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TWO-PROBE PITCH INSPECTION METHOD FOR LARGE GEARS

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Highlighting merits of the two-probe index inspection method for large gears with a cursory review of the Single-Probe pitch inspection methodology, breakdown of tooth index characteristics, and a cross-reference of the Single- and Two-Probe inspection methods.

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By GOTTFRIED KLEIN



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COMPANY PROFILE NORD Gear Corporation markets and produces a complete product line of mechanical and electrical drive components including quality gear reducers, electric motors, AC Vector drives, and distributed drive technology.

By KENNETH CARTER



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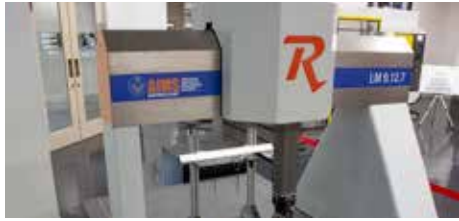
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AIMS adds SFP2 to 5-axis CMM to reduce part handling.



GF Machining Solutions unveils new laser series for mold makers.

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JAMES RICHARDS
President of James Engineering

COVER PHOTO: SHUTTERSTOCK

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FROM THE EDITOR



Taking a look at gear hobbing

As anyone associated with the gear industry can tell you: Gears are complex and often complicated necessities of almost any and all machines.

A lot of brain power goes into constantly improving both the design of gears as well as how those gears are perfected during the manufacturing process.

This month's issue of *Gear Solutions* shines a spotlight on two of those quintessential areas: shaping and hobbing.

Our cover article is an informative piece from Yefim Kotlyar and his colleague, Christoph Donner. In it, they highlight the merits of the two-probe index inspection method for large gears along with a review of the single-probe pitch inspection methodology and more.

And our friends at Gleason look at a new Chamfer Hobbing technique that adds a highly desirable process to the integrated hobbing and chamfering options now available.

This month's issue also offers plenty of material from our regular columnists, as well as an interesting Q&A with James Richards, president of James Engineering. He has a unique philosophy when it comes to his approach to his customers' challenges. It was a pleasure to talk with him about it.

You'll find that and much more in this month's issue. I hope you find it as educational as I did.

Enjoy the summer, and, as always, thanks for reading!

KENNETH CARTER, editor

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AIMS Metrology has equipped its Revolution Series LM coordinate measuring machine (CMM) with a Renishaw 5-axis REVO 2 head and the new SFP2 probe. (Courtesy: AIMS)

AIMS adds SFP2 to 5-axis CMM to reduce part handling

Until now, fabricators conducting surface finish measurements have had to use hand-held sensors or move a part to a dedicated measuring machine. To help companies reclaim lost production time, AIMS Metrology has equipped its Revolution Series LM coordinate measuring machine (CMM) with a Renishaw 5-axis REVO 2 head and the new SFP2 probe. Because the SFP2 is interchangeable with other probe options, it gives manufacturers the flexibility to inspect a diverse range of features on one CMM. The SFP2 automates surface finish measurement for reduced part handling and higher throughput.

“When an operator has to size a part on a CMM, then take it to a dedicated surface measurement unit, he or she is handling the

part multiple times, delaying the measurement cycle and introducing the potential for error,” said Mark Gearding, co-owner and vice-president for AIMS Metrology. “We’ve seen an uptick in sales for the LM with 5-axis inspection and the new capabilities of SFP2.”

The SFP2 surface finish system is managed by the same I++ DME compliant interface as the REVO system, and full user functionality is provided by Renishaw’s MODUS metrology software. The lab-grade LM is built with linear motors that work off of permanent magnets that don’t wear out. Electronic signals are sent to the motor, using the natural force of the magnet to generate a small magnetic field that interacts with the magnets. The result is precise positioning and reliability along with little to no maintenance. The LM has a granite work plate and aluminum mobile bridge for higher rigidity and lower inertia.

“Automotive suppliers in particular are opting to use a 5-axis LM integrated with

REVO 2 and the SFP2 probe,” Gearding said. “Parts for today’s vehicles are becoming increasingly complex, a trend that is making measurement cycles longer. The LM with REVO 2 and the SFP2 is able to reduce cycle time significantly and increase throughput. We engineered the LM to be used in the controlled environment of a laboratory, but we’re finding automotive customers who want to bring the LM onto the shop floor. We can do that by designing and constructing a protective enclosure around it. As a CMM OEM we don’t just build equipment, we partner with customers to meet their needs.”

AIMS was founded in 2009 to equip the industry with the tools to perform accurate, flexible, three-dimensional inspection for in-process and post-process parts. In addition to matching customer requirements with the right turnkey CMM system, AIMS provides installation, service/support and training. Machine retrofits and refurbished equipment are also available.

MORE INFO www.aimsmetrology.com

GF Machining Solutions unveils new laser series for mold makers

To serve the needs of today’s mold makers and manufacturers who demand the highest levels of productivity and design quality for surface texturing applications, GF Machining Solutions has introduced its new AgieCharmilles LASER S series. Unveiled for the first time in North America at a special event at its North American headquarters in Lincolnshire, Illinois, the new all-in-one machines offer a number of innovative technologies that result in advanced capabilities and outstanding speed – leading to cycle time reductions of 30 to 50 percent.

More than 50 customers specializing in texturing, engraving, and graining attended the event, during which GF Machining Solutions demonstrated the speed of the new



SEND US YOUR NEWS Companies wishing to submit materials for inclusion in Industry News should contact the editor, Kenneth Carter, at editor@gearsolutions.com. Releases accompanied by color images will be given first consideration.



GF Machining Solutions unveiled its new AgieCharmilles LASER S series for the first time in North America. (Courtesy: GF Machining)

LASER S 1000 U by setting it up alongside a LASER P series machine. Both worked on a part featuring complex 3D shapes with an intricate hexagonal texture inspired by nature and designed to demonstrate how the machine overcomes common challenges among mold makers and other shops requiring precise textures.

The event also included a look at the company's "Championship" workpiece, a hyperbolic paraboloid resembling a bird preparing to take flight from a prismatic perch. Each surface of the workpiece demonstrated another capability of the LASER S machines, from the creation of highly precise geometric patterns to quick engraving and surface finishing – part features all made possible by the series' advanced capabilities.

A part of the digital transformation currently underway in manufacturing, the AgieCharmilles LASER S series, which includes the LASER S 1000 U and LASER S 1200 U, provides a fully digital solution to the limitations of conventional and manual surface texturing methods that reduces quality deviations without additional machining processes. The new machines make difficult-to-realize designs easy to generate, allowing for greater creative freedom and faster time to market, especially in industries such as automotive, information and communications technology (ICT), medical and packaging.

As optional replacements for the standard 50 and 100-watt lasers, LASER S series machines may be instead equipped with 30 and 50-watt FlexiPulse sources. The FlexiPulse solution gives engineers the opportunity to shorten or lengthen the laser pulse duration, which allows them to adjust the laser instability time depending on the application and material used to find the

ideal quality-to-speed ratio.

The LASER S series' higher material removal rate is further improved with far faster scanning. Its new excelliSHIFT system features a 600 mm/sec mechanical travel and 30,000 mm/sec optical travel at the 254 focal length for even further reductions in required machine movement. The new system enables true 3D scans for optimal productivity.

The innovations continue beyond the hardware level. Smartpatch, a software module included in the GF Laser Workstation Software package, analyzes jobs to generate the optimal patching strategy to help users obtain the highest quality in the shortest amount of time possible. As a result, the latest grain geometries and complex patterns can easily be created without the errors common with suboptimal patching strategies.

MORE INFO www.gfms.com

Achieve faster times with Hexagon's GLOBAL S HTA solution

Hexagon's Manufacturing Intelligence division announced the availability of the latest version of the GLOBAL S HTA (high throughput and accuracy) solution for the aerospace industry, which brings major enhancements to Hexagon's high-speed, non-contact compressor blade measurement system. It builds on the performance strength of the GLOBAL S HTA's predecessor, which delivered a cycle time that was between two and five times faster than traditional tactile measurement. New software upgrades now mean the GLOBAL S HTA further reduces measurement cycle time by up to 30 percent on average. Software improvements include easy, three-step aerofoil measurement routine creation and eliminating processing wait times during measurement execution for faster measurement cycle times.

The GLOBAL S HTA solution delivers high-density measurement data for enhanced aerofoil geometry analysis by using Hexagon's HP-O non-contact scanning technology. Its advanced HP-O Multi optical scanning probe technology deploys frequency-modulated laser interferometry technology to provide rapid non-contact scanning with sub-micron repeatability to verify the most challenging blade characteristics including knife edge, leading, and trailing edges (LE/TE), 3D aerofoil geometries, platform, root, and shroud features.

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GLOBAL S HTA optical scanning system further streamlines the creation and execution of measurement routines. (Courtesy: Hexagon MI)

pressure to increase throughput while maintaining high levels of measurement accuracy,” said Ken Frescoln, business development manager, Aero Engine, North America. “With new and improved enhancements, GLOBAL S HTA is the only dedicated compressor blade solution on the market to offer such a significant reduction in measurement cycle time, providing a new level of throughput to meet customer demand. Another bonus is its intuitive user interface, designed to help quality engineers quickly access and analyze the data they need to improve processes and operate more efficiently.”

The GLOBAL S HTA is available worldwide. More information is available from local Hexagon representatives and dealers.

MORE INFO www.hexagonmi.com

Weiler Abrasives kicks off 75th anniversary celebration

Weiler Abrasives, a leading provider of abrasives, power brushes and maintenance prod-

ucts for surface conditioning kicked off what will be a months-long celebration of its 75th anniversary with its National Sales Meeting the week of April 22. The celebration is geared toward its customers, coworkers and community to thank them for contributing to the growth and longevity of the company — once a small jewelry polishing brush business and today a global abrasives leader.

Founded by Karl E. Weiler in 1944 as the Weiler Brush Company in Long Island — with only fifty dollars and a big dream — the company continues to be privately-owned and operated at its current headquarters in Cresco, Pa. under the fourth-generation leadership of Chris Weiler, CEO. Chris’ father, Karl M. Weiler serves as chairman.

The company now has 1300 employees across eight different countries and still stands by its key values: integrity, customer focus, accountability, learning and competence, and passion.

Weiler Abrasives’ commitment to manufacturing excellence ensures the delivery of high-performance, quality products and innovative solutions. At the foundation of its success is a commitment to collaborating with its customers and fostering mutual



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"We are proud of the growth Weiler Abrasives has undergone in its 75 years in business and the innovation it brings to the marketplace," said Chris Weiler, CEO of Weiler Abrasives. (Courtesy: Weiler Abrasives)

growth. The company has made a top priority of developing long-term partnerships, while also addressing customers' toughest cleaning, grinding, cutting, deburring, and finishing challenges. In fact, after 75 years, Weiler Abrasives still does business with its very first customer.

"We are proud of the growth Weiler Abrasives has undergone in its 75 years in business and the innovation it brings to the marketplace," said Chris Weiler, CEO of Weiler Abrasives. "The hard work of our employees, our customers' loyalty, and the support of our community have been the backbone of our success."

To acknowledge the role its customers have had over the course of its business, Weiler Abrasives will be offering a variety of promotions in the coming months. It will also host employee activities, including a family Fall Harvest celebration in October at its headquarters, which will close out the anniversary celebration.

As an industry leader and global manufacturer of surface conditioning solutions, Weiler Abrasives Group is dedicated to forging collaborative relationships with our customers in diverse markets — metal fabrication, industrial production and maintenance, repair and operations — to tackle their toughest cleaning, grinding, cutting, deburring, and finishing challenges.

MORE INFO www.weilerabrasives.com

Kyocera to acquire tool distributor SouthernCarlson Inc.

Kyocera Corporation announced that it has concluded an agreement to acquire 100 percent ownership of SouthernCarlson, Inc., a U.S. distributor of tools, fasteners, packaging, and facility supplies, headquartered in Omaha, Nebraska. Under the agreement, SouthernCarlson will operate as a U.S.-based subsidiary of Kyocera Corporation.

SouthernCarlson, established in 1947, serves a broad array of end markets from more than 150 branches across North America. It is a leading distributor of the most recognized and highest-quality brands of construction fasteners, tools, packaging, facility supplies, and tool repair services.

Kyocera entered the industrial tools market in the 1970s with a line of high-speed metal processing tools, and has steadily expanded into precision tools for automotive, aerospace, energy, medical, and wood-working applications. With the acquisition of SouthernCarlson, Kyocera will serve a wider range of customers across the North American residential, manufacturing and industrial professional tool and fastener markets.

MORE INFO www.global.kyocera.com

KISSsoft extends materials database in latest release

More than 55 plastics are available for the gear design of KISSsoft. The material database of KISSsoft has been extended by additional plastics for the upcoming release 2019: Six additional gear materials from the LEHVOSS Group are now available.

Wear and static strength calculations can currently be carried out with the materials. In the course of further cooperation, the measurement of fatigue strength values will be carried out in order to be able to perform the load-bearing capacity calculation according to VDI 2736 in the future. The material data are high-performance compounds based on PA 66, PA 46, PPS and PEEK, which are reinforced by carbon and glass fibers.

The collaboration between LEHVOSS Group and KISSsoft AG will be further expanded in the future.

MORE INFO www.kisssoft.com

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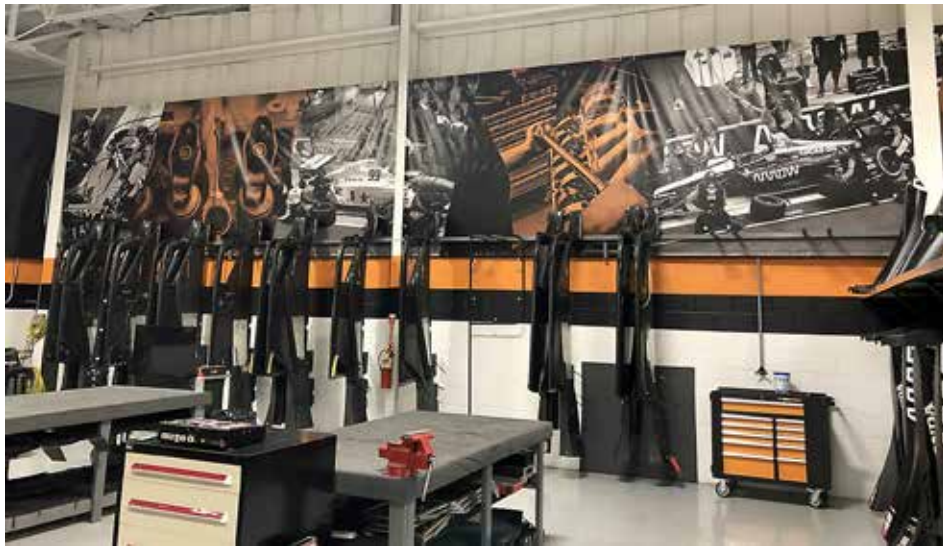
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Apex brands, including Gearwrench (hand tools and storage), Cleco (power tools), and Weller (soldering equipment), make up the bulk of the sponsorship. (Courtesy: Apex Tool Group)

Gearwrench[®], Cleco[®], and Weller[®] bulk up Arrow SPM garage

What do you get when forward-thinking tool makers work directly with world-class tool users? You get better. Better insights. Better tools. Better performance.

That's the basis for the growing partnership between Apex Tool Group and Arrow Schmidt Peterson Motorsports. After getting started a year ago, the partnership has grown substantially, thanks to the willingness of both sides to work together toward a common goal of doing everything better.

If 2018 was a toe in the water for the relationship between Apex Tool Group and Arrow Schmidt Peterson Motorsports (Arrow SPM), 2019 is officially a cannonball. Apex Tool Group (ATG), one of the world's largest manufacturers of professional hand and power tools, is making a splash as Arrow SPM's official tool partner.

Apex brands, including Gearwrench (hand tools and storage), Cleco (power tools), and Weller (soldering equipment), make up the bulk of the sponsorship, filling out the Indianapolis-based NTT IndyCar Series team's garages with tools and tool storage options that far exceed the initial investment just a year ago. Product development and content creation are two other areas that will see dramatic growth from the previous season.

"We couldn't have picked a finer partner," said Jim Roberts, CEO of Apex Tool Group. "We realized quickly that our two organizations share a set of values that center around celebrating the whole team. It's as much

about the guys turning the wrench as it is about the guys turning the wheel, and we're proud to help shine the spotlight on them through this partnership. It's about putting the best tools in the hands of the best mechanics the racing industry has to offer."

The partnership includes two of the four IndyCar drivers on the Arrow Schmidt Peterson Motorsports team — James Hinchcliffe and Marcus Ericsson — along with their more than 50 crew members. That team of skilled mechanics and engineers will use Apex-supplied tools every day to get the most out of their cars. The impact will be on display with Gearwrench branding taking over the space in the team's garage in Gasoline Alley at Indianapolis Motor Speedway leading up to the 103rd Running of the Indianapolis 500.

The collaboration also creates a testing ground for advanced tool development. Arrow SPM mechanics and engineers will get to test-drive new concepts and tool prototypes from ATG designers, provide real-time feedback, and impact future products. The result is better tools for better performance.

MORE INFO www.apextoolgroup.com

Digital Metrology marks 20 years of metrology successes

Digital Metrology Solutions, provider of measurement software, consulting, and training, marked its 20th year of service in May, 2019. Founded in 1999 by Dr. Mark Malburg, the

company has aided hundreds of companies to solve product and process development issues by developing and applying advanced metrology technologies.

"We realized early on people don't want to measure... they want to understand. It isn't the measurement that matters, it's what you are able to do with the data," said Malburg. "We have made it our mission to provide tools to help users communicate and effectively use measurement data for understanding and improving component performance."

Digital Metrology was originally formed to develop software for custom metrology applications, such as measuring unusual profile geometries and/or features of interest. In recent years, Digital Metrology has collaborated with instrument manufacturers around the world to develop measuring systems and to embed software in custom and off-the-shelf metrology systems.

The success of its earlier custom work eventually led to several widely successful, general-purpose software packages, including OmniSurf for two-dimensional surface profile analysis, OmniRound for roundness and harmonic analysis and, more recently, OmniSurf3D for three-dimensional surface texture analysis.

Today, Digital Metrology continues to help people explore measurement data, to develop new metrology analysis tools, and to forge collaborations with metrology instrument companies. "We are proud to be able to say that Digital Metrology is at the core of many modern measurement systems in surface and form metrology," said Malburg.

MORE INFO www.digitalmetrology.com

Hexagon's MI division breaks ground on Center of Excellence

Hexagon's Manufacturing Intelligence division has broken ground on the construction of a new expansion project on a 5-acre site in Novi, Michigan. Slated for completion in the fall of 2019, the 88,000 sq. ft. building will house a technology showroom, a technical training center, and a 15,000-square-foot laboratory and calibration hub. The two-story office area will have glass walls and windows presenting an exceptional view of the nearly 11,000-square-foot Hexagon showroom and demonstration area from both levels.

Expanding Hexagon's presence in the Midwest, the Center of Excellence will serve



State-of-the-art facility built with Hexagon technology, Hexagon style. (Rendering courtesy: Hexagon Manufacturing Intelligence and Faudie Architecture)

as a cornerstone to support advanced manufacturing in the region. Hexagon will consolidate all its Manufacturing Intelligence businesses in the greater Detroit area into a central location, which includes MSC Software, Production Software (formerly Vero Software), Q-DAS and its metrology solutions portfolio. Employees from the AutonomouStuff and Safety Critical brands of Hexagon's Positioning Intelligence division will also work from the new site.

The two-story property will meet or exceed all aspects of the current Michigan Uniform Energy code. The building design will incorporate lighting controls and sen-

sors to reduce energy consumption and take advantage of exterior daylight to supplement office area lighting. Focused on the employee experience, the floor plan features open common office spaces and separate huddle areas to encourage collaboration and innovation. All interior spaces will be outfitted with modern furniture designed for the various ways employees work, whether on their own, in teams or informal collaborations. Other employee amenities include a fitness gym, coffee bars, lounges, and a modern break room designed for multi-purpose functions including meetings, events, and every-day meals and refreshment breaks. A high-tech solutions provider, Hexagon is focused on providing an environment that empowers teamwork, problem solving, and a high level of productivity among formerly separate areas of the business. The new center will be finely appointed in the Hexagon style with its modern color scheme and other company design elements.

"This is an exciting project for us, as we will utilize our vast wealth of Hexagon technologies during the build process — from total stations for surveying to digital construction. Ultimately, this state-of-the-art

facility reflects the next phase in Hexagon's own data-driven evolution across industries to shape smart change," said Angus Taylor, president and CEO of Hexagon Manufacturing Intelligence North America. "Our investment in this Center of Excellence allows us to consolidate our technology teams and put them into a 21st Century workspace that will serve both customers and employees with the highest quality services and workplace environment."

MORE INFO www.hexagonmi.com

GF Machining Solutions to debut four products at 2019 Solutions Days

GF Machining Solutions will unveil four new products for the first time in North America at its 2019 GF Solutions Days: the AgieCharmilles CUT C 350; the Microlution ML-10 and MLTC; and the DMP Flex 350.

The two-day event will occur at two locations. On June 27, the company's U.S. headquarters in Lincolnshire, Illinois, will feature

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Microolution's new ML-10 further improves upon the industry's leading laser micromachining platform, the exceptional ML-5. (Courtesy: GF Machining Solutions)

machine demonstrations, presentations and seminars. The event moves to GF Machining Solutions' newly expanded Microolution production facility in Chicago, Illinois, on June 28 for a ribbon-cutting ceremony, facility tour, and technical discussions.

The new AgieCharmilles CUT C 350 offers GF Machining Solutions' quality for the lowest operating costs. With a \$99,000 starting price point, the machine is not only cost-effective, but also provides optimized cutting speed and reliable accuracy, while the equipped AC CUT HMI 2 system makes for easy programming through efficient EDM expert modules.

Created in collaboration with 3D Systems, the DMP Flex 350 builds upon the success of the DMP Factory 500, which GF Machining Solutions introduced to U.S. audiences at IMTS 2018. Featuring a 10.82" x 10.82" x 14.96" working area, as well as 3D Systems' powerful additive manufacturing (AM) software, 3DXpert, the DMP Flex 350 is made to handle R&D projects and high-volume production alike. GF Machining Solutions will also give a sneak peek of the upcoming AgieCharmilles CUT AM 500 machine for the removal of build plates for additive manufacturing.

Microolution's new ML-10 further improves upon the industry's leading laser micromachining platform, the exceptional ML-5. The perfect femtosecond solution for industries ranging from automotive to medical, the ML-10 extends GF Machining Solutions' range to ensure all manufacturers have the machines they need to succeed. For tube-cutting applications, the company will also be introducing its MLTC model, an ultra-fast laser that provides medical-industry

manufacturers with exceptionally precise hole-making in metal and polymer tubes.

In addition to highlighting the company's new machines, Solutions Days will include a trip to the ribbon-cutting ceremony at the Microolution facility. Along with the introduction of new products – and lunch in the new showroom – participants will have the chance to receive tours of the facility; see demonstrations of Microolution's ML-5, ML-10, MLDS and MLTC; and hear how other Microolution customers have deployed the technology successfully.

The event will offer numerous presentations by GF Machining Solutions experts, including seminars on milling, additive manufacturing and 3DXpert, wire/consumables, System 3R automation, laser micromachining, and laser texturing.

New machines at the event will be accompanied by others from GF Machining Solutions, including the Mikron HSM 200 U LP, MILL P 500 U and MILL P 900; the AgieCharmilles FORM P 350 with System 3R Transformer, DRILL 20 and CUT P 550; and the AgieCharmilles LASER P 400 U fs, LASER S 1000, Microolution ML-5 and MLDS.

MORE INFO www.gfms.com

Exact Metrology participates in career fairs at universities

Exact Metrology was present at two career events, one at Northern Kentucky University and the other at Cincinnati State University.

Northern Kentucky University held its 2019 Career Expo in February. There were 140 employers meeting with students and alumni for internships, co-ops, and full-time positions. Employers present were from fields such as accounting/finance, athletic training and exercise science, math/science/EGT, business, computer science, and more.

Cincinnati State University also held its Career/Co-Op job fair in February 28. Approximately 40 companies and organizations participated.

Both events were attended by Matt Martin, the company's branch manager and an application engineer at Exact Metrology. At these two events, Exact Metrology featured the Artec Eva 3D handheld scanner, from Artec 3D, a world-renowned developer and manufacturer of professional 3D scanners and software. Artec Eva is a handheld scanner ideal for quick, textured, and accurate scans. Artec Eva doesn't require markers or calibration and the scanner captures 16 frames per second. These frames are automatically aligned in real time, making scanning easy and fast. The aim was to foster relationships with these universities, recruit interested students and offer additional tools and information about the company.

Exact Metrology, with facilities in Cincinnati and Milwaukee and affiliated offices throughout the Midwest, is a comprehensive metrology services provider, offering customers 3D scanning, reverse engineering, quality inspection, product development, and 2D drawings. The company also provides turnkey metrology solu-



Exact Metrology's application engineer demonstrates Artec Eva 3D. (Courtesy: Exact Metrology)

tions, including equipment sales and lease/rental arrangements.

Artec 3D is an international company, headquartered in Luxembourg, with subsidiaries in the United States (Santa Clara, California) and Russia (Moscow). Artec develops and produces innovative 3D solutions and products. Artec has a team of professional experts in the collection and processing of 3D surfaces as well as biometric facial recognition. Artec's products and services can be used in many industries, such as engineering, medicine, media and design, entertainment, fashion, historic preservation, security technology, and more.

MORE INFO www.exactmetrology.com

Find the right chain at Timken's new driveschain.com

The Timken Company, a world leader in engineered bearings and power transmission products, has launched driveschain.com to

make specification fast, easy, and accurate for customers who want to spend less time looking for the right chain.

Drives® Chain by Timken including precision roller, attachment, agricultural, and engineered-class chain is designed to excel in the most demanding applications and environments and can be custom manufactured to meet specific needs. To assist customers in selecting chain, Drives launched its new website where visitors can explore a range of complete product offerings, learn more about product performance in varied markets, and access vast technical resources and engineering tools, including:

- ▶ An Attachment Chain Configurator that allows users to build their chain, visualize the new assembly, submit a request for a quote to Drives, and generate 2D and 3D CAD models.

- ▶ A Master Catalog, among other handy materials, for sourcing from one of the most comprehensive chain offerings available.

- ▶ Brochures, literature, and technical documents that will give visitors the detailed specs they need to make an informed purchasing decision.

In addition, driveschain.com can put

customers in touch with their nearest Drives distributor or link them to PT Place, where registered users can purchase products directly. The new website gives visitors the ability to search for chain solutions by industry if they prefer, from food and beverage, forestry, paper and mining, to agriculture, metal processing, and more.

MORE INFO www.timken.com
www.driveschain.com

Romax Technology partners with Advanced Mobility Products Inc.

Romax Technology Limited is proud to partner with Advanced Mobility Products Inc. (AMP), a Canadian owned and operated consulting firm dedicated to sustainable electrification and engineering solutions, to be a sole reseller for Romax's software and services solutions in Canada.

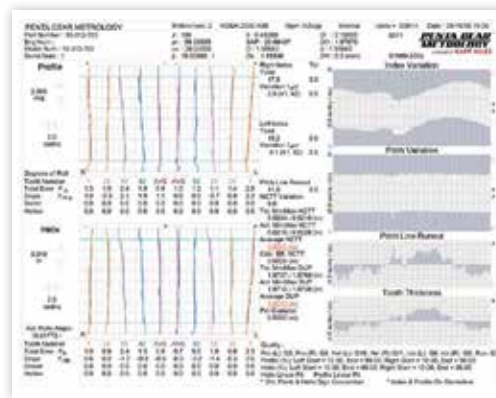
The newly formed partnership is founded on matching philosophies about the development of highly efficient pow-

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ertrains, rotating machinery, and electrified propulsion. AMP is very excited to bring the suite of Romax software on board, especially at a time when efficiency, sound quality and power density are so important to the development of world-class electrified powertrains. The Romax software suite provides an exceptional degree of flexibility coupled with analytical fidelity and the exciting launch of the new R19 software suite will further enhance its position as the global leader in drive sys-

tem simulation.

The strategic partnership will allow customers to access Romax solutions across various industries in Canada. Key sectors that will be particularly attracted to the solutions include automotive, mining, aerospace, academia, government, and infrastructure. In addition, AMP will be supporting the Americas region with application engineering.

MORE INFO www.romaxtech.com


Jorgensen Conveyors taps Whittemore as Midwestern rep

Jorgensen Conveyors, Inc. announced the addition of The Whittemore Co. as its new manufacturers' representative for nine Midwestern states including Illinois, Iowa, Nebraska, Kansas, Missouri, Minnesota, South Dakota, North Dakota, and Indiana.

The Whittemore Co. employs a non-competing, limited, complementary, and most importantly, application-based product line philosophy, which enables them to focus on specific market segments, adding value through technical application expertise for metalworking industries.

Dave Zaval, the president of The Whittemore Co., said, "Jorgensen Conveyors is an exciting partner for Whittemore. As a US-based manufacturer, they have a long and prestigious history manufacturing standard and custom-engineered conveyors and filtration systems. We believe these attributes are in line with our commitment to bring only the highest quality products and services to our metalworking industrial customers. The fact that they are a family-owned business is a huge bonus for our customers because it means we, as their representative, have a direct connection with management and can respond quickly to issues in the field."

Greg Anzia, national sales manager for Jorgensen Conveyors, Inc. said, "This partnership is very exciting for both of our organizations. The Whittemore Co. has been in business for over 100 years and has deep knowledge and expertise in the metalworking industry. The partnership aligns with Jorgensen's core strategy on many fronts and can help our customers make informed decisions for their toughest chip processing applications."

Since 1950, Jorgensen Conveyors, Inc. has been a manufacturer of custom engineered conveyors, coolant filtration and material handling equipment for the metalworking industries. Customers are OEM machine tool manufacturers and dealers, a broad range of manufacturing companies, and waste management recyclers. Jorgensen is owned and operated by the third-generation descendants of the founders. Jorgensen's headquarters is a state-of-the-art 100,000-square-foot manufacturing and office facility located in Mequon, Wisconsin. 

MORE INFO www.jorgensenconveyors.com
www.whittemore-inc.com

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American Gear Manufacturers Association



Casandra Blassingame
AGMA Vice President,
Education Services

AGMA and Chicago college partner to help build the industry's future

In April, the American Gear Manufacturers Association and Richard J. Daley College, one of the seven City Colleges of Chicago, entered an agreement to establish The AGMA National Training Center. This is an incredible venture for the gear-manufacturing industry. It is critical, now more than ever, that industry and education partner to create environments and/or curricula that teach industry standards' education and training content.

The Richard J. Daley College campus has just built a 52,000-square-foot building known as the Manufacturing Technology and Engineering Center (MTEC). This facility prepares students for the anticipated jobs coming to the region during the next decade. What better partner could AGMA have to build up the gear-manufacturing workforce? This phenomenal institution is on the forefront of job training so students can learn the skills they need to launch careers in a growing field. AGMA has been in partnership with the Daley Campus since 1993. The "Basic Training for Gear Manufacturing" course has been held there twice a year, training more than 1,000 learners over the years. It was time to take the partnership to the next level.

With more than 20 years of experience in continuing education and workforce development, I can share first-hand how rewarding it was to work with a community college and to witness the students' passion for learning a new job skill or professional development. This is also where I learned how imperative it is for industry to inform education on current and future trends and best practices. Workforce development starts with education, and it often starts with continuing education and the needs of the community. Community colleges offer the ability to develop relationships within the surrounding communities and industries to prepare and assist people in having life-changing and career-enhancing experiences.

The Richard J. Daley College campus practices these same principles – continuing education (both personal and professional), adult education, and dual enrollment programs – through their Reinvention Initiative. The primary purpose was to build programming and partnerships in a way that ensured students were prepared to further their education and have the skills for jobs in the 21st century. The college has done a remarkable job in homing in on what's important: connecting with industry to inform their program offerings and make them relevant and attractive to the workforce of the future. Partnerships with FANUC, Snap-on, Amada America, Inc., and Haas Automation – just to name a few – have added significant value to learning experiences for their students.

The collaboration between AGMA and Daley College is a game-changing move for our association. We have aligned ourselves with an institution that values partnership, industry standards, and



The Richard J. Daley College campus has just built a 52,000-square-foot building known as the Manufacturing Technology and Engineering Center (MTEC).

investing in the workforce of the future. At AGMA and within our education department, our strategy has been to develop courses that encompass the application and design process at the engineering level. And now, we are creating operator-level courses that educate and train machinists and operators along with providing supply-chain management courses to help develop the business services of our industry.

To my knowledge, an association partnering with an institution of higher learning to establish such a collaboration is not common. This is the kind of innovation, creative, and re-invention necessary to keep our industry in the forefront.

So, what does this mean for us? The AGMA National Training Center provides us with a platform to provide our membership with a location that is centrally located to house our operator-level courses, most engineering courses, a meeting space for committees, an opportunity for expanded partnership through joint curriculum development efforts, equipment acquisition, and an opportunity to attract the next generation of the gear-industry workforce.

Have questions? Contact Casandra Blassingame at blassingame@agma.org.

AGMA Welcomes New Board Members

The American Gear Manufacturers Association (AGMA) announced the election of John Cross, president of ASI Drives as the new AGMA Chairman of the Board, at the AGMA Annual Meeting April 11-13 in Scottsdale, Arizona.

Other changes to the board include a new treasurer and Business Management Executive Committee (BMEC) chairman.

The new AGMA Executive Committee is:

- ▶ John Cross, chairman; and president of ASI Drives
- ▶ Todd Praneis, TDEC chairman; and director of Product Development, Cotta Transmission

▶ Greg Schulte, treasurer; and president of Bonfiglioli USA

▶ Mike McKernin, BMEC chairman

▶ Jim Bregi, president; chairman emeritus, Doppler Gear Company

Additionally, AGMA welcomes four new members to its Board of Directors. These directors will serve a three-year term (2019-2021). The new board members were elected by AGMA corporate members in the first quarter of 2019 and announced during the AGMA Annual Meeting.

The newly elected board members are:

- ▶ Zen Cichon, president, Innovative Rack & Gear Company

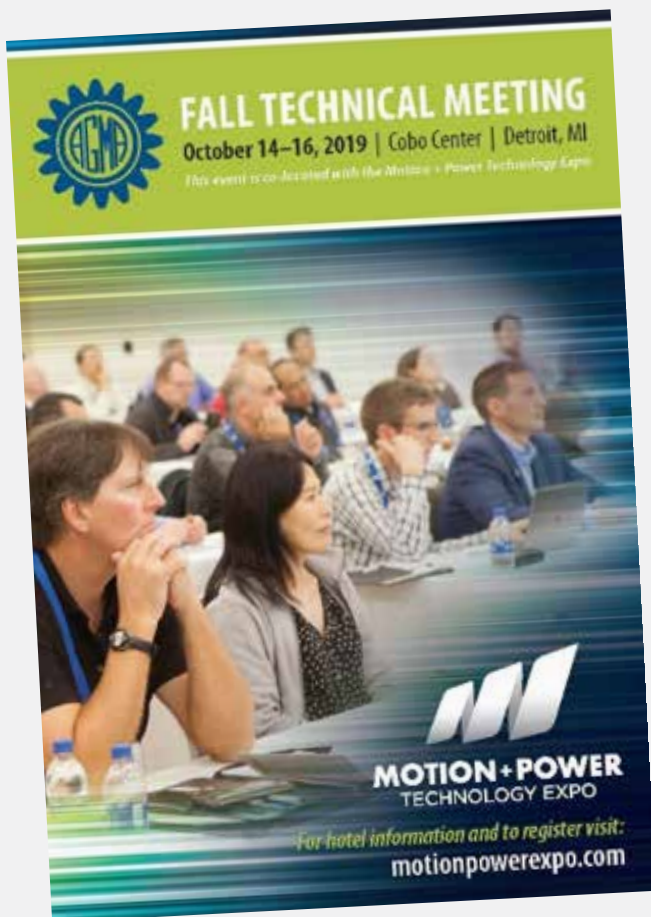


▶ Ruth Johnston, CEO and president, Croix Gear & Machining

▶ Jack Masseth, site manager — Howell, Meritor, Inc.

▶ Sara Zimmerman, vice president of Business Development, Sumitomo Drive Technologies

Fall Technical Meeting is Open for Registration



Take a deep dive into the gear industry at the Fall Technical Meeting. This meeting brings together top researchers from across the globe who will provide the latest information on their peer-reviewed gear-industry research. Be among the first to learn about new techniques for noise reduction, strain wave gear technology, clean steel, and more. Network with the researchers and engineers, ask your burning questions, and see what is in the future of this industry. Admission to the exhibit hall is included with your FTM registration.

FTM Sessions Include:

Session 1 — Application, Design, and Rating
Monday, October 14, 1-5 p.m.

Session 2 — Efficiency, Lubrication, Noise, and Vibration
Tuesday, October 15, 8 a.m.-noon

Session 3 — Materials and Heat Treatment
Tuesday, October 15, 1:30-5 p.m.

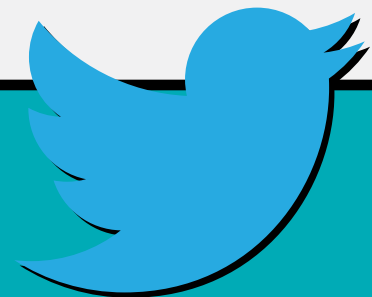
Session 4 — Manufacturing, Inspection, and Quality Control
Wednesday, October 16, 8 a.m.-noon

Session 5 — Optimization, Gear Wear and Failure
Wednesday, October 16, 1:30-5 p.m.

To register, visit: <https://motionpowerexpo.com/>



American
Gear Manufacturers
Association



AGMA Training

BEVEL GEAR SYSTEM DESIGN

JULY 10-12, 2019 | OAKLAWN, ILLINOIS

Learn how to design and apply bevel gears systems from the initial concept through manufacturing and quality control and on to assembly, installation, and maintenance. Engage in a practical hands-on guide to the bevel-gear design, manufacture, quality control, assembly, installation rating, lubrication, and most especially, application.

DETAILED GEAR DESIGN

AUGUST 20-22, 2019 | CLEARWATER BEACH, FLORIDA

Learn how to improve gear designs and gain new insight into concepts presented through illustrations and demonstrations. Explore all factors that go into good gear design from life cycle, load, torque, tooth, optimization, and evaluating consequences.

BASIC TRAINING FOR GEAR MANUFACTURING

SEPTEMBER 9-13, 2019 | CHICAGO, ILLINOIS

Learn the fundamentals of gear manufacturing in this hands-on course. Gain an understanding of gearing and nomenclature, principles of inspection, gear-manufacturing methods, and hobbing and shaping. Using manual machines, develop a deeper breadth of perspective and understanding of the process and physics of making a gear as well as the ability to apply this knowledge in working with CNC equipment commonly in use.

This course is at Daley College. A shuttle bus is available each day to transport students to and from the hotel.



Online Education

Don't have the ability to come to one of AGMA's fantastic face-to-face courses? We understand that you are busy and that is why we offer online education to meet your schedule. Now you can grow your gear knowledge, get the same quality AGMA education, and save money on travel by learning directly at your own computer.

AGMA's online education courses include:

- ▶ Gear Failure Analysis.
- ▶ Gearbox CSI: Gears Only.
- ▶ Detailed Gear Design—Beyond Simple Service Factors.
- ▶ Fundamentals of Gearing.
- ▶ Hobbing.
- ▶ Parallel Gear Inspection.



AGMA has over 1,000 Twitter followers! Join the conversation @agma

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CALENDAR OF EVENTS

Whether you're looking for technical education, networking opportunities, or a way for your voice to be heard in the standards process, AGMA has something to offer you. If you would like more information on any of the following events, visit www.agma.org or send an email to events@agma.org.

JUNE

- June 13 — Wormgearing Committee Meeting — [WebEx](#)
- June 19 — Helical Enclosed Drives High Speed Units Committee Meeting — [WebEx](#)
- June 20 — Helical Enclosed Drives Marine Units Committee — [WebEx](#)

JULY

- July 9 — Lubrication Committee Meeting — [WebEx](#)
- July 10 — Helical Enclosed Drives High Speed Units Committee Meeting — [WebEx](#)
- July 11 — Metallurgy and Materials Committee Meeting — [WebEx](#)
- July 16 — Cutting Tools Committee Meeting — [WebEx](#)
- July 16 — Aerospace Gearing Committee Meeting — [WebEx](#)
- July 17 — Gear Accuracy Committee Meeting — [WebEx](#)
- July 18 — Plastics Committee Meeting — [WebEx](#)
- July 24 — Vehicle Gearing Committee — [WebEx](#)
- July 25 — Helical Gear Rating Committee Meeting — [WebEx](#)
- July 26 — Fine-Pitch Gearing Committee Meeting — [WebEx](#)

AUGUST

- August 6 — Helical Gear Rating Committee Meeting — [WebEx](#)
- August 14 — Helical Enclosed Drives High Speed Units Committee Meeting — [WebEx](#)
- August 14–15 — TDEC — [Chicago, Illinois](#)
- August 22 — Lubrication Committee Meeting — [WebEx](#)



AGMA LEADERSHIP

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- John Cross:** Chairman
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- Greg Schulte:** Treasurer
Bonfiglioli USA
- Michael McKernin:** Chairman, BMEC
Circle Gear and Machine Company, Inc.
- Todd Praneis:** Chairman, TDEC
Cotta Transmission Company, LLC
- Jim Bregi:** Chairman Emeritus
Doppler Gear Company

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- Matt Croson:** President
- Amir Aboutaleb:** VP, Technical Division
- Jenny Blackford:** VP, Marketing
- Jill Johnson:** Director, Member Services
- Cassandra D. Blassingame, M.Ed.:** VP, Education Services

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- Zen Chichon:** Innovative Rack & Gear Company
- Michael Engesser:** Reishauer Corporation
- Bent Hervard:** CFT
- Ruth Johnston:** Croix Gear & Machining
- David R. Long:** Chalmers & Kubeck Inc.
- Jack Masseth:** Meritor, Inc.
- Scott Miller:** Caterpillar, Inc.
- Gary Neidig:** ITAMCO
- Shawn O'Brien:** Mclhnes Rolled Rings
- Cory Ooyen:** Global Gear & Machining, LLC
- Carl D. Rapp:** The Timken Company
- Sara Zimmerman:** Sumitomo Drive Technologies

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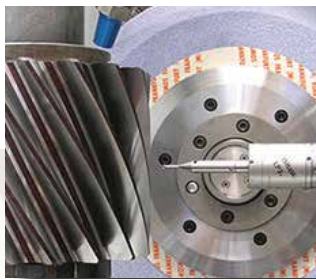
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I graduated; now I am an engineer!?!

Does an undergraduate engineering education make someone an engineer?

In my previous columns, I tried to connect real-world experiences with concepts of gearing in order to entertain and educate you, the reader. In this column, I wish to discuss the discipline of engineering in general.

Several years ago, I was interviewing candidates for an entry-level application engineer opportunity. This position would require the engineer to interact with clients via phone and email in order to assist them in determining the proper gearing mechanisms for their unique applications. It would blend the topics of statics, dynamics, strength of materials, machine design, thermodynamics, physics, and mathematics. It would also entail using CAD software to draft custom gear designs for production.

One candidate who I interviewed was a recent graduate of New York City College of Technology. She had earned a Bachelor of Technology in mechanical engineering technology; she had participated in several college clubs; she had worked several retail jobs, and she was looking for an entry-level opportunity. As the interview progressed, I noted that her retail jobs had given her the opportunity to learn how to engage with clients, her experience with the school clubs had expanded her practical knowledge of engineering concepts beyond the classroom, and her classwork in an ABET accredited program gave her the well-rounded education that would help her grow as an engineer.



Another candidate I interviewed was also a recent graduate, but he had just received his Bachelor of Science degree in mechanical engineering from the prestigious Columbia University Fu Foundation School of Engineering and Applied Science. He did not join any of the school clubs nor did he participate in any of the research projects at the engineering school. He did not have any prior work experience. During the interview, I inquired about the lack of work experience and his lack of participation in any extracurricular activities. The response was not what I had hoped for. His position was that he was a graduate of Columbia University and that trumped everything else. He also demanded a starting salary of \$85,000, as that is the value that he placed on his diploma.

Whether the degree is a BTech in mechanical engineering or a BSME, all students should make certain that their degree is accredited by the Accreditation Board for Engineering and Technology (ABET). This accreditation ensures that the educational standards are equivalent regardless of whether the student is attending a public college with an annual tuition of \$16,000 or an Ivy League university with an annual tuition of \$72,000.

Within the general populace, there is a misnomer regarding being

employed as an engineer and being a Professional Engineer. Any student with a basic understanding of physics, material science, and general mathematics can learn the concepts of engineering and work as an applications engineer. However, being a Professional Engineer (PE) is a licensed profession. Like being a doctor, a lawyer, or a teacher, being a Professional Engineer requires more than just a college degree. In order to qualify as a Professional Engineer, the student must first complete an ABET accredited engineering program and then pass the Fundamentals of Engineering (FE) exam. This exam, which is administered by the National Council of Examiners for Engineering and Surveying (NCEES), consists of 110 discipline-specific questions and has a passing rate of approximately 72 percent. If successful, the engineer is granted the distinction of being an Interim Engineer (IE).

After passing the FE exam and working under the guidance of a licensed PE for a minimum of four years, an IE has the opportunity, but not the obligation, to sit for the Professional Engineering (PE) exam. This is an 80-question, 8-hour, discipline-specific exam that has a passage rate of 70 percent for first-time test takers and 40 percent for repeat test takers. Once granted, the PE license is subject to a periodic renewal that requires the holder to maintain their engineering education through continuing education courses.

Engineering is a vast discipline that covers many topics. Because of this, an ABET accredited engineering degree program is focused on a broad stroke approach to engineering education. This exposes the future engineer to many concepts but makes them a master of none.

Gearing is a topic that is much broader and deeper than what is discussed in an engineering education. The typical ABET accredited mechanical engineering program requires a single semester course in machine design. During that 16-week term, there is usually a single lecture that details the basics of gearing. Maybe there is one question about gearing on that chapter's quiz. As such, it is up to us in the gearing industry to educate our newly minted engineers into the knowledgeable industry experts that we need them to be.

At the end of my interviewing process, I didn't hire either engineer. I didn't hire the city college candidate because she was already hired by another firm that saw the same potential in her that we did. I didn't hire the Columbia University engineer because he didn't understand that the value of his education wasn't the name on his diploma but the effort that he put into it. I did eventually hire a passionate, well-rounded recent graduate.

During my 25-year career, I have interviewed hundreds, hired dozens, and mentored many recent college graduates. Most of those who I have mentored have gone on to work at Fortune 100 firms, regardless of the school they graduated from, because an engineer is a person who designs, builds, or maintains mechanical solutions for real-world problems, while holding their employer's and the environment's best interests at heart. 🧠

ABOUT THE AUTHOR

Brian Dengel is general manager of KHK-USA, which is based in Mineola, New York. Go online to www.khkgears.us



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Back to basics: Austempering and its advantages

This isothermal process can achieve high toughness parts by producing a microstructure consisting of only bainite.

In the previous articles, we discussed the processes of quench and temp, and martempering. In quench and tempering, the part is heated to the austenite region until transformed, then quenched into quenchant at 100°C or less. The part is then tempered yielding a microstructure of tempered martensite. In martempering, the part is again heated to the austenite region, and then quenched into a bath at an elevated temperature near or above the martensite start temperature. The part is held at this temperature for a short period of time, and then is cooled to room temperature in any convenient manner. Martempering is only performed when distortion control is critical. In this article, a new process called austempering is introduced.

Austempering is an isothermal process to achieve a solely bainitic structure. This is accomplished by heating the part within the austenite range and then quenching the part into a bath of hot oil or molten salt held at a constant temperature of 260-400°C or 500-750°F (above the M_s temperature of the alloy). The part is then allowed to transform isothermally to achieve a bainitic structure, and allowed to cool in a convenient manner, usually in air. This process is illustrated in Figure 1.

The advantages offered by austempering include:

- ▶ Increased ductility or notch toughness.
- ▶ Reduced distortion.
- ▶ Shortened overall cycle time.

For true austempering, the part must be cooled so that the center and surface of the part miss the nose of the TTT curve.

The selection of a steel for austempering is primarily based on the TTT curve of the alloy. There are three important considerations for the application of a given steel for austempering:

- ▶ The location of the nose of the TTT curve and the time needed to bypass the nose;
- ▶ The time required to achieve complete transformation to bainite; and
- ▶ The temperature of the start of martensite transformation, M_s .

Carbon steels are generally unsuitable for austempering because the time to bypass the nose of the TTT curve is very short. Medium carbon alloy steels such as 5140 are well-suited to austempering because the nose of the TTT curve is sufficiently to the right, that it is possible to bypass the nose without forming pearlite. A completely bainitic structure is achieved within 1-10 minutes at 315-400°C.

The maximum section thickness is important in determining the slowest quench rate that will miss the nose of the TTT curve. Because of this limitation, very high hardenability steels are needed to achieve a fully bainitic microstructure in sections greater than 13 mm. When it is permissible to have some pearlite present in the microstructure, the allowable section thickness can be increased. Because of the section size limitation, the range of austempering applications is usually limited to parts fabricated from small diam-

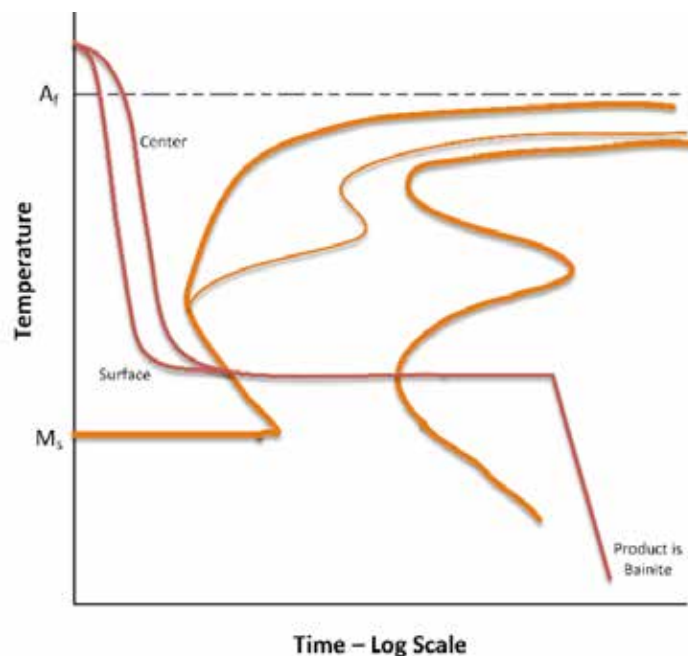


Figure 1: Typical schematic of the austempering process, where the final microstructure is bainitic.

eter bars, or strips with thin cross sections.

Austempering is to be substituted for regular quench and tempering operations to achieve improved toughness and ductility (Table 1), or to decrease cracking or distortion. In some applications, austempering is less expensive than quench and tempering due to the lack of tempering. Cycle time can also be decreased.

In general, molten salts of mixtures of sodium and potassium nitrite/nitrate are used exclusively for austempering. There are several reasons for this – the primary one is that it survives the elevated temperatures of austempering (260-400°C). Molten salt transfers heat rapidly by conduction. Molten salt has a high thermal mass, so heat transfer is very uniform across all the surfaces. In general, there is no vapor phase present, so agitation requirements are minimal. After austempering, the now solidified salt can be cleaned from the part using water, and the salt recovered for reuse.

The selection of a steel suitable for austempering is based primarily on the time to transformation of austenite to pearlite (the knee of the TTT curve); the Martensite Start Temperature, M_s ; and the time for transformation of austenite to bainite at the austempering temperature. In other words, it is necessary for the steel to have sufficient hardenability that the part can be quickly quenched and miss the nose of the TTT curve, and the part is held for a specific time indicated in the Time-Temperature-Transformation curve. The limitations of transformation indicate that to avoid the nose of the curve at the center of the part, high hardenability alloys are required, along with thin sections.

One other limitation of the use of steel alloy for austempering is

Specimen	Heat Treatment	Hardness, HRC	Impact Strength	
			J	Ft-Lb
1	Water Quenched and Tempered	53.0	16	12
2	Water Quenched and Tempered	52.5	19	14
3	Martempered and Tempered	53.0	38	28
4	Martempered and Tempered	52.8	33	24
5	Austempered	52.0	61	45

Table 1: Mechanical properties of 1095 steel processed by different methods [1].

Steel	Section Size		Salt Temperature		Ms Temperature		Hardness, HRC
	mm	in.	°C	°F	°C	°F	
1050	3	0.125	345	655	320	610	41-47
5140	3	0.125	345	655	330	630	43-48
5160	26	1.035	315	600	255	490	46.7
8750	3	0.125	315	600	285	545	47-48

Table 2: Section sizes and alloys used for austempering [1].

the time required to transform austenite to bainite. For some alloys, such as SAE 5140, this time is relatively short (10-15 minutes). In other alloys, the time for complete transformation is extremely long (24 hours+) making these alloys impractical for austempering. SAE 9260 is an example of very long bainite transformation times. For the most part, plain carbon steels that contain 0.50-1.00 percent carbon and 0.60 Mn minimum are suitable for austempering. Other alloy steels, such as the 41XX and 61XX with a carbon content greater than 0.4 percent C are suitable for austempering. Verification with your heat-treater or examination of the specific Time-Temperature-Transformation diagram will help de-termined suitability.

As indicated previously, the alloy hardenability, and the physical thicknesses are the primary limitations to ensure that complete transformation of austenite to bainite occurs. Table 2 illustrates some typical thicknesses and alloys used during austempering.

Austempering is usually used to improved mechanical properties – specifically toughness and ductility at high hardnesses. These parts are typically small and fabricated from bar, strip, or thin plate that require high toughness at a hardness of 40-50 HRC. A lawn mower blade is an excellent example of a part that is austempered. High hardness is required to hold a sharp edge, but the part must be very tough to prevent shattering when hitting a rock. Typical low alloy parts that are austempered include lawn mower blades, springs, and fasteners. Alloy steel parts that are austempered include socket wrenches, gears, and shafts.

One additional application of austempering is the austempering of ductile iron [2]. In this process, the ductile iron is austenitized, then rapidly quenched in salt to an intermediate temperature and

then held at temperature to allow the metastable carbon rich austenite matrix to transform to ferrite plus carbide. The part is then cooled to room temperature to maintain the metastable ferrite/carbide microstructure. One major difference between austempering steel and ductile iron is that, in ductile iron, the part is cooled before transformation of bainite occurs, as bainite in cast irons tends to decrease toughness.

The properties of austempered ductile iron can be manipulated by changing the austempering temperature. A higher temperature (375°C) results in a coarser structure that has excellent toughness and fatigue strength. A lower austempering temperature (260°C) produces a harder and wear-resistant structure.

CONCLUSION

In this short article, we introduced the concept of austempering to achieve high toughness parts by producing a microstructure consisting of only bainite. Some simple applications were illustrated, as well as an overview of the process for selecting steels for austempering applications.

Should you have any questions regarding this or any other article, please contact the author. ✉

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ISSUE
FOCUS

GEAR HOBBING



TWO-PROBE PITCH INSPECTION METHOD FOR LARGE GEARS

Highlighting merits of the two-probe index inspection method for large gears with a cursory review of the single-probe pitch inspection methodology, breakdown of tooth index characteristics, and a cross-reference of the single- and two-probe inspection methods.

By YEFIM KOTLYAR and CHRISTOPH DONNER

A gear's pitch (a k a index or spacing) accuracy is one of the most fundamental gear characteristics affecting its performance. Pitch errors affect the transmission accuracy, vibration, noise, and even the load carrying capacity. No wonder gear designers, manufacturers, and users pay close attention to pitch quality. Nowadays, there are many different pitch measuring technologies available to verify pitch accuracy: Specialized gear measuring centers, CMMs, optical gages, laser gages, and more. This article will provide a cursory review of pitch characteristics, overview of a single and a two-probe pitch measurement – the two distinct pitch inspection methodologies, and will discuss some beneficial aspects of the two-probe inspection method as applied to large diameter gears.

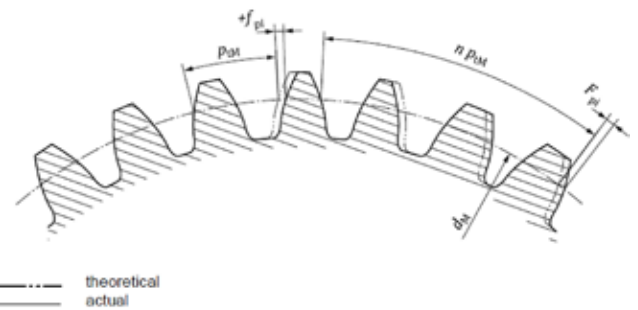
GEAR PITCH CHARACTERISTICS

Most, if not all, widely used standards, e.g. AGMA, ISO, DIN, etc. recognize and provide tolerance systems for at least three major pitch characteristics. The latest ANSI+AGMA+ISO+1328-1-B14 standard labels these three characteristics as: Cumulative Pitch Deviation F_p , Pitch Deviation (a k a Pitch Variation) f_p , and Adjacent Pitch Difference (a k a Spacing Variation) f_u . Other naming conventions for these three pitch characteristics were also accepted in different times and different countries. While labels for the three characteristics were different, the substance of these characteristics remained the same.

Pitch deviation, f_p , is the difference between the actual distance between two adjacent teeth and the ideal distance. The ideal circular distance between two teeth is the distance between adjacent teeth that are equally spaced around circumference and it equals the circumference of the measured diameter – typically as close as possible to the pitch diameter – divided by the number of teeth. It is depicted as p_{TM} on Figure 1. The pitch deviation for this particular adjacent tooth pair, f_{pi} also shown on Figure 1, indicates the difference between the actual

circular distance between the two adjacent teeth and the ideal distance. It has a positive sign because the actual distance is larger than the ideal (theoretical) distance.

The measurement is conducted for all gear teeth pairs and the maximum deviation is reported as maximum Pitch Deviation error. The top graph on Figure 2 depicts 18 measurements and individual values of pitch deviations between all adjacent tooth pairs. The



NOTE: $p_{TM} = \pi d_M / z$

Figure 1: Pitch deviation [1].

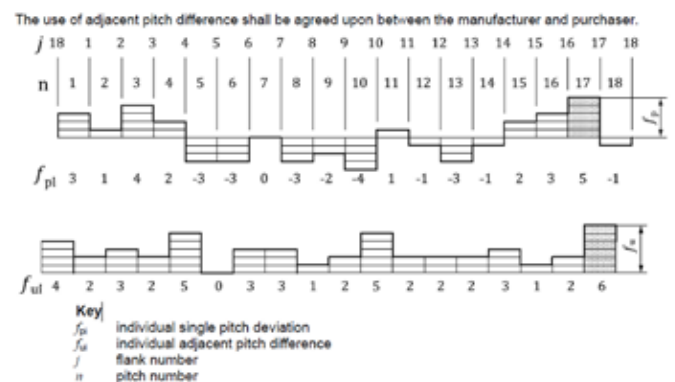


Figure 2: Pitch deviation graph [1].

maximum absolute value between flanks 16 and 17 would be reported as the maximum pitch deviation error located on pitch number 17.

Cumulative Pitch Deviation is plotted by algebraically adding individual pitch deviations as depicted in Figure 3. The difference between two extreme points of the graph is reported as the Total Cumulative Pitch Deviation error, F_p .

Adjacent Pitch Difference, f_u , (a k a spacing varia-

Some large gear manufacturers attempt to qualify their universal gear inspection machines by comparing Single Probe Pitch inspection results with the Two-Probe inspection results.

tion) is the difference between the actual adjacent pitches. It does not have an algebraic sign, as the absolute values of the differences are determined. Adjacent Pitch Difference is determined for every two adjacent pitches and the maximum absolute value is reported as max Adjacent Pitch Difference, see bottom graph of Figure 2.

PITCH INSPECTION METHODS

Gear pitch inspection has a long history. Mechanical pitch inspection devices preceded computerized universal gear inspection machines that are so familiar to us nowadays. While there are many different technologies available for measuring pitch errors, e.g. specialized gear measuring machines, CMM, optical gages, laser gages, and more, there are only two fundamental pitch inspection methodologies:

- ▶ Single-probe method.
- ▶ Two-probe method.

Most pitch inspection technologies available today, such as universal gear inspection machines, use the single probe method. While this method can provide an accurate and repeatable inspection for small and medium size gears, it has certain limitations when it comes to larger gears. In fact, for a given universal gear inspection machine, there is a linear relationship between the pitch inspection accuracy and the gear diameter.

The single-probe method, see Figure 4, relies on the rotary encoder's angular measurement that is converted to linear measurement at the gear pitch diameter. The inspection accuracy therefore depends on the encoder's diameter and resolution. These two features are constants for a given inspection system. In addition, however, the inspection accuracy depends on the size of the gear, specifically on the radial distance between the machine's rotary encoder and the gear's pitch diameter. The larger the gear, the farther the gear's pitch diameter is from the encoder, the less accurate is the measurement.

The single-probe pitch inspection process starts with setting the angular datum for all measurements. The probe is moved to the measuring diameter, typically the pitch diameter. After that the gear is rotated until the probe reaches the optimum deflection for its zero reading. The zero probe reading signals the system to record the angular reading of the rotary encoder. The rotary encoder reading for the first tooth is set as the datum reference for all subsequent measurements. The actual encoder readings are compared with the expected angles (determined as the first tooth datum angle plus ideal angular advance to the corresponding tooth). The angular difference between the encoder reading and the expected angle converted to the linear displacement yields the Cumulative Pitch error for each respective tooth.

$$F_{pi} = dA * R_m$$

Where:

F_{pi} : Cumulative pitch error for the respective tooth i .

dA : Difference between the rotary encoder reading and the expected angle, radians.

R_m : Gear radius where probe contacts the gear surface, typically close to the pitch radius.

Whatever measuring inaccuracy dA contains, it is always magni-

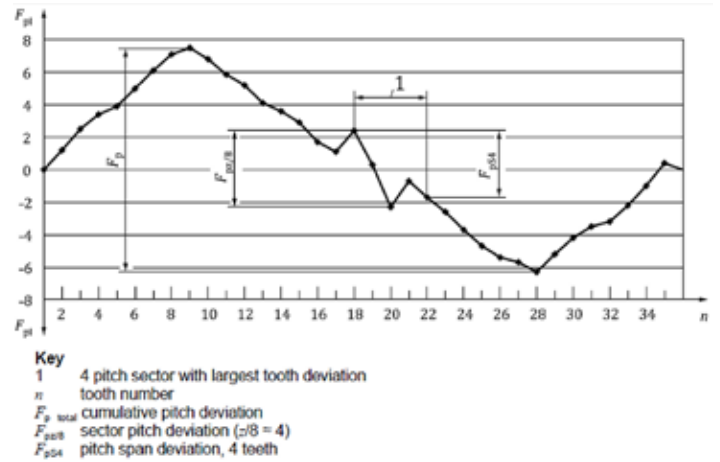


Figure 3: Cumulative pitch deviation [1].

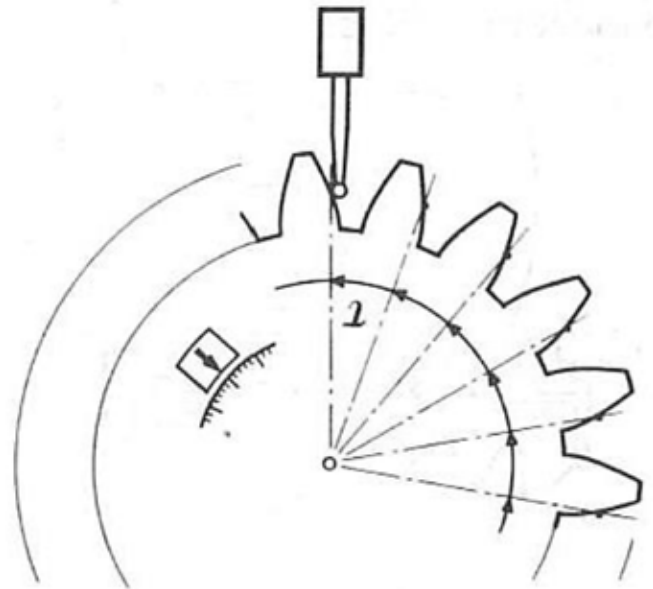


Figure 4: Single probe pitch measurement [3].

Circular Error for 1 Second Encoder Resolution

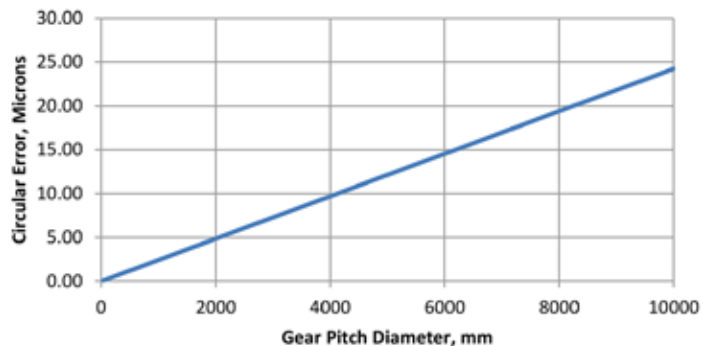


Figure 5: Relationship of gear diameter and measuring inaccuracy.

fied by the gear's pitch radius. The resulting inaccuracy of F_{pi} measurement is proportional to the gear's pitch diameter. The larger is the gear diameter, the greater the measuring system inaccuracy. Even when a high precision encoder with one second resolution is used, the measuring inaccuracy can be significant for large gears. Figure

The measurements for every pair of teeth are recorded in a table and the three pitch characteristics (F_p , f_p , and f_u) are determined based on math model as described in the following section:

CROSS-REFERENCES OF SINGLE AND TWO-PROBE PITCH INSPECTION METHODS

While there are three characteristics under the auspices of the pitch error (F_p , f_p , and f_u), they are mathematically interrelated, thus only one set of measurements is required to determine all three characteristics.

Each inspection method is aided with a respective math model for converting the measurements into the three commonly used pitch characteristics: Cumulative Pitch Deviation (F_p), Pitch Deviation (f_p), and Adjacent Pitch Difference (f_u).

An example of pitch inspection by both the single and the two-probe methods as well as a cross-reference between the two methods can be found in the legacy AGMA 2000-A88 standard, "Figure 9-9 Relationship of Pitch, Spacing, and Index Spacing, and Index Spacing, or Accumulative Pitch" [2]. The table shown in Figure 7 is mostly based on that example.

or Accumulative Pitch" [2]. The table shown in Figure 7 is mostly based on that example.

The left three columns (A, B, C) depict the single-probe math model to determine f_p and f_u , as the single-probe measurements directly provide the Cumulative Pitch errors.

► The Cumulative Pitch errors are depicted in column A highlighted by the yellow background. The Total Cumulative Pitch error is determined by the difference between the max and min readings $4 - (-2) = 6$, see pink background.

► Column B shows the Single Pitch Deviation, f_p . Each Single Pitch Deviation is determined by subtracting the previous Cumulative reading from the current one. The max absolute value (-6) represents the Max Single Pitch Deviation error.

► Column C depicts the Adjacent Pitch Difference, f_u . It is determined by subtracting adjacent Single Pitch Deviations. Absolute values are used as the Adjacent Pitch Difference. In this particular example, two Adjacent Pitch differences have the same value "8" marked with pink background.

The right four columns (D, E, F, G) depict the two-probe math model to determine F_p , f_p , and f_u .

► The measuring results are depicted in column D highlighted by yellow background. In addition to individual measuring results, the average is calculated, as shown at the bottom of the column.

► The Single Pitch Deviation, f_p , is determined next by subtracting the average value from the individual readings. The results are depicted in column F.

► Cumulative Pitch Deviation, F_p , is determined by accumulating the Single Pitch Deviations, see column G.

► Finally, the Adjacent Pitch Difference, f_u , is determined by subtracting adjacent Single Pitch Deviations. The results are depicted in column E.

Assuming that gears are indicated to similar runout conditions, these two inspection methods should produce very similar results.

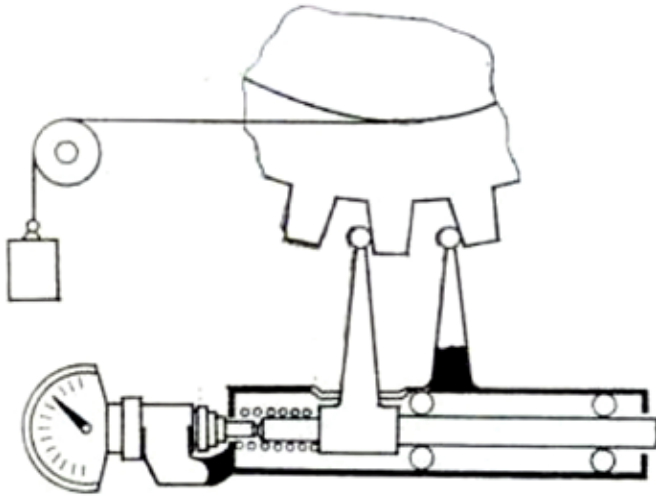


Figure 6: Two-probe pitch inspection concept [4].

Description	Single Probe Measuring Method			Two Probe Measuring Method			
	A	B	C	D	E	F	G
Legacy AGMA 2000-A88	Accumulative Pitch Variation	Pitch Variation	Spacing Variation	Teeth	Spacing Variation	Pitch Variation	Accumulative Pitch Variation
Current ISO 1328-1-B14	Cumulative Pitch Deviation, F_p	Single Pitch Deviation, f_p	Adjacent Pitch Difference, f_u	Reading	Adjacent Pitch Difference, f_u	Single Pitch Deviation, f_p	Cumulative Pitch Deviation, F_p
	A	B	C	D	E	F	G
	0	2	0	0	2	0	0
	2	B - A	0	A to B	2	(A to B) - Avg	B
	4	C - B	0	B to C	2	(B to C) - Avg	C
	8	D - C	2	C to D	2	(C to D) - Avg	D
	-6	E - D	8	D to E	8	(D to E) - Avg	E
	0	F - E	4	E to F	4	(E to F) - Avg	F
	-2	G - F	4	F to G	4	(F to G) - Avg	G
	0	A - G	0	G to A	0	(G to A) - Avg	A
	Total Cumulative Pitch Deviation, $F_p = 6$ (Max-Min)	Max Single Pitch Deviation, $f_p = -6$	Max Adjacent Pitch Difference, $f_u = 8$	Avg, -2	Max Adjacent Pitch Difference, $f_u = 8$	Max Single Pitch Deviation, $f_p = -6$	Total Cumulative Pitch Deviation, $F_p = 6$ (Max-Min)

Figure 7: Cross reference of single- and two-probe pitch inspection methods [2].

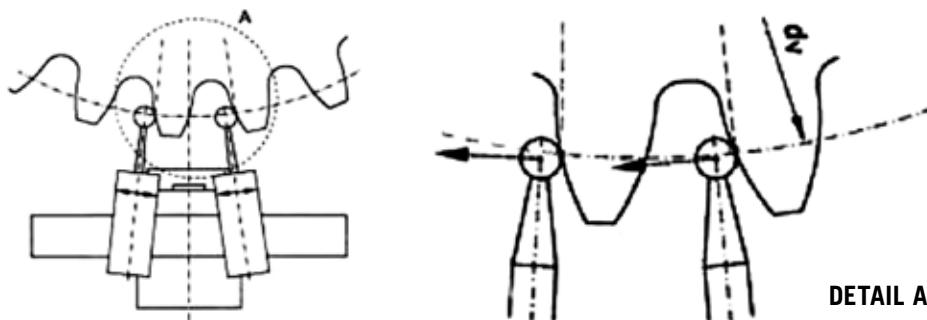


Figure 8: D & P ES4100.

5 quantifies measuring errors depending on gear diameter when a high — one second — resolution encoder is used.

The two-probe method measuring accuracy, however, does not depend on the quality of the rotary encoder, nor does it depend on the gear's pitch diameter and therefore provides measurements with consistent inspection accuracy regardless of the gear size. Figure 6 shows one of the earlier mechanical instruments that conceptualizes the Two-Probe measuring principle well. One probe (on the right) has a mechanically fixed reference position; it is rigidly fixed to the inspection unit housing. The other probe moves relative to the fixed probe and measures the distance between two adjacent teeth. This process is repeated for every single pair of adjacent teeth. Thus, every preceding tooth is the datum for the measurement of every successive tooth.

PITCH INSPECTION ON LARGE GEARS

The Two-Probe Portable pitch testers are frequently used to address several challenges arising with the pitch inspection of large diameter gears.

One challenge is presented when the gear is larger than the inspection capability of a typical universal gear checker. The Two-Probe portable gear checker has no maximum gear size limitation and therefore can be employed for the oversized gear pitch inspection.

Second, large gears are more difficult and expensive to move back and forth between cutting and inspection machines. In addition, when the gear is moved from one machine to another multiple times, the important coincidence of the gear's datum (e.g. journal, bore, centers, etc.) and the actual center of gear rotation on the cutting and inspection machines can be compromised and produce erroneous inspection results.

Third, and the most significant challenge, is when a large gear is manufactured for high precision and pitch sensitive applications. The pitch inspection for these gears using the Single Probe method could be compromised as the encoder's inaccuracies e.g. resolution and others errors would be magnified by the gear's pitch radius.

Despite the fact that most of the pitch inspection technologies today use the single-probe method, some companies that deal with most sensitive pitch accuracy applications for large gears prefer the two-probe pitch inspection method because it is portable, has no maximum gear size limitation, and most importantly yields remarkable and consistent accuracy and repeatability. In fact, some large gear manufacturers even attempt to qualify their universal gear inspection machines by comparing single probe pitch inspection results with the two-probe inspection results.

MODERN PORTABLE TWO-PROBE PITCH TESTER

A modern automatic two-probe pitch tester uses the same principle as the mechanical tester depicted on the Figure 5. However, instead of the mechanical rigid probe for creating the datum, see the right probe shown in Figure 5, a modern automatic two-probe pitch tester uses one of the two precision electronic probe to establish the datum for every pitch measurement, see Figure 8. While the gear rotates slowly and continuously (or intermittently) the two probes advance into the tooth gaps, take the pitch measurement, and quickly retract after the measurement is taken. The advancement, measurement, and retraction of two probes are automatically repeated for every single pair of gear teeth.

In the second half of the 20th century, at least two companies — Maag and Hoefler — made automatic electronic two-probe pitch testers. Today, however, neither of these two companies produces this type of product.

Today, however, there is one company that makes modern automatic portable pitch testing equipment utilizing the two-probe method: Donner & Pfister AG (D&P), founded in 1989 by Meinrad Donner, the inventor of Maag ES401 automatic pitch tester. Through the years, D&P also made improvements and kept pace with the computer technology developments. Their newest D&P ES4100-2 pitch tester, Figure 9, includes probes with digital scales, wireless WiFi connection with

a commercial tablet or a computer, and invar base for reducing the thermal effects on accuracy.

EXAMPLES OF THE TWO-PROBE PITCH INSPECTION METHOD REPEATABILITY

Evaluation of the newest generation Two-Probe Pitch tester, D&P ES4100-2, in three separate repeatability tests including right and left flanks resulted in a remarkable repeatability. The statistical evaluation of three separate tests with about 900 measurements each yielded one standard deviation of 0.06 to 0.08 microns. Even when applying the six sigma process variation model (that is con-



Figure 9: D&P ES4100-2 portable pitch tester.

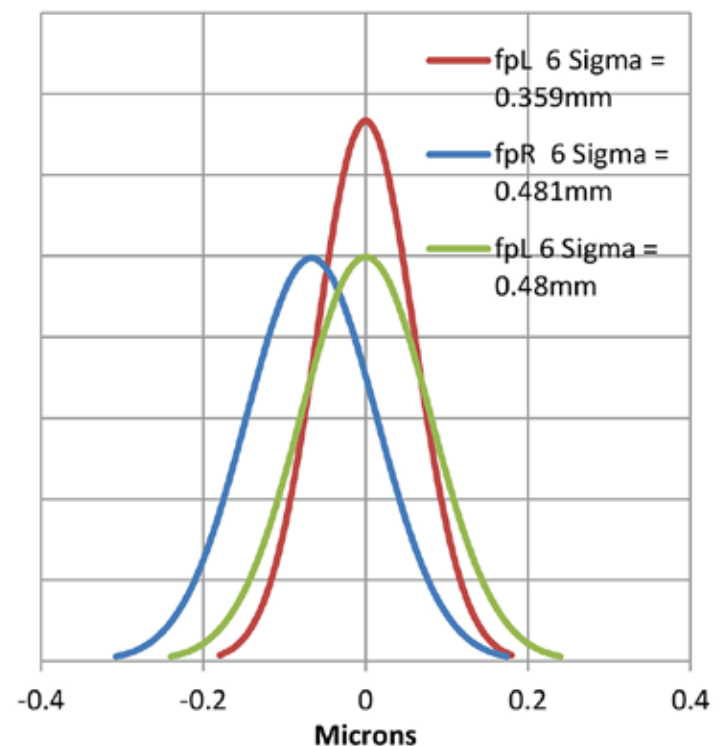


Figure 10: Normal distribution curves of three repeatability tests.

servative for precision instruments) the resulting six sigma pitch inspection repeatability variation is between 0.36 to 0.48 microns, see Figure 10.

SUMMARY

Gear pitch accuracy is one the most important characteristics affecting gear's performance.

There are two fundamental methods for gear's pitch inspection: single and two-probe. Both could provide accurate and repeatable results for a wide range of fine and medium pitch applications. However, when it comes to large gears, only the two-probe pitch inspection method provides consistent accuracy and repeatability regardless of the gear size.

The legacy two-probe pitch inspection methodology combined with modern computer and materials technologies, e.g. digital probes, wireless communication, and materials with a small coefficient of thermal expansion can yield remarkable repeatability – the six sigma repeatability variation below half a micron.

The two-probe pitch measuring method is most beneficial for large diameter gears. Most importantly, the inspection quality does not deteriorate with the increase of gear diameter. In addition, since the two-probe pitch inspection is a portable measuring unit, it can check large gears that are beyond the capacity of a traditional universal gear measuring machine. Lastly, the two-probe pitch inspection portability can sometimes reduce processing time and cost as it would not require moving the gear back and forth from cutting/grinding to an inspection machine. 📷

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ABOUT THE AUTHORS

Yefim Kotlyar is the applications engineering manager at Machine Tool Builders (MTB), responsible for development of new gear manufacturing and gear metrology technologies. His broad experience in the art of gearing includes developments of various gear cutting and grinding technologies, analytical inspection, and evaluation technologies for gears and hobs, as well as gear systems design and validation. Kotlyar has served on a number of AGMA technical committees, and he has authored many articles on gearing subjects.

Christoph Donner is the CEO at Donner+Pfister AG, which has been in business for more than 30 years and is located at the upper reach of Lake Zurich in Switzerland. He earned the Dipl. Ing. (FH) degree in Zurich before starting his professional experience in the family-owned company more than 20 years ago. Donner leads the development and manufacturing of high precision gear grinding machines and high precision portable and stationary gear inspection machines, the development of specialized gear and hob inspection software, and servicing and re-controlling of legacy Maag gear grinding and inspection machines.

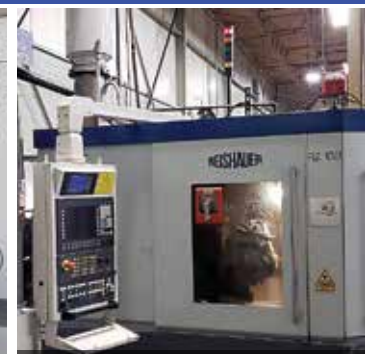


G&E Model 120GH CNC Gear Gasher

- 150" Diameter – can extend to 8M Diameter
- NEW CONDITION



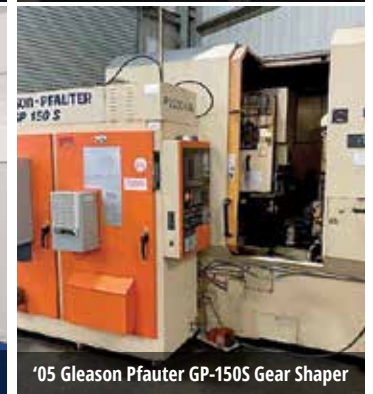
'07 Samputensili S-750 Gear Hobber



'08 Reishauer RZ-150 Gear Grinder w/Hoffman Filtration



'97 Liebherr LC-122 CNC Gear Hobber



'05 Gleason Pfauter GP-150S Gear Shaper



CHAMFER HOBGING, PERFECT TIMING

The new Chamfer Hobbing process offers an extremely efficient solution to create the desired chamfer without secondary burrs. (Photos courtesy: Gleason)



New Chamfer Hobbing adds a highly desirable process to the integrated hobbing and chamfering options now available to gear manufacturers — just in time for eDrives.

By GOTTFRIED KLEIN

New gearbox developments, particularly for eDrives, are creating a whole new set of gear design and manufacturing criteria. Compact gearbox design is paramount, and the requirements can include gears designed for high torque on one side and high RPM on the other side. To ensure optimum power transmission, producing defined chamfers with tight tolerances is often a requirement. Precise chamfers minimize the potential for sharp, brittle chamfers after heat treat and avoid flank edge load which can lead to breakouts in the gearbox under load.

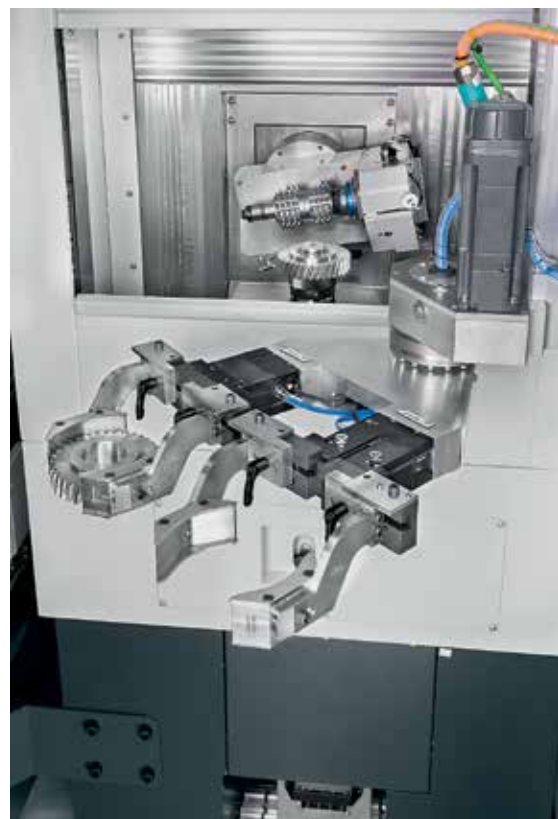
Preparing the flank for a hard-finishing operation downstream is yet another significant reason for chamfering, especially for gear power honing, where excessive stock and hardened burrs can greatly diminish honing tool life and, as a result, significantly increase tool cost per piece.

An additional benefit of chamfering and deburring is to help reduce the health and safety risks that can result from operators handling parts with sharp burrs.

THE OPTIMUM SOLUTION FOR EVERY APPLICATION

Gleason offers manufacturers several highly desirable chamfering and deburring solutions that are just as easy to apply as the primary soft and hard processes. With the latest series of Gleason hobbing and chamfering machines, users now can apply the optimum chamfering technology for their particular application using forming or cutting technologies. These technologies include tried and true chamfer rolling, ideal for planetary pinions with cycle times of less than 10 seconds or for shafts with obstacle contours in high volume production; Chamfer Contour Milling, for highly flexible cutting chamfering with indexable carbide inserts for small and medium batch production of truck-sized gears; and now Chamfer Hobbing. Chamfer Hobbing is the process of choice for medium and high-volume production and dry cutting for highest tool life with lowest tool cost per workpiece.

While chamfering with hobs has been known for decades, Chamfer Hobbing takes the process to a completely new level. Chamfering is performed using a Gleason Chamfer Hob. The new cutting tool has characteristics very similar to a gear hob. It's made with high-speed steel materials such as G30, and features AlCroNite® Pro coating for exceptional tool life in dry cutting conditions. With Gleason Chamfer Hobbing, one Chamfer Hob is used for each tooth flank, with a tooth profile specifically designed for the particu-



Integrated chamfering/deburring station performs Chamfer Hobbing in parallel to hobbing. A high speed 2-position gantry loads the workpiece for hobbing, transfers the workpiece to the chamfering station, and delivers the finished workpiece to the parts conveyor.

lar chamfer form that's required. The Chamfer Hob looks similar to a standard gear hob but with asymmetric teeth. One flank is designed for cutting the chamfer, the other flank is designed to not touch the counter flank. This process delivers great flexibility regarding required chamfer angles. Additionally, comma or parallel-chamfer forms are possible as well as chamfers along the tooth edge only, or including the root area. Chamfer angles similar to those commonly produced in the chamfer rolling process are easily achievable (15-30 degree on obtuse edge, 25-45 degree on acute edge).

LOWERING THE COST PER WORKPIECE

In the Chamfer Hob design process, Gleason technology software is used to simulate the required chamfer and identify and avoid all potential collisions of the tools with the counter flank and with interfering

contours above and below the actual gearing. By cutting into the gap, burrs are avoided on the face side of the gears. With chamfer angles such as those produced by the chamfer rolling process, there are no measurable burrs on the flank that require removal downstream. Since Chamfer Hobs use materials and coatings similar to gear generating hobs, low tool cost per part is expected, especially since tool shifting is possible. Existing sharpening capabilities for gear hobs can be used as well for Chamfer Hobs. Ultimately, longer tool life not only increases the efficiency of the process but also leads to minimized changeover times and, ultimately, to lower manufacturing cost per piece.



Chamfer Contour Milling in parallel to gear hobbing on the Gleason 400HCD does not add cycle time and is ideal for trucksize gears.

While two Chamfer Hobs are sufficient for workpieces with parallel gear faces, up to four Chamfer Hobs on a single spindle could serve parts with non-parallel gear faces such as inclined gear faces or special gears like beveloid, sprockets, asymmetric profiles or even two gears on a shaft — all of which could be chamfered in one setup.

THE PERFECT MACHINE PLATFORM

The new-design Genesis® 160HCD combines the proven Genesis vertical hobbing platform with an integrated chamfering/deburring station to perform the new Chamfer Hobbing process in parallel to hobbing, and thus achieving cycle times to satisfy the requirements for double clutch or eDrive transmission gears. The 160HCD is based on the well-known Genesis 210H Hobbing Machine, and incorporates several product improvements. These include: reduced machine footprint; modification of the fluid power unit for easier adaption to automotive specifications; improving the hydraulic primary deburring; and, most importantly, adding a high-speed, 2-position NC-gantry for efficient and fast workpiece loading.

This NC gantry loading system connects the hobbing station with

the Chamfer Hobbing unit and the parts conveyor. A pallet ring conveyor is standard, although other stocking systems or interfaces to external automation can easily be applied to integrate the machine into different production environments.

The integrated Chamfer Hobbing unit employs an axis configuration similar to the main hobbing machine; all NC-controlled by the shared Siemens 840D sl control. The fluid power unit serves both operations as well. The standard configuration of the Chamfer Hobbing unit contains a Chamfer Hob head with the capacity to mount two Chamfer Hobs. An optional Chamfer Hob head with outboard support accepts up to four Chamfer Hobs for non-standard gears as described above. Alternatively, longer Chamfer Hobs could increase tool life per hob and decrease unproductive tool changes. Chamfer Hobs are mounted on a hob arbor with HSK interface to ensure accuracy and fast tool change. For shaft-type parts up to 380 mm in length, a tailstock is available not only at the hobbing position but in the Chamfer Hob unit as well.

Even in medium and high-volume production environments, the ability to machine economically in smaller batches is essential. Short tool change is one key element — workholding changeover is another one. With Gleason's Quik®-Flex system the fixtures in both the hobbing and Chamfer Hobbing stations can be changed in under a minute each. While the expanding bushing and the base plate are the same for both operations the locating ring and fixture body are optimized for each process: rigid clamping close to the root diameter of the workpiece is chosen for high speed hobbing and achievement of shortest hobbing times. Slimmer fixture bodies with smaller location rings are preferred for more clearance below the root diameter for root chamfering and achieving chamfer angles accord-

ing to the gear design requirements.

Finally, the application of new GEMS® operating software greatly enhances the machine/operator interface. Data input is supported with interactive graphics that guide the operator through the setup and changeover process. The software interface is also designed to minimize the learning period and to avoid wrong inputs with plausibility checks.

SUMMARY

Every gear production challenge is different. Fortunately, manufacturers now have a variety of integrated and automated chamfer/deburr options available, whether the proven chamfer rolling process for shortest cycle times, Chamfer Contour Milling process for highest flexibility, and now Chamfer Hobbing, for medium to high volume production, producing chamfer forms according to customer standards, and with low tool cost-per-part. Depending on the specific requirements it is very likely that one of Gleason's well-known or brand-new chamfer technologies will address the varying challenges customers may have. ☒

ABOUT THE AUTHOR

Gottfried Klein is director of Product Management, Hobbing, Chamfering and Shaving at Gleason Corporation.



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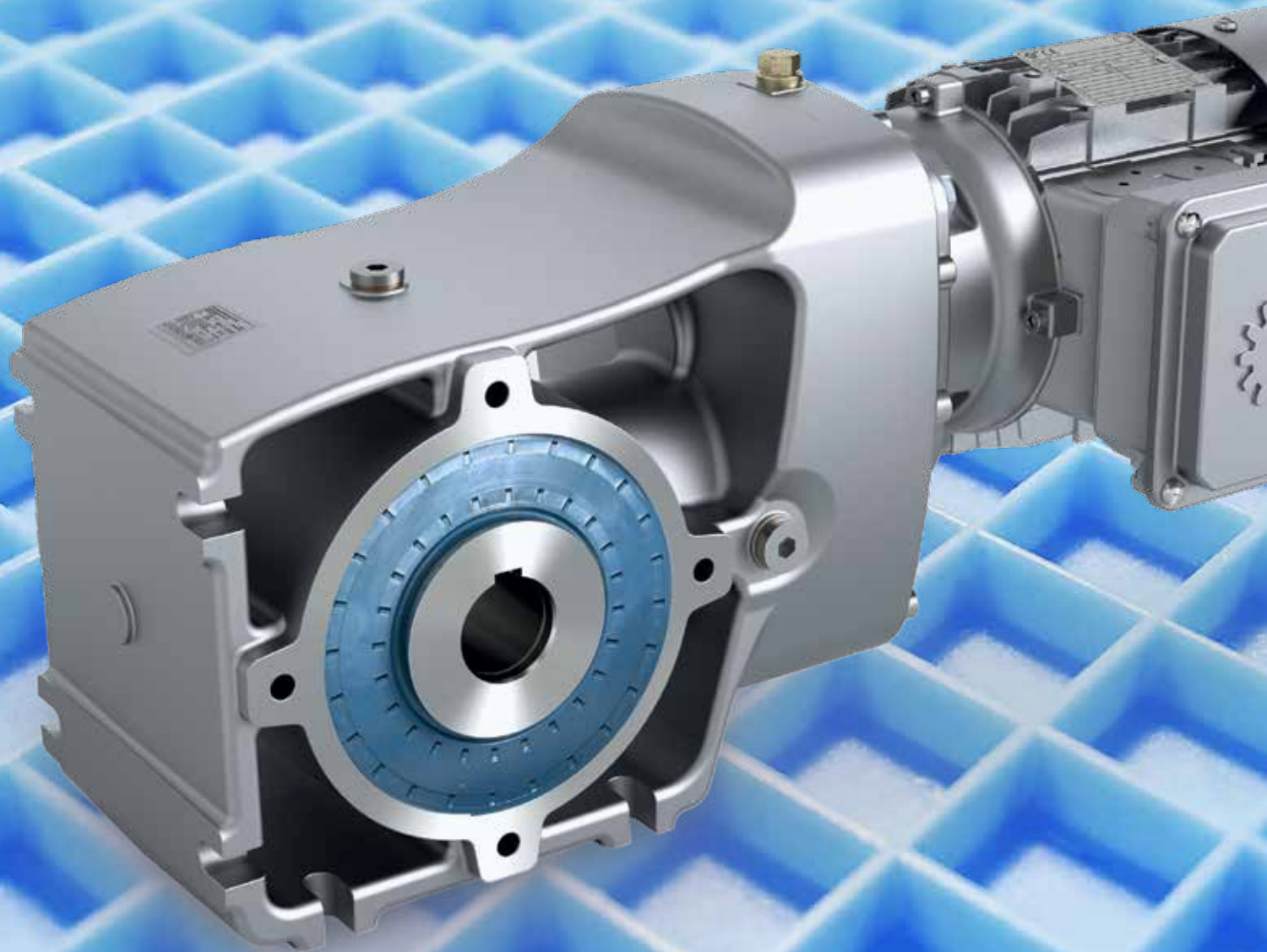
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NORD Gear Corporation markets and produces a complete product line of mechanical and electrical drive components including quality gear reducers, electric motors, AC Vector drives, and distributed drive technology.

By KENNETH CARTER, Gear Solutions editor

For customers of NORD Gear Corporation, the company has 20 million reasons why it's the right fit for their needs.

"NORD's philosophy to the gear manufacturing industry is really to have a flexible product," said James Wubbolding, vice president of sales at NORD. "Our gear product range has about 20 million different combinations, and the company has worked hard to provide a modular product line centered on what our customers need. We want to provide them with a wide range of modular gear products and deliver those in a short period of time."

NORD's product portfolio is extensive and constantly evolving in order to meet the needs of a fast-changing market, according to Wubbolding. NORD's range of drive equipment includes helical-inline, helical shaft-mount, helical-bevel, helical-worm, worm gears, and large industrial gearboxes, offering torque from 90 lb-in to 2.2 million lb-in, AC electric motors rated from 1/6 HP to 250 HP and AC Vector Drives rated up to 250 HP.

NORD drive components are calculated according to DIN 3990, NIEMANN, and AGMA standards. NORD is also ISO 9001 certified.

CORE PRODUCT LINE

"NORD's core product lines are gear motors, and in 1985 we added a line of control products and variable frequency drives that control our motors," Wubbolding said.

That flexibility gives NORD an edge when it comes to servicing its customer base.

"A lot of the original equipment manufacturers that we work with are building a product line, and we are a component supplier for them," Wubbolding said. "So, what they need from a partner is somebody who can react quickly to whatever business or projects they receive."

To that end, NORD has a \$30 million inventory to provide products to customers quickly and reliably, according to Wubbolding.

"On average, nearly 25 percent of our orders ship same-day or next-day, and about 45 percent ships within five days," he said. "The value that we bring to

customers is: They don't worry about keeping gears and gearboxes on the shelf, waiting for an order. When they get an order, they know we can deliver in a short period of time."

That's not to say NORD only offers off-the-shelf solutions. According to Wubbolding, when customers come to NORD with a challenge, the company's engineering experts are ready.

"We have a highly technical engineering staff," he said. "What we would typically do is invite the customer to one of our facilities. If it's a product design or a delivery challenge, we would engage people at NORD—for example, our application engineering department



Part of the 60,000-square-foot expansion of NORD's manufacturing space in Waunakee, Wis. (Courtesy: J.H. Findorff & Son Inc.)

— and sit down with the customer, understand what the challenge is, and then develop a solution."

40 YEARS IN THE U.S.

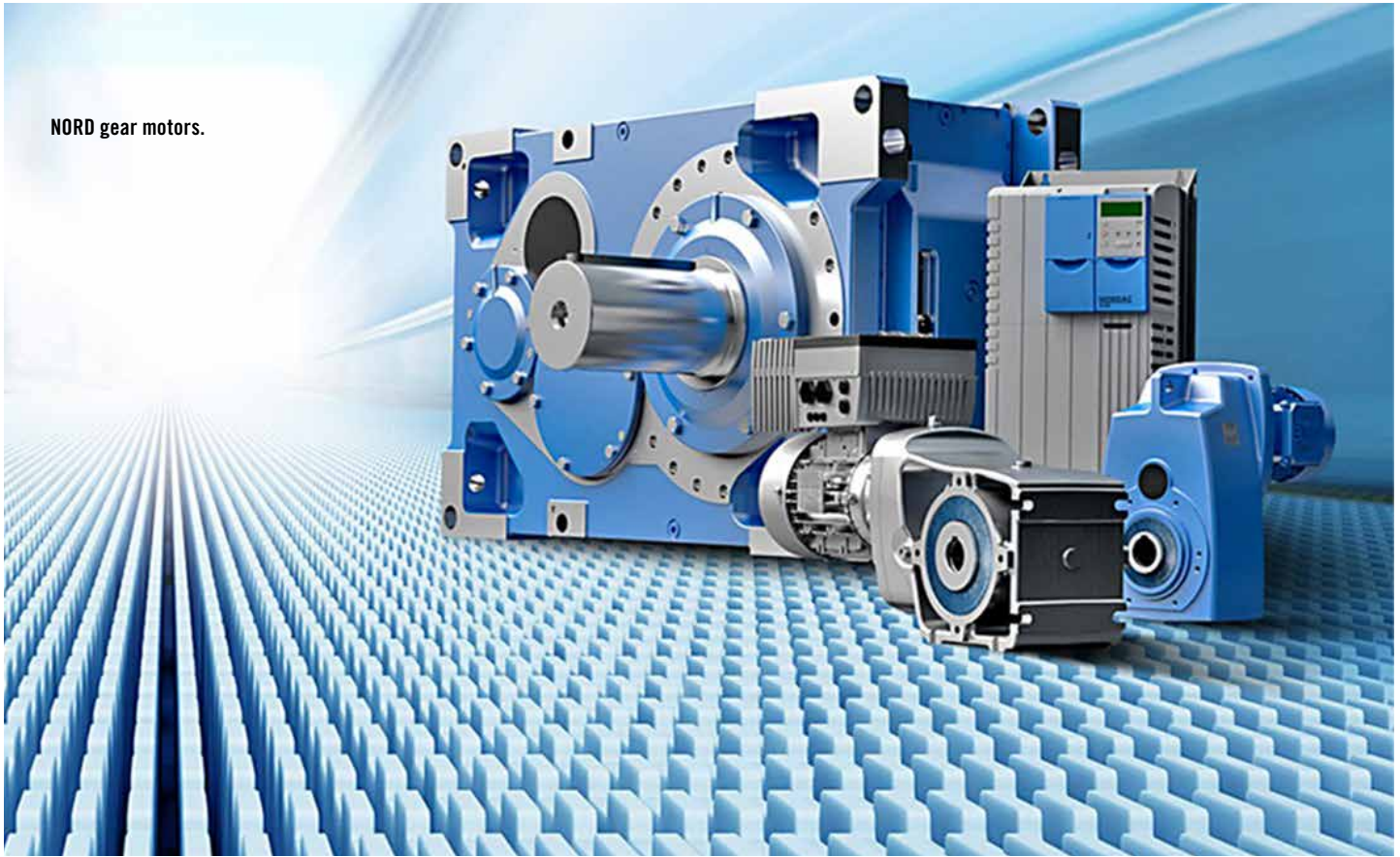
NORD is currently celebrating 40 years in the United States.

"We came to Wisconsin in 1979 and have had a number of expansions in the U.S., and we're expanding again this year," Wubbolding said. "We're adding about 86,000 square feet of manufacturing and office space. This is a big year for us."

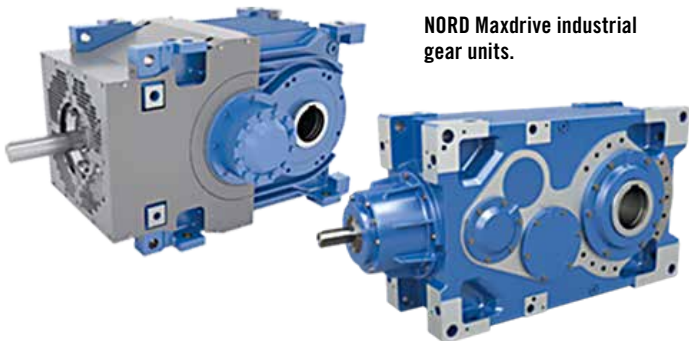
A lot has changed in those four decades, and Wubbolding said the advance of everyday technology has had a hand in that change.

"I think the biggest change in the industry, in

NORD gear motors.



NORD UNICASE helical shaft drive motor.



NORD Maxdrive industrial gear units.

terms of gearboxes, has been how the Internet has allowed customers to have a wide range of information available at their fingertips,” he said. “We need to continue to provide a high level of service that ensures the pertinent information – our drawings, access, how to configure our products – is on the Internet and available to customers.”

That has created more creative freedom with customers, according to Wubbolding.

“Most customers, especially in the engineering world, want to design and do things on their own without having to call and contact people,” he said. “So, we’ve seen our industry change to making sure that the competitive advantages that we offer in terms of gearboxes are available and accessible for customers online.”

GERMAN ROOTS

NORD has made bold leaps and bounds in the industry, and what makes it more impressive is that when the company started, there were only two employees, according to Wubbolding.

“NORD was founded in 1965 in our current headquarters in Bargteheide, Germany, which is just outside of Hamburg,” he said. “Two gentlemen, Mr. (G.A.) Küchenmeister and Mr. (Günter) Schlicht, started the company. They were designing and delivering gear motors locally. Since then, they’ve expanded both in manufacturing facilities as well as subsidiaries globally, to now where we have over 4,000 employees.”

But it’s NORD’s flexibility with its modular designs that has been the key to serving its customers so well over the company’s lifetime.

In the 1980s, NORD engineers developed an important innovation in gearbox construction: the UNICASE housing. The UNICASE housing is a one-piece housing that supports all transmission components. The benefits of this design include leak-free sealing, greater operational reliability, low noise, higher output torque, high overhung and



“We’ve seen our industry change to making sure that the competitive advantages that we offer in terms of gearboxes are available and accessible for customers online.”

thrust capacity, longer maintenance intervals, and longer gearbox life, according to Wubbolding.

INTERNET OF THINGS AND PREDICTIVE MAINTENANCE

How will NORD products change as it enters its fifth decade in the U.S.?

“Gears and gearboxes are still going to be the core of the industry, meaning that it takes gears and gearboxes to multiply torque

and turn shafts, and that part won’t necessarily change,” he said. “But what we do see changing in the next 10 to 20 years is making sure that those gearboxes and gears, in their form of connecting to a motor, have the ability to work with electronic systems in a wide range of areas.”

NORD expects the electronics in all types of businesses, including areas such as machines and warehouse and distribution, to drive what types of gears are needed, along with their ability to be connected via the Internet of Things and predictive maintenance, and allowing the customer to know, for example, when they need to change the oil in a gearbox in a predictive manner, according to Wubbolding.

To help with that communication, Wubbolding said NORD’s line of control products will help usher in that wave of technology.

“We call it decentralized control products, meaning these are devices that can be right next to the gear motor and the gearbox, and what they basically allow our customers to do is to communicate with the gearbox and control it via some network connection,” he said. “They’re able to take a component that we supply and electronically integrate it into their machine. And so for us to stay relevant, if you will, with a gearbox, we have to make sure that we have a product line that allows the customer of tomorrow to efficiently connect to it. And we’ve put a lot of investment into those products to keep us on the growth path we’ve been on for the last several years.”

MORE INFO

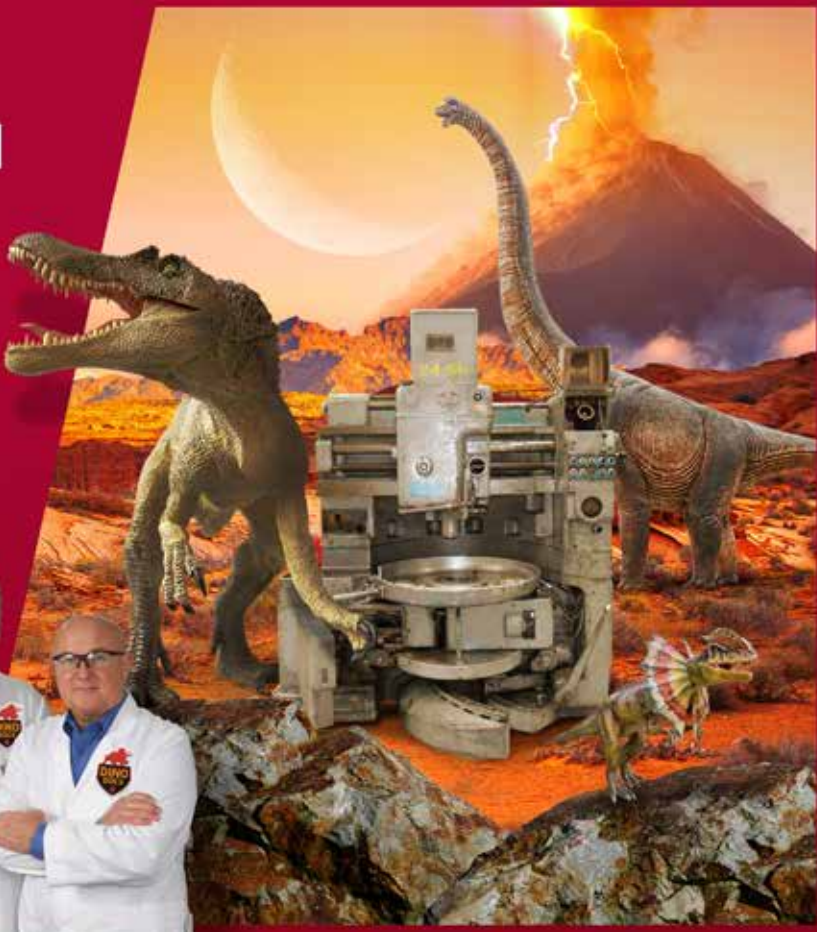
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Dillon full grip jaws are machined from 6061 extruded aluminum for increased strength. (Courtesy: Dillon Manufacturing)

Dillon extruded aluminum full grip jaws available in new size

Dillon full grip jaws, machined from 6061 extruded aluminum for increased strength, are now available up to 28 inches in diameter.

Machining from bar stock eliminates the porosity inherent with large diameter aluminum castings, providing a stronger and more reliable workholding product. These jaws can be modified to heights of 10" and widths that extend beyond the chuck face diameter, thus increasing the chuck's capacity.

Dillon chuck jaws can provide both standard and special pie jaws in 1.5mm x 60°, 3.0mm x 60°, 1/16th x 90°, and 3/32 x 90° serrations, American standard and metric tongue and groove, and acme and square serrated key type mounting interfaces. They are also available in 1018 CR steel and cast iron. Most standard and special jaw modification have less than a two-week lead time. Dillon chuck jaw products are made in the USA in an ISO 9000-2015 registered facility. Dillon Manufacturing, Inc. manufactures a complete line of standard and custom workholding solutions including chuck jaws,

chucks, vises, soft jaws, hard jaws, collet pads, and more. It manufactures jaws using 1018, 1045, 4140, 8620, A-2, and 6061 aluminum. Dillon Manufacturing is ISO 9000-2015 registered.

MORE INFO www.dillonmfg.com

Forest City Gear expands advanced turning and milling facility

Forest City Gear has expanded its turning and milling operations with a state-of-the-art facility designed to greatly improve lead times and quality for the production of precision gear blanks.

This highly productive 8,500-square-foot facility is in close proximity to Forest City Gear's main facility in Roscoe, Illinois, and now dedicated almost solely to the precision turning and milling operations needed to produce precision gear blanks.

That's good news for Forest City Gear customers, said Forest City Gear Turning and Milling Supervisor Mike Miller. "This gives us complete control over the quality and

delivery of the blanks (and slugs) that are the 'near net shape' starting point for many of the gears we produce," Miller said. "The types of projects we take on here at Forest City Gear for customers around the world have never been more demanding from a quality and delivery standpoint. If we start off a project with turned blanks out of tolerance, or waiting for blanks from a supplier, this can ultimately create a devastating production bottleneck when operations upstream are sitting idle waiting for product to arrive."

Miller said the facility, with its four late-model CNC lathes, three CNC machining centers, and dedicated Zeiss CMM, easily meets current capacity requirements, and gives the company additional room to grow.



Forest City Gear's new facility is now dedicated almost solely to the precision turning and milling operations needed to produce precision gear blanks. (Courtesy: Forest City Gear)

Two Mazak Quick Turn 250 Turning Centers will arrive later this year to further expand capacity, and future plans call for the addition of a 5-axis machining capability for the production of small planetary housings and carriers.

MORE INFO www.forestcitygear.com

GF Machining Solutions offers cost-effective CUT C Wire EDMs

GF Machining Solutions offers its AgieCharmilles CUT C 350 and CUT C 600 wire EDM machines for U.S. manufacturers who want high performance with low costs.

At a \$99,000 starting price point, the machines are not only cost-effective, but also provide optimized cutting speeds and reliable accuracy, while their AC CUT HMI 2 systems make for easy programming through efficient EDM expert modules.

Both the CUT C 350 and CUT C 600 offer manual mode setup for access to main functions that enable operators to perform manual measurements and machining. The machines feature low-maintenance designs that use minimal components and consumable parts to reduce operating costs. Along with an integrated anti-collision protection system, the machines include linear glass scales and encoders for high production accuracy.

Easily accessible wire spool holders allow for fast and easy changes, and standard automatic threading systems thread hard, soft, coated, or uncoated wire for reliable lights-out manufacturing.

Both the CUT C 350 and CUT C 600 operate with digital Intelligent Power Generators (IPG) for optimized cutting speeds and feature several Expert Intelligent technologies to manage surface quality and part precision while they streamline overall operation. With IPG, the machines generate surface finishes of 0.25 μm Ra in carbide and 0.30 μm Ra in steel.

For wire breakage prevention on variable-height parts, the Power-Expert intelligent function automatically selects optimal power levels. Corner-cutting strategies automatically adjust machining parameters during changes of cutting direction to create accurate sharp angles and small radii.

File and project management intelligent features on the CUT C 350 and CUT C 600 enable operators to configure and sequence jobs, follow job progress, manage digital project documents and access the AC CAM EASY programming system for autonomous operation.

MORE INFO www.gfms.com

Heule Tool Corporation rolls out new catalog of tooling machines

Heule Tool Corporation has a new 12-page, full-color catalog which introduces its line-up of tooling to machine front and back bore edges in a single pass, saving the time and labor normally required to flip the workpiece. Manufactured of hardened tool steel and fitted with exchangeable carbide blades, innovative Heule tools feature coatings and



Heule Tool Corporation has a new catalog available. (Courtesy: Heule)

blade geometries matched to the material to be machined to maximize service life of the blades and tooling life cycle. Designed for use with automatic machine tools, they are ideal for front and back deburring, chamfering and countersinking, and more.

Copies are available in English, Spanish and French for download, with

hard copies available upon request. Standard back bore machining technologies detailed include COFA tooling for deburring, SNAP tooling for chamfering, DEFA for chamfering with high dimensional accuracy, and VEX for drilling and chamfering. Additional standard technologies detailed include BSF tooling for back spotfacing, SOLO tooling for automatic front and back counterboring, GH-Z/E tooling for countersinking and back spotfacing, and GH-K tooling for chatter-free countersinking.

In addition to standard products available from stock, Heule provides tailored solutions which combine multiple operations in a single tool or adapt tool dimensions and blades to suit particular machining requirements.

Heule Precision Tools has manufactured high-quality cutting tools since 1961, supporting a wide range of hole-finishing tools for front and back deburring, countersinking, chamfering, and counterboring for larger industrial manufacturing companies throughout the world. It specializes in high-production environments in the automotive, aerospace, energy, and medical industries.

MORE INFO www.heuletool.com

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Hexagon's new inline gap and flush measurement system enhances quality

Hexagon's Manufacturing Intelligence division has launched a new wireless, inline, gap and flush measuring system, which was displayed for the first time at the Control trade show for quality assurance in Stuttgart May 7-10. The NextSense Calipri C15 is the latest addition to the Calipri fam-

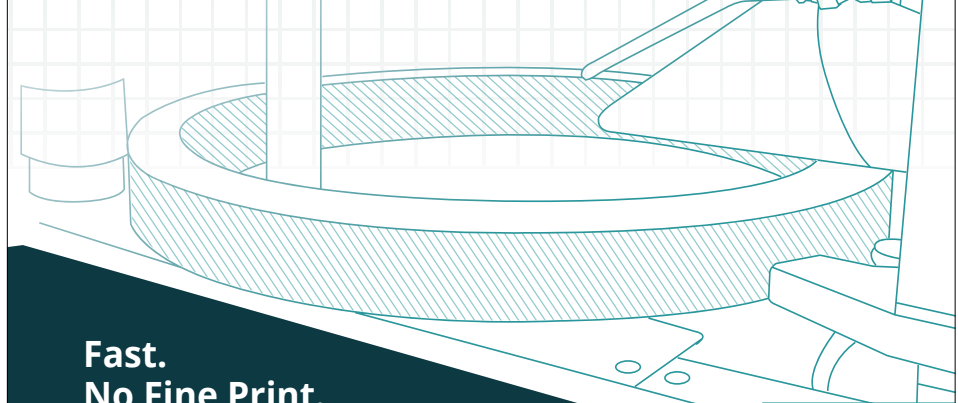
ily of non-contact measurement systems, which uses a patented sensing technique to rapidly and accurately measure gap and flush, seal gap, and feature lines throughout the manufacturing process. Acquired by Hexagon in 2018, NextSense is a specialist in non-contact profile and surface measurement solutions for the automotive, railway, and steel industries.

The new, wireless Calipri C15 complements the wired Calipri C11, which provides continuous laser-based, hand-guided gap and



The new wireless, blue light, non-contact Calipri C15 tool gives manufacturers greater flexibility when inspecting fit and finish in production and assembly lines. (Courtesy: Hexagon MI)

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flush measurements on a production line, including in the automotive, aerospace, and domestic appliance industries. Because the Calipri C15 is cable-free, operators can use it to quickly reach hard-to-access areas and it can be configured for 360° or linear measurement, making it ideal for car body, inline, and final assembly inspections as well as in rework stations. All data synchronization is performed wirelessly and in real time.

In addition to bringing extra flexibility to handheld inline measurement, the Calipri C15 uses blue light laser technology. This makes it ideal for measuring shiny surfaces, including the hemming on car doors, and brushed metal surfaces. It is also equipped with a small screen where operators can check measurement data on the fly, and its sturdy design means it can withstand knocks, collisions, and prolonged, repetitive use. The C15 is available in two versions – the C15 Fix, which is optimized for stationary measurements, and the C15 Flex, which is designed for versatility and can be moved easily from one production line to another.

MORE INFO www.hexagonmi.com

Bottom of form determining excitation force in KISSsoft

Since the March 2018 release, KISSsoft contact analysis also calculates the excitation force according to the FVA Report 487 (module ZA30) in addition to the transmission error. This serves as an alternative for the evaluation of the tothing with regards to vibration and noise excitation.

A modified base model is used to calcu-

late the excitation force: for the transmission error, the calculation is based on the assumption that there is a static situation in which the gears in contact have the possibility to yield to one another. This makes it possible to compensate for deformation in the elastic elements (teeth, shafts, bearings, etc.) and adjust the continuous, externally applied torque.

The idea behind excitation force is that the gears turn as quickly as possible so that, due to the mass moment of inertia, no error is possible. This results in constant gear torsion as a boundary condition – no transmission error, but rather a change in the tooth force because of inconstant tooth rigidity. As a result, the torque changes periodically.

The topic of excitation force is also part of the special training that will be held from November 19-20, 2019: “Contact Pattern Analysis for Cylindrical Gears, Bevel Gears and Planetary Gear Units.” During this training, contact analysis modules in KISSsoft will be used to teach the theoretical foundations that are required in order to efficiently size and optimize gear units with regard to noise, transmission error, as well as profile and tooth trace modifications. In addition to the training course, an optional one-day workshop will be held on November 21, 2019, that will give participants the opportunity to individually apply and deepen what they have learned.

MORE INFO www.kisssoft.com

Nord delivers next-generation conveyor systems for airports

The challenge of engineering baggage handling systems for international airports is immense. Miles of conveyors. In-line CT-scan screening machines. Multiple in-feed lines. Four-way sorters. High-speed diverters. Spiral power curves. Inclined claim conveyors and more.

These are some of the equipment designs in the Raleigh-Durham International Airport, all powered by integrated drive electronics from Nord Drivesystems. Nord’s modular gear reducers, motors, and VFDs are driving baggage handling systems in airports across North America and around the globe, including Charlotte, Oklahoma City, Cleveland (featuring an Ethernet IP Network), London, Montreal, and Istanbul.

At the American Association of Airport

Executives Conference & Exposition June 16-19 at Boston’s Convention & Expo Center, Nord is showcasing many of its high-performance drive solutions. Visit Booth 332 to meet with Nord experts and learn about products such as:

Nord’s 92.1 two-stage helical bevel gear reducer, which delivers up to 97 percent gear efficiency. Designed using finite element modeling technology with oversized output bearings and extremely strong one-piece housing construction means extended ser-

vice life, even under high radial loads. Plus, with flexible mounting and shaft designs, product installation and maintenance are fast and easy.

Integrated drive solutions: Like the gear-motors and drives used with the Cleveland Hopkins International Airport, Nord’s premium efficiency IE3 motors and VFDs can be pre-configured and delivered with customer-specified power connectors, and photo eye, sensor, and high-speed Ethernet IP plugs needed for easy daisy-chain installation.



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eration and guarantees full motor torque throughout the entire speed range. Nord customizes airport solutions to provide the specific features and functionality customers need.

With the new Nordac® Access Bluetooth stick (and Nordcon app), Nord created a mobile commissioning and service solution for all Nord drives. The app provides mobile dashboard for drive monitoring and diagnosis. For example, a drive system can be optimized while in operation with the aid of

the oscilloscope function. Parameterization of drive units is simple and easy due to the integrated “Help” function and rapid access to parameters. In addition, the app provides further practical functions such as a parameter backup and recovery function.

MORE INFO www.nord.com

Open Mind announces joint technology seminar with Grob Systems

Open Mind Technologies USA, a leading developer of CAD/CAM software solutions, has announced a joint 5-Axis Machining Technology Seminar with Grob Systems, a manufacturer of universal machining centers.

On June 4, 2019, from 8:00 a.m. to 3:30 p.m., Open Mind and Grob Systems will offer a complimentary 5-Axis technology seminar in Auburn, Washington, at Machine Tools Northwest. Highly innovative production solutions for aerospace and other industries will be presented.

During the seminar, experts from Grob Systems and Open Mind will demonstrate ways for manufacturers to make their production facility more efficient. Technical presentations will alternate with live milling demonstrations, and participants will learn specific manufacturing strategies to boost productivity. Presentations will include Industry 4.0 – Connected Machining, as well as the ideal interplay between the powerful hyperMILL® CAM solution and the latest Grob machining centers.

Live milling demonstrations will show aerospace, including structural and turbomachinery components, and other parts milled on a Grob G350 5-axis universal machining center. The NC-programs will be created using the hyperMILL MAXX Machining performance package, offering high-power strategies for roughing, finishing, and drilling. Open Mind developed a 5-axis tangent plane finishing program for conical barrel cutters specifically for the extremely efficient finishing of hard-to-reach planes. The technology has been expanded to other surface types. The optimization potential is enormous: 90 percent cycle time savings over conventional methods, while achieving excellent finishes, extremely short production times, and longer tool life.

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The G350 and the entire Grob universal machine range offers a unique solution for complex components, because it enables overhead (upside-down) machining for immediate and thorough chip removal. It also features a unique spindle which fully retracts from the machining area during part positioning or tool changes to eliminate any chance of collision and fully use the work zone.

MORE INFO www.openmind-tech.com

parts2clean 2019: Future-proofing industrial parts cleaning

The industrial parts and surface cleaning sector is facing new challenges. parts2clean 2019 shows how these challenges can be met.

The 17th International Trade Fair for Industrial Parts and Surface Cleaning will be held from October 22-24, 2019, at the Stuttgart Exhibition Center.

Areas of current interest include new and modified production technologies,

such as the growing use of adhesive bonding, laser welding and coating processes, as well as the additive manufacturing of components. At the same time, there is increased demand for the cleaning of workpieces made from new materials or material combinations, as well as complete assemblies. And then there are the tougher regulatory requirements, such as those contained in the new European Medical Device Regulation (MDR).

These changes are forcing business enterprises to review existing processes and question old ways of doing things.

“parts2clean is the perfect place for businesses to gather the information they need for positive changes,” said Olaf Daebler, global director of parts2clean at Deutsche Messe. “As a global meeting place for industry, the event and its exhibitors not only showcase the very latest technological advances in industrial parts and surface cleaning, but also highlight key trends and offer best-fit solutions.”

The range of leading-edge exhibits allows visitors from many different sectors such as the car and component supply industry, medical technology, mechanical engi-

neering, the aerospace industry, precision engineering and micro-engineering, optics, electronics, semi-conductors and coating technology – to find the information they need quickly and easily.

For the all-over or selective cleaning of surfaces in various situations, there is now a growing trend toward the use of dry-cleaning processes. parts2clean reflects this development with a broad range of offerings, which include systems for CO2 snow blasting, plasma cleaning, laser cleaning, vibratory finishing, and cleaning with compressed air. Visitors will be looking for the right process engineering and plant to remove particulates or film-type contaminants efficiently and with consistent results in order to comply with new, tougher standards. Others will be more interested in technology for cleaning parts made from new materials, parts with highly complex geometries, and more. Also popular with visitors will be solutions for the control and monitoring of cleaning, rinsing and drying processes, as well as systems for checking and quantifying the degree of cleanliness achieved. 📧

MORE INFO www.parts2clean.de



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- Contact pattern of asymmetrical gears
- Crossed helical gear with rack
- Feasibility assessment for „Power Skiving“

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“I try to build machines that will perform, not just the deburring that they need to do, but to do it efficiently and fast enough.”

What's a typical day like for you at James Engineering?

I usually get up and get in here a couple of hours ahead of everyone, so I can have my time when it's peaceful and quiet. I'm not always working, but I'm usually thinking and planning the day out. I do the design work. I also spend a lot of time in the day running around making sure things are happening the way I expect them to.

If I'm designing something, I'll be back in my corner drawing on paper, and I'll interface with the guys in the design department to get it digitally converted into 3D solid models. We're a smaller company — we've been double our current size in years past. But we're now implementing a plan to move far beyond our past accomplishments. We build some complicated machines and manufacture more than 2,000 parts in-house. This strategy is nurtured through growth. We're able to do more, not less, designing and building of our machines. The goal is to give our customers what they really need using the most direct and efficient means possible.

How would you describe your overall philosophy when it comes to the industry?

If I'm not an asset to my customers, then I'm probably a liability. I fundamentally try to be an asset. With that being said, I try to build machines that will perform, not just the deburring that they need to do, but to do it efficiently and fast enough to where I'm actually saving them money by making that process friendly and fast and efficient.

Some of the deburring I see out there, it's really a liability, because it looks terrible. We've always tried to be on the leading edge of quality. Recently, we've added surface finishing. We're able to surface finish the whole part with the MAX System. That's a bigger value-add. When you get a part that's done on the MAX — the chamfering, the deburring, and the surface finishing — the overall quality of the part is far superior. That's another asset to my customer.

What sets James Engineering apart from its competition when it comes to gear manufacturing?

I'm creative at building new machines that do a better job. As I build machines, I find areas that are lacking or tools that aren't powerful enough. I've got patents on motors that we use in our systems and things that allow me to do the job better and faster. That's one of the assets I give my customers. I can deburr a part very quickly.

The first thing I brought to the industry was multiple operations happening concurrently during the deburring cycle. Before, you had to run the part through the machine multiple times to do two or three operations, and it wasn't efficient. We tried to optimize the deburring and chamfering capability and now we're adding surface finishing to it. We're always trying to improve the process.

What other innovations make James Engineering a leader in the gear industry?

I take all my ideas, and I try to formulate them into a machine

that is as flexible as it can be, so we can do multiple things within a cycle.

On the ergonomic side of it, I've seen a lot of deburring machines where I can't get my head in to see what I'm doing. The openings are too small, or you have to get too contorted to get in and try to make changes. My dad was an automobile mechanic. The one thing I hated was getting on a creeper and crawling underneath the car because everything fell in your eyes. Probably from that young age, I've always wanted to be in a good work position.

Now, with our machines, they're not only ergonomic to get up and work on, but we've brought the computer into it. Through computer programming, we've brought repeatable processing back with the select ENTER, cycle-start capability of computers. It's a game changer to the industry.

Where do you see the gear industry in the next 10 years or more and your place in that future?

In general, we're going to see gears get smaller, tighter, with more accuracy and better metallurgy coming, especially with the ability of some of the powder metals where we can deal a mixing of dissimilar materials in a powder-press format. Vapor deposition coatings are also going to be huge. It is huge now, but it's going to just continue to get bigger.

Gear deburring has always been a necessary evil. We make gears, and because of that, people like me have built gear deburring machines. Through the years, gears have been defined as being round for the most part. The burrs usually have also been confined to the outer edges. But advances in machine designs have changed all of that.

When it comes to non-gear parts, there isn't really a machine out there that does that, short of mass finishing, and mass finishing erodes precision-part dimensions and designs.

With the MAX System, we are capable of deburring non-gear parts and the many new gear designs. It isn't that we're going to get away from gears, we're going to be as important to gears as we've ever been, but we now have a machine that's capable of going and doing the cases the gears go in, the shafts that the gears go on — all of this type of stuff.

You go into a CNC shop of medium size now, and you usually see the operators standing there with a piece of sandpaper, sand deburring parts during cycles.

If we can automate that process, then an operator can run two or maybe three machines or do more valuable work and less repetitive hand work. I'm hoping I can bring some automated deburring to general machining. A lot of my customers make parts besides gears. 📧

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