manufacturing Extension Partnership (MEP) known as FloridaMakes. He's also active with numerous advisory councils for a variety of educational institutions in the Tampa area.

Opportunity knocking

The debate surrounding the government's tariff strategy has thrust the U.S. manufacturing industry onto the world stage, front and center. As an industry, we must seize this rare opportunity to introduce this nation to an industry that is clean, safe and brimming with well-paying career opportunities to program and operate the most innovative, technologically advanced machines and processes available today. Plus, we must make abundantly clear the

U.S. Bureau of Economic Analysis, Value Added by Industry: Manufacturing as a Percentage of GDP [VAPGDPMA], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/VAPGDPMA, April 2, 2025.

strength of U.S. manufacturing and its place in today's economy.

Take a minute to consider how prolonged access to this media spotlight is an opportunity for the industry to shatter the public's negative views of manufacturing. Given that the tariffs are intended to spark a manufacturing renaissance, there's a real possibility the public's focus on the industry will linger — despite the 90-day tariff pause announced a week later.

Notably ignored by much of the ensuing tariff analysis was any mention of the lessons learned from the COVID-19 pandemic, such as the vulnerability of extended global supply chains, especially those heavily reliant on single-source suppliers — many of which are in China or Southeast Asia. Plus, labor shortages compounded supply chain bottlenecks during the pandemic due to worker absenteeism, illness and burnout.

While automation, upskilling and workforce retention are now priorities throughout the industry, the skilled labor shortage remains a major hurdle. And, there's no quick fix for a problem decades in the making.

The once-thriving American middle class, long anchored by a strong manufacturing base, bore the economic brunt of offshoring. Little wonder why the public may still hold a dim view of manufacturing career prospects. Exasperating the labor shortage, meanwhile, has been a 50-plus year crusade in this country pushing everyone to seek higher education.

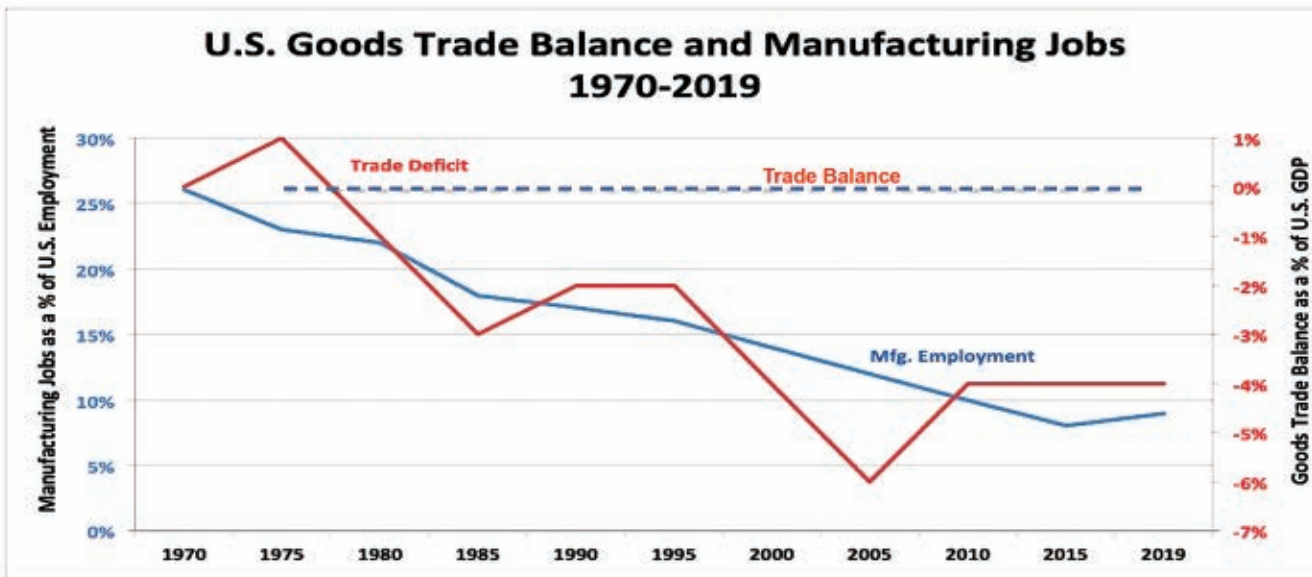
For a successful renaissance, Moser observed, manufacturing output would have to increase by 30% or more, and that's not possible unless the federal government and the industry work together to first resolve the skilled labor shortage.

No longer the global leader

The public's perception that manufacturing is an industry in decline became more entrenched in 2010, which is when China overtook the U.S. as the world's manufacturing powerhouse. Until that point, the U.S. had reigned as the global manufacturing leader for decades while China struggled with wars, unrest, weak government, natural disasters and poor economic policies. China began turning things around when it implemented economic reforms in the late 1970s, and over the next 30 years transformed into the world's largest manufacturing hub, according to a 2007 research paper by Angus Maddison titled, "The Organization for Economic Cooperation and Development, Chinese

Reshoring Initiative

Trade Deficit Drove Jobs Down



Economic Performance in the Long Run, 1960-2030."

As of 2023, China's share of global manufacturing reached 31.8% — more than double the 15% global share produced by the U.S., according to the 2024 edition of the International Yearbook of Industrial Statistics published by the United Nations Industrial Development Organization. For some perspective on China's rapid industrial rise, its

share of global manufacturing output stood at just 3% in 1990.

Yet, U.S. manufacturing remains strong. As of 2024, the U.S. manufacturing sector added $2.94 trillion to the economy, accounting for 10% of the nation's Gross Domestic Product (GDP). Again, for perspective, the National Association of Manufacturers (NAM) has compared the U.S. manufacturing output alone against the total GDP of other countries to see where it would rank. This year, U.S. manufacturing would be ranked as the eighth largest economy in the world.

After China and the U.S., the top 10 list of countries with the largest share of global manufacturing output in 2023 includes Japan with 6.6%, Germany with 4.6%, India with 3.2%, the Republic of Korea with 3.0%, the United Kingdom with 1.9%, Italy with 1.8%, Mexico with 1.8% and France with 1.7%.

The accompanying chart, "Trade Deficit Drove Jobs Down" on page 17, shows China experiencing much of its growth over U.S. manufacturing between the years 2000 and 2010. Following the aught years, Moser said, there's some gradual improvement for U.S. manufacturing, "albeit we're losing jobs less rapidly."

Moser added, however, that U.S. manufacturing managed to stanch the flow of jobs to China during the aught years. Since 2010, Moser has tracked all job announcements tied to reshoring and foreign companies investing in some way in manufacturing jobs on U.S. soil, otherwise known as foreign direct investment (FDI).

In fact, U.S. manufacturing jobs from reshoring and FDI reveals overall consistent growth since 2010. (See chart, "Reshoring + FDI Jobs Announced per Year" on page 22.)

"The rate of job announcements has risen from 11,000 in 2010 to 240,000 in 2024, much better than anyone anticipated in 2010 when we were founded," Moser observed.

Though the companies that have reshored or gone the FDI route have been able to find the workforce they need, he continued, other companies choose not to reshore directly because of the skilled labor shortage, further emphasizing the importance of workforce development efforts to alleviate the problem.

What's more, a recent Reshoring Initiative survey of about 500 U.S. manufacturers found that "a sufficient quantity and quality of workforce" within the U.S. would bring back more manufacturing than any of the other surveyed options, Moser reported. A sufficient workforce was the clear favorite among


SHEER
POWER
MORSE
SHEAR M DRILL
TM
Premium Submicron Carbide K P
HIGH PERFORMANCE DRILLS
3XD Coolant Through
3XD Non-Coolant Through
5XD Coolant Through
8XD Coolant Through
Available Now
PTSolutions
Follow Us
morsecuttingtools.com

the other options presented in the survey, which included tariffs, a lower value for the U.S. dollar, lower tax rates and fewer regulations.

The group as a whole said that a 15% additional tariff applied to everything from everywhere would help increase their output by 24%, Moser continued. By contrast, the same group said an abundant U.S. workforce with higher skills would on average increase their output by 30%.

"Having the right workforce," Moser concluded, "would create about 2 million manufacturing jobs."

The relationship between reshoring and workforce development is symbiotic, Moser stressed. "Reshoring needs a skilled workforce. A skilled workforce needs reshoring to succeed and prove the value of manufacturing careers."

The skilled labor shortage not only hampers reshoring but could have long-term consequences for the U.S. economy. The Manufacturing Institute forecasts a workforce shortage of 1.9 million people by 2033.

"At such a level," Moser said, "manufacturing will shrink by 10% and push automation much harder." Still, Moser is quick to point out that technology alone cannot solve the workforce shortage. "We see automation as a necessary but not sufficient condition to enable reshoring," he said. "Like in Alice and Wonderland, we need to run as fast as we can to stay even. So, automation and AI are not enough to enable reshoring but they are necessary."

Battling an outdated perception

Changing the perception of manufacturing in this country usually is a reference to the public's notion that manufacturing jobs are still dark, dirty and fraught with safety risks. But there's also the idea that the industry is dying and, therefore, not worth mentioning as a career option to high school or college students. In fact, the pervasive view of manufacturing is so outdated, it's jarring.

Comedian and talk show host Bill Maher questioned the desire to revive manufacturing in the U.S. during a March 2025 episode of

about the author

Dennis Spaeth, a 45-year media veteran, is the owner and publisher of Cutting Tool Engineering. He can be reached at dspaeth@ctemedia.com.

his HBO series, Real Time with Bill Maher.

"Why do we want to bring back manufacturing? It's so '70s, I mean, that ship has sailed," Maher said to his guests before noting the folly of trying to compete with clothing makers in other countries.

This perception, in a nutshell, is what the manufacturing industry must combat in order to chip away at the public's resistance to manufacturing careers.

At the heart of efforts to build a future U.S. manufacturing workforce are people like Iverson, whose mission is to change the public's perception of manufacturing careers. "We need to reach not only the students, who simply don't know that manufacturing careers are a viable option," Iverson said, "but also parents who think that manufacturing is stuck back in the pre-computerization age."

Unfortunately, noted Iverson, parents still clinging to the promise of college don't bother to weigh the extreme cost of a four-year degree against the earning potential of the jobs for which their children are being trained. Manufacturing careers, he added, not only offer a well-paying alternative straight out of high school, they provide benefits such as paying for higher education.

"Today's manufacturers," he explained, "are more than willing to help pay to educate or upskill their future employees and leaders."

Iverson has employed a variety of strategies to reshape the narrative around manufacturing, including publishing two books, creating a series of educational videos, awarding scholarships, and launching a podcast. Most recently, CHAMPION Now! introduced Camp CHAMP, a hands-on workshop designed to introduce middle school students to modern manufacturing environments. "The program is very much in its infancy with only 12 camps held," Iverson noted, but added, "we have received great initial feedback from the high school mentors as well as career and technical education instructors who help run the workshops."

Studies support the value of early exposure to manufacturing careers. One study conducted by the Student Research Foundation, in collaboration with The Manufacturing Institute, found that 63% of students who had enrolled in career and technical education courses credited their own interests and prior exposure to the industry as major influences on their career decisions.

Sweatman echoed the importance of early engagement for the next generation of skilled labor. "We typically will have about a dozen middle and high school tours each year (at SMT)," Sweatman said.

"We have had some success in getting some good hires from those," Sweatman said. The hardest part of the school tours, he added, occurs when he learns about students who were excited about manufacturing during the tour only to get a negative reaction from their parents afterward. "I haven't been able to figure out how to get to most parents."

Iverson wrote his second book specifically to engage students and their parents at the same time. Beginning with its subtitle, "Discover The Path to a Debt-free Career," the book lays out the case for putting manufacturing careers back on the radar in this country.

One book, or one voice, however, cannot by itself erase the emphasis this country has placed on higher education. That focus has clearly come at the expense of manufacturing careers, which are still not widely mentioned as an option for high school students to consider. For that matter, several generations of youth in this country have had little exposure to the manufacturing industry, let alone the careers it offers.

Why is that important?

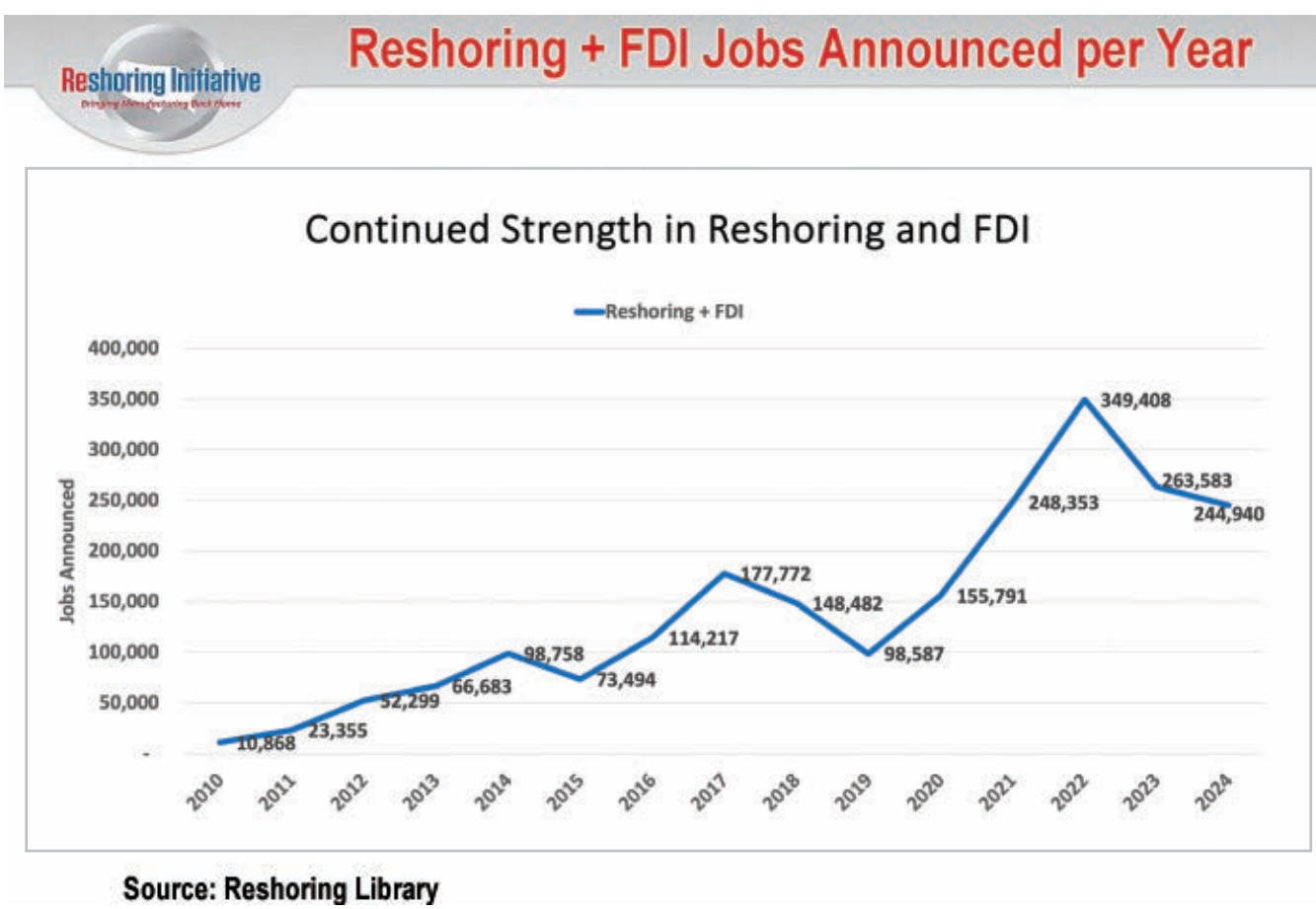
A Kronos 2018 Manufacturing Day survey found that only 49% of parents were likely to encourage their child to consider a career in manufacturing, compared to 88% for technology and 82% for engineering. Other surveys have shown more than a fifth of parents still associate manufacturing jobs as outdated and dirty work environments, while a quarter of parents don't think manufacturing pays well.

Another survey collaboration between Deloitte and The Manufacturing Institute in 2022 suggested some improvement in the perception of manufacturing careers held by parents. Of the parents surveyed, 64% agreed that U.S. manufacturing jobs are creative, innovative and employ problem-solving skills, which was up from 39% in 2017. Plus, 40% of parents said they are likely to encourage their child to pursue a career in manufacturing, which was up from just 27% in 2017.

Whether the needle has moved on the perception of manufacturing careers among parents, reaching parents to update their perceptions about manufacturing careers remains a significant challenge, Iverson said, noting that more industry involvement will be needed to reach parents.

"Industry leaders need to get engaged," Iverson said. "They need to become active participants with their high schools and promote internships at their companies."

Sweatman emphasized the need for industry collaboration to over-



Source: Reshoring Library

come the labor shortage. "Industry collaboration is very important," he said. "Unfortunately, it is a struggle to get manufacturers to take time away from their businesses to do so. If all machine shops had apprenticeship programs, the skilled labor shortage would go away."

SMT works closely with local technical colleges and school systems to develop apprenticeship programs and training curricula. "We worked with [Pinellas Technical College] to convert the CNC apprenticeship from time-based to a hybrid with reduced hours and a certain number of NIMS credentials," Sweatman said.

Funding obstacles

Funding remains a persistent challenge for workforce development initiatives like CHAMPION Now! "Most of it for the last 12 years has come from both myself and board members," Iverson said. "During IMTS 2024, we received a five-figure donation from a very large machine tool distributor. The only way we can make an impact is to print and distribute books, produce podcast interviews, and conduct camps."

The Illinois Manufacturing Excellence Center (IMEC) has funded Camp CHAMP for two years, but is potentially slated to be eliminated by recent cuts.

"Camp CHAMP is a great initiative," said Sweatman, "but it is costly to ship the machines around the country. What would work better — if enough people got involved and supported it — would be to have regional locations with a set of machines that could more easily be transported to various locations to hold the camps."

CHAMPION Now! calls this manufacturing localism.

"The skilled labor shortage will not go away unless everyone gets involved," Sweatman continued. "One small initiative like CHAMPION Now! cannot do it by itself unless it gets enough support from industry."

Informing and engaging younger generations about manufacturing careers through early exposure, modernized vocational education, and collaborative community efforts can positively influence their career choices. These strategies not only address the skilled labor shortage but also ensure a robust future workforce for the U.S. manufacturing industry. But as all three leaders make clear, the manufacturing industry itself must step up, collaborate, and invest in the next generation of skilled workers — before the opportunity to bring jobs back home slips away. CTE

Heidenhain

NEXT-GEN AUTOMATION

Machine shops adopt intelligent, flexible systems to overcome labor gaps and streamline production.

By Alan Richter

Material handling is the No. 1 application for robotics, according to Alex Shikany, executive vice president of the Association for Advancing Automation (A3) in Ann Arbor, Michigan. Material removal is one of the smaller but fastest-growing applications, including grinding and polishing.

"There's a growing focus on automating finishing applications like grinding and polishing because they're physically demanding, repetitive and require precision," Shikany said. "With advancements in force control, vision and AI-driven programming, robots are now handling these tasks more effectively than ever."

He added that small and medium-sized manufacturers, including job shops, represent the largest untapped market for automation. "These companies are increasingly recognizing that automation isn't just for high-volume production — it's a competitive necessity," he said. "The key is helping them take that first step with the right solution."

Unlike the fixed automation solutions of the past, which were costly and difficult to reconfigure, today's manufacturers prioritize flexibility. "Scalability and redeployment are critical," Shikany said. "Companies need automation solutions that adapt as production demands change."

Hermle is one machine tool builder that understands that end users producing parts in a low-volume, high-mix environment require automation that can accommodate planned and unplanned changes, said Frank Keller, sales director of automation and technology for HLS Hermle Systemtechnik GmbH in Gosheim, Germany. Hermle USA Inc. is in Franklin, Wisconsin. "We supply flexible clamping systems, flexible vises, flexible robot gripping systems — and all are controlled with very easy-to-use software."

Having spoken with customers across North America, Europe, Asia and South Africa, Keller noted that the common theme driving automation is the lack of skilled labor. "As a side product, which is of course very nice to have, you are much more efficient and have a much lower cost per part at the end of the day."

For workers relieved of dull, dirty and dangerous tasks, automation creates a more interesting and less exhausting work environment that is flexible and family-friendly, he added. "Basically, you are able to fulfill your commitment to your family, and everyone is happy."

When launching a machine automation project, Keller recommends selecting enthusiastic people and involving them early. Frequently, other workers who were hesitant at first see the benefits automation brings. "All of a sudden, the whole atmosphere changes, and these people want more and more automation."

The improvements can be significant. For example, a customer running one shift achieved 800 spindle

Heidenhain's digital twin technology uses encoder data to simulate real-time performance.

hours annually on a machine out of potentially more than 8,700. With flexible automation, spindle hours increased to 4,000 or more, Keller said, noting that Hermle has customers achieving 7,000 spindle hours. "The whole system is sometimes amortized in less than a year."

On average, he added, customers achieve a return on investment in two years.

Once automation is in place, Keller added, there's no returning to the old way. "Not a single customer," he stressed, "has ever gone back after they started with automation" — no matter the industry, company size or number of employees.

First Things First

Before automating a machine tool, Gisbert Ledvon, vice president of marketing for Heidenhain Corp. in Schaumburg, Illinois, recommends ensuring a machine can achieve a specified part accuracy. This requires reliable, thermally stable machines that hold tolerances throughout the day. If you can make one part and that's accurate, then you can be confident the machine will reproduce those parts day and night, and that automation makes sense, he said.

In other words, the machine must be capable of accurate and repeatable results. "That's what we see from the Heidenhain side," Ledvon said, noting that encoder technology provided to robots is becoming increasingly important to ensure motion within all axes is repeatable and accurate.

With a reliable automation process in place, the need to double-check elements of production is eliminated, he added. "The technology in the Heidenhain CNC will do that for you."

To help the next generation of operators gain efficiency and run more machines, Heidenhain replaced its traditional CNC panel with one that allows touchscreen customization, similar to a smartphone or tablet. And multiple operators can customize the screen to their individual preferences. "That helps attract new people into the field," Ledvon said, while also providing them "much higher confidence and a shorter learning curve to operate in an automation environment."

For that matter, he noted, "even an experienced operator wants much more help from the control technology."

Other Heidenhain enhancements to the control include:

- The introduction of video tutorials. "The operator can say, 'I want to do a setup on this part, and I want to touch probe this part — how do I do that?' You click on that video, and it gives you a quick overview."
- The addition of more dynamic collision monitoring to avoid crashes by simulating the part, fixture, toolholder and cutting tool in a test run before production.

Engaging Atmosphere

The skilled labor shortage aside, automation helps manufacturers find, hire and retain employees in general, according to Jeff Bennett, senior automation and control engineer of the A+ Automation team at Absolute Machine Tools Inc. in Lorain, Ohio. "They're forced to automate because the process is so mundane and repetitive that operators don't want to stand there and do it."

Bennett noted that A+ Automation covers robot integration, programming, training, automatic doors and safety — everything in the automated work cell. Many customers don't need all the bells and whistles, such as a cobot opening and closing a machine door instead of an automatic door. "We go through and give them an option, sometimes multiple options."

Jonathan Sbert, vice president, Americas, for Universal Robots USA Inc. in Novi, Michigan, is familiar with the potential for cobots in machine tool automation. Universal Robots has sold more than 90,000 cobots for various applications, from machine tending and welding to serving lattes and food.

"We make a product that can be told to do a million different things, but it doesn't do anything out of the box," Sbert said, noting that Universal Robots relies on more than 1,200 partner companies to develop the end equipment.

Welding automation, Sbert said, for example, has experienced tremendous growth thanks to exceptional offerings from Universal Robots partners, as well as a severe labor shortage "that's going to hit us like a ton of bricks."

Although manufacturers typically target a return on investement (ROI) of less than 18 months when purchasing a cobot, the payback can be quicker for welding applications, particularly those previously performed by skilled welders. "Technical welders are well paid and hard to find," Sbert noted.

However, convincing companies to make the initial purchase can be challenging. "Once they buy the first one, they tend to buy the second and third pretty quickly thereafter," he said.

Selling a Cell

Robots are often integrated into work cells, Bennett said. For example, an operator might work on two machines while a robot tends one, or two to three robots might run four to six machines while an operator feeds workpieces and checks quality.

Manufacturers with a high mix of parts are ideal candidates for automation because robots are easy to program and setup time is minimal. However, automation is difficult to justify for lot sizes below a certain quantity. "Three hundred parts is the threshold where the setup time is worth it," Bennett said.

Absolute Machine Tools typically serves as a one-stop shop unless a specialized machine control is involved. "The vast majority are controls we're used to seeing, so we're the only contact a customer needs," Bennett added.

Most customers target an ROI of 12 to 18 months, he said, noting that even a couple of extra hours of unattended production each day can speed up payback. "When the robot is running and the operator goes to lunch or break, the operator is still getting parts out."

Automation and AI

As with many areas of technology, artificial intelligence (AI) plays an evolving role in machine tool automation. "AI will, in the next 10 years, completely change our industry," said Hermle's Keller.

One area where AI can help is capturing the know-how of retiring workers and transferring it to the next generation, Keller explained.

contributors

Absolute Machine Tools Inc.
800-852-7825
www.absolutemachine.com

Association for Advancing Automation
734-929-3274
www.automate.org

Heidenhain Corp.
847-490-1191
www.heidenhain.us

Hermle USA Inc.
414-421-9770
www.hermleusa.net

Universal Robots
844-462-6268
www.universal-robots.com

about the author

Alan Richter is editor-at-large of CTE. Contact him at alanr@ctemedia.com.

Retaining such expertise is vital, concurred Shikany of the Association for Advancing Automation. "You need to somehow capture or transition that knowledge within your organization. Otherwise, you lose a big piece of what made you successful."

AI can also help optimize tool life by removing the guesswork from decisions about when to change a worn cutting tool, Keller said. There's no reason to burden skilled people with such decisions, he added, when AI can be trained to optimize the use of expensive cutting tools.

Additionally, AI is being explored to write CNC programs because many end users struggle to create enough programs quickly. "There's huge potential," Keller said.

Heidenhain's Ledvon cautioned that users shouldn't fully trust AI-generated programs without verification. "Maybe AI can give you basic programming, and you put it into the machine and run it through a verification process to make sure the code is right."

Shikany noted that large language models can generate robot programs with impressive accuracy. "AI-assisted programming is accelerating deployment, but you still need human oversight to refine and optimize for real-world production."

Universal Robots is also developing AI applications in partnership with chip manufacturer Nvidia, with the first focusing on vision sensing and more promising ones on the horizon. "You can imagine the Holy Grail would be you just put a cobot next to an employee and it can just watch and learn what he does every day. Then all of a sudden — boom — your program is created. I don't think we're that far away."

A common pitfall, Ledvon said, is attempting to automate everything at once. He recommended ensuring machines are solid and rigid enough, with accurate kinematics and the ability to be recalibrated. A tool presetter should be used to transfer tool data and maintain a complete tool library in the machine.

"The first step into automation is 3+2 machining in one setup and machining five sides of a part, which will significantly improve quality and productivity — even without adding a robot or pallet changer," Ledvon said.

Shikany emphasized the importance of working with an experienced automation integrator. "Start smart — focus on the application that will create the most value," he said. "Some deceptively simple tasks present the biggest challenges, so selecting the right starting point is critical." CTE

AEROSPACE SETS A HIGH BAR

Insights into the intense standards, exotic materials and rigid processes that define aerospace manufacturing.

By Christopher Tate

I have had the opportunity to work in several industries machining parts and programing machine tools over the course of the past 32 years. Without a doubt, machining parts for aerospace companies is the most demanding. Of course, the compensation reflects the difficulty.

The global aerospace parts manufacturing market reached $913 billion in 2023, according to Grand View Research, a market research and consulting company headquartered in San Francisco. Grand View Research also noted that the market segment is expected to grow at a compound annual growth rate of 4.2% through 2030.

As rewarding as aerospace machining can be, however, breaking into the aerospace market is not easy.

Aerospace work is challenging for one simple reason — safety, which we all appreciate when flying. Component failures on an airplane can cause catastrophic problems. Because of the critical nature of aerospace parts, engineers subject their part designs to countless calculations, physical tests and multiple design reviews to ensure everything is right. There is little allowance for error, and every feature is tightly controlled to ensure the component functions as designed and tested.

For shops not currently in the market, even getting the opportunity to submit a quote can be a challenge. Sourcing teams in large aerospace companies are under extreme pressure to control costs while improving inventory turns and ensuring there are no stocking issues. It is a challenging role, so keep in mind that buyers have limited time to process new vendors through a bureaucratic maze.

They are also hesitant to accept the risks associated with poor quality, late deliveries or working with vendors who lack financial stability. These combined elements can make it almost impossible to get an opportunity to quote, if you can even get the opportunity to talk to someone in sourcing.

Winning the work is only the beginning. Next comes the qualification process that, when complete, demonstrates the vendor is capable of successfully manufacturing the part with no quality issues. While I'm sure most shops have been through some kind of qualification before, aerospace qualifications are on another level.

Qualifications for the aerospace industry are intense. Most machined parts require 100% dimensional inspection. That means every single dimension on the drawing will be measured, usually on a batch of parts, to demonstrate that the machining processes are repeatable and success is not a one-off event. There is no allowance for error, and one incorrect dimension on one part can sink the qualification.

Once a shop has made it to the qualification phase, it becomes apparent that aerospace tolerances are tight. Tight is a relative term, and means different things depending on the industry and type of machining that is performed. When considering the mechanical function, aerospace tolerances are typically tighter than

those found on other types of parts. For example, the tolerance on a bearing journal for industrial equipment may have a total range of 0.0005" while the tolerance range on the same size journal for an aerospace component would be just 0.0002". Tapped hole locations on a normal industrial part may be +/- 0.015", but the same type of part in an aerospace application would require a three-datum true-position call out of 0.005". I have seen a true position tolerance of 0.005" for a tapped hole that mated with clearance holes that were 0.020" larger than the screw diameter.

Compounding the difficult tolerancing are the materials that are often used for aerospace components. Anything that goes inside of an engine is going to be made from one of the many materials that fall into the not-fun-to-machine category, like titanium, nickel alloys and other nasty materials that can live in harsh environments. Exotic materials like nickel alloys are used extensively in jet engines because these materials retain their strength and other mechanical properties at elevated temperatures. However, the same material properties that make exotic alloys good for use in a jet engine makes them difficult to machine. The nickel alloys used in jet engines are the most difficult to machine materials used in industry.

Airplanes use immense amounts of aluminum, which is easy to machine. So, aluminum aerospace parts must be easy, right? In some ways, yes. Knocking off aluminum chips is easy. Tools don't burn up. You can run as fast as you want. No bird nest of stringy chips. However, these parts are subject to the same qualification requirements as others with close tolerances, and present a different type of challenge.

A large number of aluminum aerospace parts are made from wrought alloys in the form of bar or plate. These wrought alloys like to move around when they are machined. Machining a large volume of chips from a piece of plate relieves the internal stress and can make those parts wander all over the place. A large aluminum structural part can be dimensionally perfect until it is unclamped. Then it begins to bend, curl and bow out of tolerance. Of course, shops that make these kinds of parts have ways of mitigating such problems, but they have learned these lessons the hard way over many years.

So, if a shop nails the qualification with tight tolerances on a difficult-to-machine material, then everything should be like machining any other part, right? Not really.

It is normal for aerospace manufacturing processes to be "frozen" or "locked" after a successful qualification. This means the shop does not have the same freedom to change manufacturing processes to address cost, productivity or quality issues that it would if it were making tractor parts.

Aerospace companies, often compelled by agencies like the FAA, do not allow manufacturers to change manufacturing processes without initiating a requalification. The restrictions vary depending on the part and the consequences of failure, but there is always some level of control over machining processes. These controls make process improvements challenging and can be a barrier to reducing manufacturing costs.

All the challenges of aerospace machining make it exceptionally profitable — and once qualified, a shop is almost guaranteed to keep the work. I did mention that aerospace machining can be rewarding. CTE

about the author

Christopher Tate is the owner of Tate Engineering, a Natchez, Mississippi, firm that helps manufacturers solve efficiency problems. Tate, who earned his bachelor's and master's degrees from Mississippi State University, has 32 years of experience in the metalworking industry. Contact him at chris23tate@gmail.com.

CYBERSECURITY FOR AEROSPACE

Strategies to combat escalating attacks.

By Tyler Massey

With sensitive intellectual property (IP), global supplier networks and growing reliance on connected technologies, the aerospace and defense industry has become a prime target for cyberattacks. In fact, the average cost of a data breach reached a record $4.45 million in 2023, according to IBM's annual Cost of a Data Breach Report. This represents a 15.3% jump since 2020. For aerospace manufacturers, the stakes are especially high.

Aerospace manufacturing environments often involve a complex web of suppliers, contractors, and both legacy and modern technologies. This includes a mix of information technology (IT) and operational technology (OT) systems — each with different security needs and vulnerabilities. The increasing adoption of Industrial Internet of Things (IIoT), Cloud computing and artificial intelligence (AI) technologies adds further layers of risk.

These evolving threats demand proactive, multi-layered defenses. Just how are aerospace manufacturers expected to implement secure methods for data sharing and collection? Essentially, the necessary cybersecurity solution begins by taking two key steps.

Step 1: Appoint a Cybersecurity Champion

Effective cybersecurity implementation starts with leadership. Aerospace manufacturers should appoint a dedicated cybersecurity project manager or engage a knowledgeable systems integrator. This individual or team must oversee the design, rollout and management of security solutions.

Organizations can also choose to partner with trusted vendors that offer secure IT systems to safeguard IP. These systems often connect to the Cloud via a Virtual Private Network (VPN) and operate on independent networks that push data outward without exposing machines on the factory floor to inbound traffic.

Whether you appoint someone on your staff or you work with a trusted third-party vendor, it's essential to have professionals who specialize in industrial cybersecurity guiding the effort.

Step 2: Standardize with MTConnect

Regardless of the ERP system or machine tool brands a manufacturer uses, establishing a standardized communication framework is critical. Before introducing advanced cybersecurity measures, ensure that all equipment and systems are MTConnect-compliant. Developed by the MTConnect Institute, a not-for-profit standards development organization supported by AMT – The Association for Manufacturing Technology, MTConnect is like a universal translator that enables interoperability across a wide range of machine tools and software. The non-proprietary, royalty-free standard provides a secure, consistent foundation for safe data collection and exchange.

Once the foundation is in place, manufacturers need to determine where their data is headed. Understanding data directionality helps identify the right industrial protocols and compatible third-party software to use for collection and sharing. It also ensures that systems remain scalable as the business evolves — a crucial consideration in an industry where innovation moves fast.

about the author

Tyler Massey is the assistant manager of software development at Mazak. He can be reached at tmassey@mazak-corp.com. For more information about Mazak's SmartBox cybersecurity solution, visit the Technology & Solutions, Monitoring & Analysis section of the Mazak website at https://www.mazak.com.

SmartBox: A Cybersecurity Solution at the Machine Level

On the shop floor, Mazak's SmartBox technology provides a robust defense against cyber threats while enabling advanced data monitoring and analysis. Designed to securely connect machines and devices to a network, the SmartBox acts as a protective barrier that isolates machines, blocks unauthorized access, and allows only read-only data collection.

Key features of the SmartBox include:

- Network isolation: Prevents unauthorized access to and from connected equipment.
- No direct cabinet connection: Mounts externally without interfering with machine electronics.
- Plug-and-play connectivity: Easily integrates with off-the-shelf sensors.
- Multi-machine support: One unit can serve multiple machines and other production assets.

This approach satisfies stringent IT department requirements, especially when connecting legacy equipment to modern data systems via MTConnect. It also eliminates risky workarounds, such as using USB drives on the shop floor to transfer part programs.

Mazak is further advancing its SmartBox technology with the launch of SmartBox 2.0. This new version includes two managed network switches, a fieldbus coupler I/O module with Node-RED for interfacing, the capability to host up to 10 machines, as well as an onboard industrial PC for computing at the edge. These improvements give aerospace manufacturers more flexibility and control while maintaining strict security standards.

As cyberattacks grow more frequent and sophisticated, manufacturers and suppliers in the aerospace sector must implement strong defenses to prevent malicious software from infecting machines, stealing proprietary data or halting production.

Cybersecurity is no longer optional — it's foundational. As aerospace operations continue integrating IIoT and connectivity, cybersecurity is as critically important to the security of the entire business as the locks on the doors of your facilities. Cybersecurity protects both the intellectual property and the processes that drive innovation and excellence in aerospace manufacturing. CTE

BEAT THE ALUMINUM BLUES

Maximize thread quality when tapping aluminum alloys.

By Jim Nielsen

Aluminum alloys are popular in numerous industries — from aerospace to automotive — because they offer a high strength-to-weight ratio, excellent thermal conductivity and corrosion resistance. Tapping threads in aluminum components, however, presents unique challenges. Because aluminum is relatively soft and "gummy," it can lead to issues such as poor chip evacuation, built-up edge (BUE) and inconsistent thread finish. Understanding how to overcome these hurdles is key to producing reliable, high-quality threads.

Choose the Right Tap Geometry

One of the most critical decisions for tapping aluminum is the selection of a suitable tap geometry. Generally, spiral-fluted or straight-fluted taps can be used; the choice depends on the application and aluminum grade. Spiral-fluted taps are ideal for blind holes in softer materials because they facilitate better chip evacuation. They pull chips back out of the hole, helping avoid chip packing that leads to poor thread finishes or breakage.

Additionally, the tap's rake angle and relief features should be designed for softer materials. A high rake angle can help reduce cutting forces and minimize burr formation. For form taps (also known as roll taps), the geometry is optimized to plastically deform the material instead of cutting it, elim-

continued on Page 34

CoroTap® 400 is a high-speed, chip-free forming tap suitable for both through- and blind-holes in steel, stainless steel, aluminum, and HRSAs.

Tips and tricks for threading aluminum parts.

By Robert M. Layng

Just about every machine shop makes parts out of one aluminum alloy or another. Just about every shop also threads holes in those parts using taps. While taps are a highly efficient way to make threads in a hole, they come with potential problems, such as poor or inconsistent thread finishes, thread galling, and the ultimate nightmare — a tap broken off in a part. Here are some common mistakes to avoid and a few tips that have helped me.

I have found that the softer the aluminum, the tougher it is to tap because the material acts like chewing gum if not properly lubricated. Just like when machining aluminum, keeping the chip hardened is important to prevent a myriad of problems. The use of oil or flood coolant helps with preventing galling. Inversely, the harder the alloy, the easier it is to tap.

Proper toolholding also goes a long way in preventing downtime caused by tap failure, in whatever mode it presents itself. Toolholder choice is usually dictated by factors involved in the tapping operation such as the number of holes to tap, the machine being used to do the tapping, as well as the capabilities and limitations of your shop, among others.

For example, if you are about to thread a lot of parts with holes drilled by a different machine, we use a Tapmatic tapping head as it has radial play to allow for better alignment of the tap to the hole, along with an internal clutch to automatically reverse the rotation of the tap as you lift it back out of the part. Most of the time, the drilling and tapping will occur in the same machine and the same setup, so rigid tapping or power tapping with the tool in the spindle, as in a milling machine or CNC mill, is an obvious choice.

A common problem that presents itself is the cutting tool selection, and the use of the wrong tap for the job. There is, after all, an enormous list of different taps, grades of substrate, classes of fit, etc., from which to choose. Each of these facets need to be considered when selecting a tap for a

continued on Page 35

inating the production of chips altogether. Form tapping in aluminum can deliver excellent thread strength, provided the specific aluminum grade is compatible with this method.

Optimize Cutting Parameters

Aluminum's gummy nature can cause material to adhere to the cutting edge, creating BUE. To mitigate this, running at higher surface speeds — without exceeding recommended limits — may help shear the material cleanly and reduce BUE formation. However, striking the right balance is essential. Excessive speed can overheat the tap, reduce tool life and degrade thread quality.

Equally important is the feed rate. Since tapping is a synchronized process, the feed must match the thread pitch. For form tapping, slightly different speeds and feed profiles might be employed, as the process depends on material flow rather than chip removal. Always refer to tooling guidelines and perform test cuts to fine-tune parameters for each aluminum alloy.

Proper Lubrication

Effective lubrication is paramount for tapping aluminum, as it reduces friction, prevents chip welding and flushes chips from the cutting zone. Water-soluble coolants, with adequate lubrication properties, typically perform well when tapping. In some high-speed production environments, minimum-quantity lubrication (MQL) systems provide a fine mist of oil that can also help lower friction and improve chip evacuation.

To reduce the likelihood of BUE, choose a coolant or lubricant specifically formulated for aluminum. Additives like sulfur or chlorine can enhance lubricity, but always confirm compatibility with both the workpiece material and any applicable environmental or safety regulations.

CoroTap™ 100's optimized grades ensure low friction at high speeds for precision threads, resulting in excellent thread quality.

Sandvik Coromat

Ensure Rigid Setups

Maintaining rigid setups is essential for consistent tapping performance. Excessive vibration or axial runout can result in misaligned holes, broken taps and inconsistent thread geometry. Use high-quality toolholders designed for tapping — ideally with minimal runout and some float or compensation to accommodate any minor misalignment between the spindle and hole center.

Equally important is securing the workpiece to eliminate movement during tapping. For CNC machines, ensure the axis alignment is accurate and that tapping cycles (rigid or synchronous tapping) are well-suited for aluminum.

Consider Thread Milling

In applications where burrs, chips or close-tolerance threads pose challenges, thread milling can serve as an alternative to tapping. Thread milling uses a helical cutting motion and can reduce the risk of broken taps and minimize downtime. While tapping is still faster for many high-volume aluminum applications, thread milling offers more flexibility and can produce threads of various diameters with one tool. Depending on the complexity, material thickness and machine capabilities, weigh whether tapping or thread milling is the optimal solution.

By paying close attention to tap geometry, optimizing speeds and feeds, using proper lubrication, and ensuring rigid setups, manufacturers can significantly improve the consistency and quality of tapped holes in aluminum. Thorough planning and testing are essential, as each aluminum alloy can behave differently. With the right approach, tapping remains a cost-effective, high-productivity method for creating threads in these widely used and versatile materials. CTE

particular part.

Let's take blind holes as an example. The selection of a gun tap or spiral point tap may be the types to avoid in this case. When you need to reach further down, and when you want to prevent chips from compacting in the bottom of the hole and causing premature tap failure, consider switching to a spiral-fluted tap, which is designed to bring the chips up and out of the hole. The chip evacuation helps extend the tool's life and reduces the chances of tap breakage.

Another common mistake machinists make is to assume that "aluminum is almost too easy to tap," and they get too aggressive with speeds and feeds or they prolong the use of a dull tap way beyond its useful lifespan. Most aluminum alloys contain a percentage of silicon, magnesium and chromium. While those amounts may be minuscule (less than 1%), they are abrasive all the same and can play havoc with tap lifespan.

Pressing a dull tap into service beyond its useful life is a ticking time bomb. Aluminum, while one of the easiest metals to work with, still poses significant pitfalls if you become too complacent with tapping it. Dull taps only exacerbate this situation by leaving either a galled or inconsistent finished thread. They also take exponentially more torque to turn and complete the thread as a sharp one takes, and that leads to a higher probability of poor finish and/or a broken tap. The moral of this story is that saving the few dollars to press a dull tap into service right now may end up costing you a pile of money in scrapped parts or tap removal. The abrasive properties of aluminum listed above only add to the trouble lurking in the shadows.

Tap drill size

The formula that I have always used for determining a tap drill size is tap diameter minus 1/N, where N is threads per inch. For example, let's use 3/8-16 UNC. The formula would look like this: 0.375" - 0.0625" = 0.3125" tap drill size. This will result in a 75% thread engagement, which is enough for any standard application of a threaded hole. If you are having trouble with surface finishes or it takes an inordinate amount of effort to turn the tap, the above formula may be too tight of a fit. Especially so in tough or troublesome alloys.

In our shop, the common practice is to move either

continued from Page 35

one drill size larger, or 0.015" larger, depending upon the thread size. The loss of engagement is negligible and the strength is still there. It is surprising how much of a difference those extra few thousandths of an inch can make. We also take the extra few seconds to leave a healthy chamfer at the beginning of any threaded hole. I realize that time is money, and not every shop can afford the cumulative time it would take to chamfer every hole on numerous parts, but the cost savings it brings could more than pay for any time lost in process from chamfering. Chamfering the holes pre-thread can take as much as 25% off of the forces seen by the tap as it engages the hole and cuts the threads.

Whenever possible, we power tap in the same machine setup as the drilling. This ensures proper alignment of the spindle centerline with that of the hole. We also make use of our CNC mill to rigid tap because the CAM software we use generates the feeds that are perfect for any given tap we use. For example, we tap a lot of ¼-20 UNC holes in one of our legacy parts, an aluminum housing. To find the pitch, divide 1 by threads per inch, in this case 1/20. This tap advances 0.050" for every full revolution. We spin the tap at 500 rpm, so 500 rpm ÷ 20 threads per inch = 25" per minute infeed. This puts the perfect load on the tap to prevent excess torque or stretching of the tap. All modern CNC vertical machining centers have stable and strong rigid tapping cycles.

One final thing all shops must consider is the tapping fluid used. All of these other things I've mentioned are for naught if your tapping fluid isn't up to the task. Tap Magic is the standard "go to" for our shop. It is an all-purpose fluid that covers just about every metal that we cut here, from the easiest aluminum to the gummiest and toughest titanium. Everything in between, too. To give you an idea, we have tested Tap Magic against our typical cutting oil while cutting the same thread with each fluid. The Tap Magic reduced cutting forces considerably. It also resulted in the finest finishes on the threads, and it has easily boosted tap life by 50%. The same could be said for the flood coolant in a CNC. So long as your coolant concentrate is properly mixed, it should provide the lubricity necessary to prolong tap life.

Though tapping a hole may seem simple enough, neglecting any of the aspects I've covered here can lead to problems in short order. Guard against such complacency, even in a material that could be considered as easy to machine as aluminum. If you keep these pointers in mind — or easily accessible — you can help your shop tap into its potential for threading aluminum. CTE

about the author

Robert Layng is an engineering technician/machinist at Lafayette College in Easton, Pennsylvania. He specializes in prototyping and practical design. He can be reached at layngr@gmail.com.

Thank You! to our SPONSORS

Ad Index

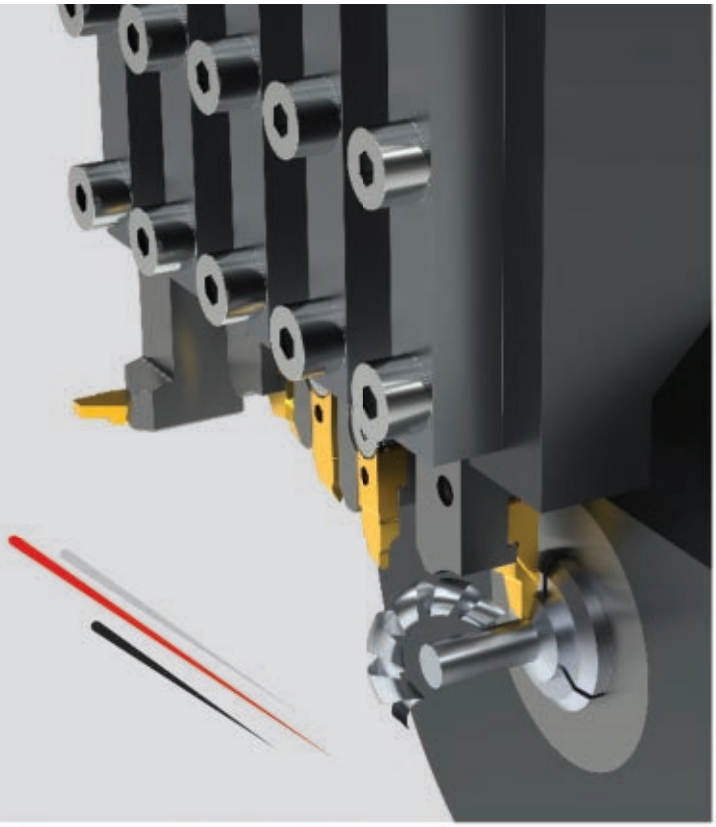
Reviewed by the Engineering Index. Cutting Tool Engineering® (ISSN:0011-4189) is published nine times a year in print and digital formats, Copyright 2025 by CTE Publications Inc., 121 S. Wilke Rd., Suite 200, Arlington Heights, IL 60005. All rights reserved. Periodicals postage paid at Winnetka, IL 60093 and additional mailing offices. Circulated in the U.S.A. to qualified individuals concerned with the material-cutting function in industry. For others, subscriptions are $94 per year in the U.S.A.; $160 in Canada. Other foreign subscriptions are $160 per year; overseas delivery via airmail, $248. Editorial and advertising offices: 121 S. Wilke Rd., Suite 200, Arlington Heights, IL 60005. Phone (847) 498-9100. This magazine is protected under U.S. and international copyright laws. Before reproducing anything from this publication, call the Copyright Clearance Center Inc. at (978) 750-8400. CTE Publications makes every effort to ensure that the processes described in Cutting Tool Engineering conform to sound machining practices. Neither the authors nor the publisher can be held responsible for injuries sustained while following procedures described herein. Postmaster: Send address changes to Cutting Tool Engineering, PO Box 2061, Cedar Rapids, IA 52401-2061.

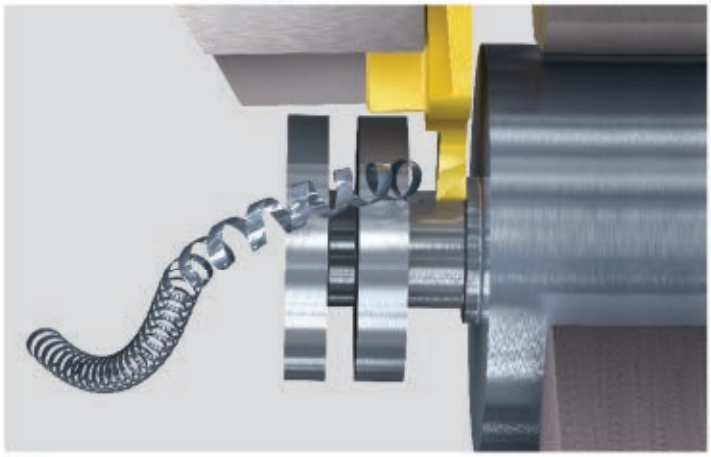
Produced in the U.S.A.

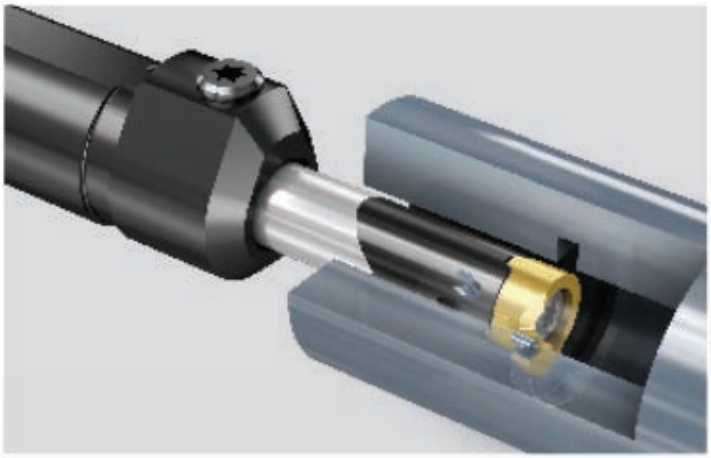
SIGNET RESEARCH INC.

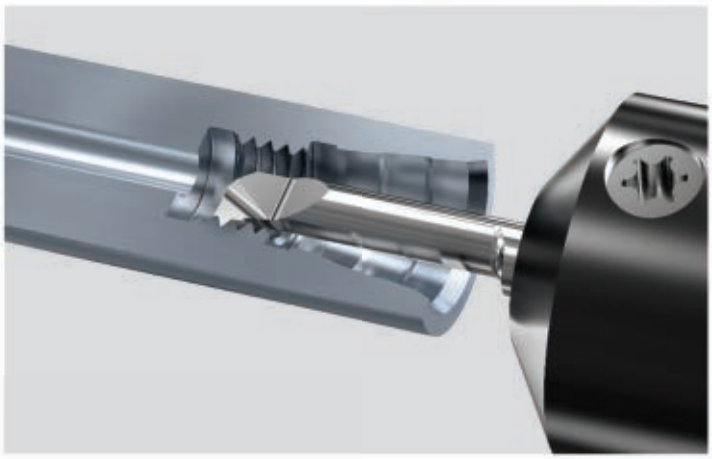
vargus
NEUMO Ehrenberg Group

MUCH MORE
THAN
THREADING!









vargus

VARGUS USA
1149 Barberry Drive
Janesville, Wi 53545

Tel: +608.756.4930
Fax: +608.741.7125

sales@vargususa.com
www.vargususa.com