LUBRICATION’S ROLE IN GEAR-FAILURE ANALYSIS

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Resharpening of cutters for both soft cutting and fine finishing can now be fully automated on Gleason vertical Power Skiving machines, greatly reducing tool cost-per-piece and helping ensure consistently high quality.
LUBRICATION AND ITS ROLE IN GEAR-FAILURE ANALYSIS

It’s important to employ best practices in order to identify gearset problems before they fail.

SELECTING A WORM GEAR LUBRICANT

Viscosity, load, material compatibility, noise emissions, component life, and the recommended service temperature range of an application should all be considered prior to selecting a worm gear grease.

POWER SKIVING WITH INTEGRATED CUTTER RESHARPENING

Power Skiving is establishing new quality and cost benchmarks with integrated resharpening, which revolutionizes the manufacturing process and current tooling concepts.

OFFERING THE TOTAL PACKAGE

COMPANY PROFILE  AIMS Metrology is an original equipment manufacturer that builds its own CMM models, which, in turn, benefits its customers by providing a ‘one-stop shop’ and a CMM supply company.
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**Broaches**
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**Inspection**
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- Posiloc Arbors
- “Quick Spline” Software

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Grain refinement is a noted benefit on gear tooth forming, heat treatment, and PHT finishing and recent advances further reduce induced stress on parts.

In this section, the premier supporter of gear manufacturing in the United States and beyond shares news of the organization’s activities, upcoming educational and training opportunities, technical meetings and seminars, standards development, and the actions of AGMA councils and committees.

AMEXCI, SLM Solutions strengthen partnership in metal-based AM.

Big Kaiser presents fifth annual donation to National Robotics League.

In this section, new products, trends, services, and developments in the gear industry.

WILLIAM MARK MCVEA

MATERIAL PRE-TREATMENT AS A FUNCTION OF PERFORMANCE

Grain refinement is a noted benefit on gear tooth forming, heat treatment, and PHT finishing and recent advances further reduce induced stress on parts.

BRIAN DENGEL

THE IMPORTANCE OF CONTACT RATIOS

How to calculate the contact ratios for various styles of gearing.

D. SCOTT MACKENZIE

NONDESTRUCTIVE TESTING VI – RADIOGRAPHY

X-rays are a helpful tool for checking the soundness of welds, effects of corrosion, and to follow the life of engine components.

New products, trends, services, and developments in the gear industry.

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American Gear Manufacturers Association

AMERICAN GEAR MANUFACTURERS ASSOCIATION

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The importance of lubrication and broaching

Without proper lubrication, the excess friction and dry metal-to-metal contact on gears would be detrimental to their proper functioning. That’s why it’s vitally important to know the challenges for proper gear lubricant formulation.

With this month’s issue, Gear Solutions is bringing you some detailed insight into this gear-industry necessity.

Lubrication has an important role to fill when it comes to gear-failure analysis, so it’s important to employ the best practices in order to identify gearset problems before they fail. In our cover article, Lawrence Ludwig Jr. and Mary Beckman take a look at this gear challenge.

Also on the subject of lubrication, Nye Lubricants’ Brian Kinkade shares his insights on selecting a worm gear lubricant.

Broaching is an important part of gear manufacturing, but alternatives to this production method are becoming more readily available, as well as economically viable.

Case in point: Power Skiving.

Gleason’s Dr. Edgar Weppelmann discusses how Power Skiving, which can be a viable alternative to hobbing and broaching, is establishing new quality and cost benchmarks with integrated resharpening — revolutionizing the manufacturing process and current tooling concepts.

Metrology is also an important tool in gear manufacturing, so, in our company profile, we shine a spotlight on AIMS Metrology. In that article, I talk with vice president and co-owner Mark Gearding on how his company is offering a wide range of measuring equipment to the industry.

And don’t forget to dive into Gear Solutions’ regularly featured columns. You’re sure to find something that you didn’t know before, and one of our columnists might even elicit a smile or two as well.

2021 may be a quarter of the way into the history books already, but Gear Solutions has a whole lot more in store for you, so “stay tuned” and keep me posted on anything you’d like to see or contribute in the coming months.

Have an amazing spring, and, as always, thanks for reading!
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AMEXCI, SLM Solutions strengthen partnership in metal-based AM

AMEXCI, an additive manufacturing company founded by eleven Nordic based industrial companies, and selective laser melting pioneer SLM Solutions have strengthened their partnership. The joint objective is to further accelerate the industrialization of metal-based additive manufacturing. To achieve this and to create the basis for increased productivity and part quality, AMEXCI has invested in the selective laser melting machine SLM®500, equipped with four 700-watt lasers.

The partnership between AMEXCI and SLM Solutions aims to boost industrialization and support companies to successfully implement AM technologies for serial production of complex metal parts. AMEXCI CEO Edvin Resebo said, “Having worked together for some time we are happy to take the next steps and further strengthen the cooperation between AMEXCI and SLM Solutions as we see their technology as a strong complement alongside our existing collaborations. Regarding the industrialization of AM, we see a growing potential in the Nordic region for the coming years. From an AMEXCI perspective, SLM Solutions showcases a strong understanding of what’s important and what needs to be in place for AM as an industrial manufacturing process.”

As part of the partnership, specific case studies will be used to evaluate additive manufacturing and test the competitive industry advantages of different machines and technologies offered by SLM Solutions. Additionally, AMEXCI evaluates the use of the recently introduced SLM® machine NXG XII 600 for industrialized series production.

Sam O’Leary, CEO of SLM Solutions, said, “AMEXCI works with a wide range of industries, especially in the Nordic region. We are proud to contribute as a solution partner to support and to realize AM business cases of their customers, from prototype up to serial production. Providing consulting services throughout the customer’s AM journey is a goal of SLM Solutions in this partnership.”

The basis for the joint cooperation is AMEXCI’s investment in the latest SLM®500 from SLM Solutions. The machine offers excellent features for industrial series production. As the first quad-laser system on the market, the machine is ideally suited for the rapid cost-effective production of large metal parts. The multi-laser overlap strategy with up to four 700-watt lasers ensures maximum efficiency. The ability to change the build cylinder minimizes machine downtime, maximizes productivity, and reduces cost per part.

AMEXCI, together with its customers, develops a new generation of products where AM acts as an enabler for higher competitiveness and more sustainable production. Furthermore, AMEXCI offers a wide range of training and workshops to build up successful business cases for their customers. At its AS9100D certified lab in Karlskoga, Sweden, AMEXCI has the capability to design, produce, and qualify components. Founding shareholders of AMEXCI are ABB, Atlas Copco, Electrolux, FAM, Husqvarna Group, Höganas AB, Saab, Scania, SKF, Stora Enso and Wärtsilä.

MORE INFO
www.amexci.com
slm-solutions.com

Big Kaiser presents fifth annual donation to National Robotics League

Customers of Big Kaiser helped to raise $6,275 to benefit the National Robotics League (NRL) — the fifth annual contribution to the program.

The donation is a 2 percent match of all qualified orders from National Tooling & Machining Association (NTMA) member companies. The donations are matched by Big Kaiser, who calculates the donations based on orders received from NTMA member companies. The donations are then distributed to NRL to support the organization’s efforts in promoting robotics and engineering education.

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.
companies during the final two months of the calendar year. Manufacturers placed orders for cutting tools, tool holders, workholding, and tool measurement systems, earning funds for the NRL at the same time.

The National Robotics League (NRL) is a manufacturing workforce development program of the NTMA that organizes student teams to design and build remote-controlled robots (Bots) to face off in a gladiator-style competition. Through the process of Bot building, students gain practical knowledge of science, technology, engineering and math (STEM) — all essential skills for manufacturing careers.

“We’re not just fighting a skills gap in our workforce, we have an ‘interest gap’ too. The NRL helps create excitement about manufacturing technology and STEM careers,” said Roger Atkins, president at NTMA. “We appreciate Big Kaiser’s continued support year over year, and of course all of the NTMA members who participate in the program to support the NRL.”

“I’m really happy we could make this contribution to NRL despite the really difficult year. We need to be there for these kids and stay engaged in all types of programs to promote manufacturing careers,” said Chris Kaiser, Big Kaiser executive adviser.

AIMS Metrology acquires Measurement Specialties Inc.

AIMS Metrology, a Dayton, Ohio-based OEM for coordinate measuring machines, has acquired the assets of Measurement Specialties Inc. (MSI). Also based in Dayton, MSI calibrated, certified, and programmed Sheffield [and other brands] CMMs and provided retrofit and repair services. In 2017, AIMS purchased CMI Technologies to expand control quality and delivery timeframes for components it produces for its Revolution Series 5-axis CMMs. MSI will expand AIMS’ service footprint.

“MSI has more than 100 years of combined experience in the measurement and inspection industry,” said AIMS Vice President Mark Gearding. “Adding that tribal knowledge to our team allows us to ramp up customer support for our Revolution Series CMMs as well as Sheffield machines and other brands. It also allows us to add employees with high-value skill sets. Since the pandemic, we’ve seen an uptick in our retrofit and upgrade business.”

AIMS plans to cross-train its service engineers to enhance support capabilities. The OEM will also be able to increase its capabilities for the development and application of...
AIMS designs and produces coordinate measuring machines integrated with 5-axis measurement technology for accurate, flexible three-dimensional inspection of in-process and post process parts. The OEM’s line of Revolution Series 5-axis LM and HB CMMs are built in the United States and engineered for the shop floor, the lab, and automated applications in smart factory settings. AIMS expanded its line in 2020 with the 5-axis multisensory Summit 10.10.10 developed for high volume, large parts inspection. The OEM’s CMMs are exclusively supported by Renishaw technology through probe heads, touch probes, scanning probes, incremental encoder scale systems, change racks, styli, controls, and Modus software. In addition to matching customer requirements with the right turnkey CMM system, AIMS provides installation, calibration, service/support, and training. Machine retrofits and refurbished equipment are also available.

MORE INFO  www.aimsmetrology.com

DMG MORI launches mobile portal app for customers

The “my DMG MORI” customer portal app offers quick and direct contact to a DMG MORI service expert with a complete status overview. With the app, users avoid waiting queues over the phone and save even more time with prefilled service requests. Inquiries will be processed immediately with priority by a specialist service expert. Users may then view the processing status of their request at any time in the order overview, and may also track any spare parts orders around the clock.

App features include:
- **Machine details**: All important details about the user’s machine.
- **New service requests**: Online service requests with photos and videos.
- **Order details**: Track and trace the current status of requests at any time.

Benefits include:
- **No waiting**: Simple online description of the problem.
- **Immediate processing**: The “right” service expert will process the inquiry with priority.
- **Digital access**: To complete machine history and documents.
- **Real-time access**: To processing status of service and spare part inquiries.
- **Free access, 24/7**: From anywhere, at any time.
- **On any device**: Computer, smartphone, or via CELOS.

Users must register at the website first before accessing the mobile app.

MORE INFO  www.us.dmgmori.com

ExOne partners with Rapidia, offers metal 3D printer

The ExOne Metal Designlab™ and X1F advanced furnace is a complete metal 3D printing system using Rapidia technology that will now be marketed and sold exclusively by ExOne. (Courtesy: ExOne)

Exsys Tool transitions into Exsys Automation to expand solutions

After 25 years of serving the manufacturing sector as Exsys Tool, Inc., with its high-precision Eppinger tool holders, the company has expanded into a new realm of manufacturing solutions under the new name Exsys Automation, Inc.

The transition reflects the company’s broadened focus on automation solutions with the introduction of Eppinger robotics, rotary tables, and other such systems to help customers further increase machine tool output. The new company will also continue to offer its popular PRECI-FLEX...
modular tooling system as well as its other
tool-holding products and gear box solutions
along with tooling repair services and appli-
cations expertise.

Exsys Automation will offer manufac-
turers new high-quality Eppinger products
designed to revolutionize chip making,
maximize productivity, and reduce per
part costs to boost their competitiveness.
Additionally, the company will offer IIoT
(Industrial Internet of Things)-ready plug-in
indexers and a range of robotic components
all designed and built by the well-known
German based manufacturer ESA Eppinger
GmbH.

MORE INFO  www.exsysautomation.com

Hurco gives Reynolds
Machinery top
distributor status

Reynolds Machinery, the exclusive distribu-
tor for Hurco CNC machine sales and service
in Ohio, won the 2020 Top Unit Sales Award
for North America, announced by Hurco.

Scott Mays, president of Reynolds Machinery, with
the company’s Hurco 2020 Top Unit Sales Award for
North America. The custom-designed award was
machined on a Hurco with special help from Online
Metals and John Force Racing. (Courtesy: Hurco)

Reynolds Machinery has been representing
Hurco in Ohio since 1996.

Hurco representatives presented
Reynolds Machinery with their award at the
distributor’s showroom and technical center
in Dayton, Ohio, with the assistance of the
Hurco job shop Automation Collaborative
Robot.

Scott Mays, president of Reynolds
Machinery, said, “We’re very proud to win
the No. 1 distributor award. We’re a com-
petitive group here at Reynolds and the
entire team worked very hard all year...so,
it means a lot to get the win. We are proud
to represent Hurco CNC machines. They are
well built and the control has the versatility
and features shops need to stay competitive,
increase productivity, and profitability.”

Scott Camloh, national sales manager for
Hurco, said, “Reynolds Machinery’s winning
formula serves their customers well because
they focus on support and service after the
sale. Not only are they extremely knowl-
dgeable about Hurco products and the advantag-
es of the Hurco control, they are responsive
to their customers and understand how to
help them gain the greatest benefits from
the powerful technology that is inherent to

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Hurco CNC machines.”

While Reynolds has always been near the top, this is their first time in the top spot. This is also the first year Reynolds has been able to offer customers the Hurco automation package from ProCobots. Hurco’s practical job shop automation package integrates the programming of the collaborative robot into the Hurco control.

“The biggest advantage of the Hurco Automation package is the ease of programming and the flexibility it gives shops. If you can program a Hurco, you can program the cobot, which eliminates the need to call an integrator each time you set up a new job. It makes automation practical and easy, especially for high-mix manufacturing environments,” Mays said.

MORE INFO www.reynoldsmachinery.com
www.hurco.com

LMC names new VP of machine tool dealers sales

LMC Workholding hired Mike Padilla as its new VP of machine tool dealers sales for North America.

Padilla is a veteran of the U.S. Navy (where he received a combat action service ribbon and Purple Heart during Desert Storm) and of the machine tool industry. His previous roles include regional manager for SMW Systems (also known as ATS Systems), accessory manager for Ellison Technologies, national sales manager for Rohm Products of America, and most recently sales/project support manager for the DMQP group of DMG Mori.

LMC hired Padilla to help further sales and support of LMC’s workholding products to the machine tool dealer network in North America. Padilla’s knowledge of both standard and custom workholding and LMC’s manufacturing capability in North America and its global supply partners will help LMC continue its drive to be the premier workholding supplier in the North American Market.

MORE INFO www.lmcworkholding.com

Manufacturing Cleaning Association launches streamlined website

The Manufacturing Cleaning Association (MCA), formed in late 2020, has a new website. The streamlined resource provides members and industry visitors with information about manufacturing and industrial cleaning as well as its importance and benefits.

Executive Director Matt Gilmore worked with developers to launch the site in February with the goal of providing technical resources, standards, and community information.

“The new website is both comprehensive and easy to navigate,” said MCA President Sherry Stepp. “As an association, our goal is to answer the question ‘how clean is clean?’ The website does this by offering up-to-date articles, white papers, and other resources from Association members and experts.”

By visiting MCA’s new site, visitors can learn more about the Association, its members, updated cleaning standards, industry resources, member benefits, and industry-related events (including conferences and online communities).

MCA is an industry association that provides educational and training opportunities to create unique and engaging networking events for manufacturing and industrial cleaning professionals and to establish and hold strict industrial standards.

MORE INFO www.manufacturingcleaning.org

Motion announces seven management promotions

Motion, a leading distributor of maintenance, repair, and operation replacement parts, and a premier provider of industrial technology solutions, made seven recent promotions to key field management positions. Each brings depth of experience and achievement to further position Motion for success, in providing the best customer experience as well as in attaining company growth goals.

Logan Carden was named Nashville Division vice president and will be responsible for overseeing the sales growth initiatives of 20 branches located in parts of Indiana, Tennessee, Kentucky, Mississippi, and Alabama. He will report to Chris Pacer, vice president group executive — Central.

Carden joined Motion in 2007, as a member of the corporate accounts support team. He continued to expand his roles within the company, ultimately earning a corporate account manager role in 2013 before his move to the field sales and branch operations side in 2019 with a promotion to branch manager of Motion’s Evansville, Indiana, location. Carden was promoted to sales manager of
the Evansville and Owensboro (Kentucky) locations in March 2020. He graduated with a Bachelor of Arts degree from Huntingdon College in 2006, and later earned his MBA from the University of North Alabama. Originally from Birmingham, Alabama, Carden is based in Indiana.

Bill Carroll was promoted to vice president of the new Philadelphia Division (Pennsylvania, New Jersey, and West Virginia), which was strategically established to serve and further the significant growth in the East group’s territory. He will be responsible for overseeing 13 branches’ sales and guiding their market growth, and will report to Phil Donnelly, vice president group executive — East.

Carroll most recently managed the Philadelphia branch, and in his career has held a variety of managerial, sales, and support positions in the company and in its industry. He started in 1989 with Eastern Bearing of New Jersey, which Motion acquired in 1999. During his Motion tenure, Carroll has managed at four different branch operations in New Jersey and Pennsylvania. He has also worked in Motion’s corporate accounts organization in a compliance manager role. Originally from Pennsylvania, Carroll is based near Philadelphia.

Tami DeWeese will assume leadership of the Pacific Northwest Division as its vice president. In her new role, DeWeese will oversee the sales growth, strategy and operations of 19 branch and shop locations. She will report to Jeremy Barton, vice president group executive — West.

A native of Washington state, DeWeese started with Motion in 2014 as a branch manager for Motion’s Portland (Oregon) branch, and in 2016 took on the added responsibility of the Longview, Washington, branch. Prior to joining Motion, she was the president of a process pump company for 13 years.

Dan Pike was promoted to St. Louis Division vice president and will be responsible for the sales growth and strategic management of 17 branch operations throughout Missouri and Arkansas. He will report to Austin Amos, senior vice president group executive — Midwest.

Pike began his career with Motion in 1991 as a corporate trainee, and his tenure has included various positions within the company including account representative, fluid power specialist, branch manager, corporate account manager, and most recently as area vice president corporate accounts for the Midwest Group. He is a native Floridian and a graduate of the University of Florida with a degree in marketing.

Dave Purvis was named Midwest Group Area Vice president, replacing Dan Pike in that role. Purvis will be responsible for lead-
ing the Midwest Group corporate accounts team, which involves managing existing corporate account relationships and driving new growth opportunities. He will also be responsible for providing corporate account partners with Motion’s full offering of services and solutions to reduce these partners’ total cost of ownership. He will report to Austin Amos, senior vice president group executive — Midwest.

Purvis started his career with Motion in 1991 at the Mattoon, Illinois, branch and has held various positions within the company, including warehouse manager, operations manager and account manager. In 2011, he was promoted to corporate account manager. Prior to joining Motion, Purvis attended Eastern Illinois University. Originally from Illinois, he is currently based in Decatur.

Steve Kammeyer was named area vice president for corporate accounts, West Group. In his new position, he will directly engage with field personnel and leadership in creating and developing internal and external sales-driven initiatives, with a focus on corporate account customers. Kammeyer will report to and work closely with Jeremy Barton (vice president group executive — West) in the execution of these efforts.

Beginning his career with Motion in 1986, Kammeyer has held various roles within the branch structure including warehousing, customer service, outside sales, and branch manager before being promoted to corporate sales manager in 2012. An Arizona native, he is based in Phoenix.

Lisa Solomon was promoted to area vice president for corporate accounts, Central Group, and will lead this group’s corporate accounts and was quickly promoted in 2016 to corporate accounts manager. Originally from Michigan, Solomon graduated from Central Michigan University with a Bachelor of Liberal Arts in broadcasting, communications and marketing.

“We are immensely proud of what these individuals have accomplished to date and are confident that their experience, acumen, and drive will help to take their Divisions and the company to a new level,” said Kevin Storer, executive vice president branch operations — North America and president of Motion Mexico. “Each of these promotions is well-deserved and we are looking forward to seeing the impact of their leadership, as part of Motion’s bright future.”

MORE INFO  www.motion.com

NUM launches innovative AI software to help monitor CNC tools

NUM has launched innovative artificial intelligence software that provides CNC machine users with highly cost-effective condition monitoring capabilities.

Compatible with all of NUM’s latest-generation Flexium+ CNC systems, the NUMai software package is a complete, fully integrated solution for CNC machine tools — it does not require any additional sensors, and runs on the same industrial PC as the CNC system’s HMI (human-machine interface).

NUMai software can be used as soon as a machine tool has been commissioned and is ready to start production, or on a machine that is already being employed for production purposes. The software initially acquires all pertinent operating data over a period of time, typically a number of hours, while the machine is being used for normal production tasks. Ideally, a diversity of part programs is run, involving a variety of different machining conditions, in order to ensure that the data is as comprehensive and reliable as possible.

The collected data is used to teach a neural network so that any deviation from the “good” machine behavior and performance can then be detected and predicted; a suitable PC program for subsequent online performance monitoring and diagnostic purposes is generated automatically.

During the software’s development, NUM beta tested the technology on a CNC milling machine equipped with three axes and a spindle, which required a neural network comprising 36 neurons with three hidden layers. In this particular instance, 396 parameters needed their values to be accurately defined; this required the acquisition of more than 2 million “known good” data points and 300 iterations of the teaching phase, which took about four hours per axis.

NUMai condition monitoring software capitalizes on the inherent flexibility of NUM’s latest-generation Flexium+ CNC platform. As standard, every Flexium+ CNC system includes a PC that can handle data from the servo drives’ measurement points, a PLC that has direct access to machine parameters, and an NCK oscilloscope feature capable of reading values in real-time. All system communications are handled by FXServer, using fast real-time Ethernet (RTE) networking.

During everyday use in the production environment, NUMai software runs in the background on the industrial PC that forms part of the machine tool’s CNC system, continuously monitoring and evaluating the machine’s performance. Any discrepancy or deviation beyond user-defined thresholds is
notified to the PLC, which decides what action should be taken — from a simple advisory message to an emergency disengagement.

The new NUMai condition monitoring software option can be installed and used on any Flexium+ CNC system running NUM’s Flexium software version 4.1.10.10 or higher.

MORE INFO www.num.com

Olympus DP28, DP23 cameras speed up imaging

New DP series cameras share a suite of smart features and precise color accuracy to simplify industrial microscopy imaging. The DP28 camera offers 4K resolution to provide high-resolution images free from artifacts, while the DP23 camera’s full HD resolution is balanced with convenient features to provide outstanding value for almost any industrial imaging application.

Microscope cameras are used to check the quality of manufactured materials to help ensure that there are no defects. Clear images and accurate color reproduction are critical features users need to be able to spot very small defects. The Olympus DP28 and DP23 cameras offer outstanding image quality with smart features that make imaging tasks fast and efficient.

DP series microscope cameras enable users to comfortably view onscreen images rather than having to look through the microscope’s eyepieces. For smooth, ultra-clear 4K images, the DP28 camera is equipped with an 8.9-megapixel CMOS sensor and global shutter. If resolution is less important, the 6.4-megapixel DP23 camera can capture HD images at up to 60 frames per second for fast sample scanning and offers a field of view up to FN25, so users can see more of their sample at once and spend less time stitching small images together (when used with the 0.35X TV (DP23).

The camera’s features make common imaging tasks easier so that users can remain focused on the screen rather than making time-consuming adjustments. Key features include the Fast Live function that provides a high frame rate during long-exposure imaging for excellent image quality in low light and focusing peaking to quickly identify which areas of the sample are in focus (when used with the 0.35X TV (DP23).

All critical data, including images, annotations and analytics, can be displayed and shared together locally or remotely. For complex or advanced image analysis, both cameras are compatible with OLYMPUS Stream™ v. 2.4.4 software to further streamline your workflow (OLYMPUS Stream is not compatible with remote sharing).

With powerful features, precise color accuracy and 4K (DP28) or full HD (DP23) resolution across a wide field of view, the DP28 and DP23 cameras provide high-quality imaging solutions for industrial microscopy applications.

MARCH 2021

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Sintavia gets AS 9100 design, development certification

Sintavia, LLC, a designer and additive manufacturer of critical thermal and airfoil components for the aerospace, defense, and space industry, has achieved AS 9100 approval for product design and development. The approval, which followed months of auditing the company’s past performance, allows the company to offer its flight and launch customers certified design solutions for critical components such as heat exchangers, combustors, and chassis. The latest certification adds to the company’s set of quality accreditations. “Over the past nine years, Sintavia has reached a number of milestones as we have developed the market for critical, additively manufactured components for the aerospace, defense, and space industry,” said Alex Bencomo, Sintavia’s vice president of operations. “AS 9100 accreditation for design and development continues this trend. Customers can now be assured that not only does Sintavia possess the capability to design and develop their critical components, but also that it maintains the processes needed to conform these parts to rigorous quality standards.”

In addition to AS 9100 certification for the design and manufacture of aviation components, Sintavia is certified to ISO 17025 and ISO 14001 standards, and holds Nadcap accreditations in additive manufacturing, heat treatment, and mechanical testing.

MORE INFO www.sintavia.com

CNC machine supplier Tormach names chief financial officer

Tormach Inc., an industry-leading supplier of affordable and compact CNC machines, has appointed Darcy Johnson as the company’s chief financial officer (CFO).

Before joining Tormach, Johnson worked with various clients as their Interim chief financial officer, partnering with Lauber Business Partners in Milwaukee. Before that, she worked for more than five years as director of finance for Dynamic Solutions (DynaTrap), where she led all finance, IT, and HR functions. She was the company’s M&A lead during its acquisition by Woodstream Corporation in late 2019, and worked with them to transition the company.

Johnson has an MBA from the Keller Graduate School of Management at DeVry University and a BA in accounting and business administration from Lakeland University.

“We are excited to have Darcy joining our team here at Tormach,” said Daniel Rogge, Tormach CEO. “She brings a wealth of experience with her to this position and we’re confident she will help us successfully manage our continued growth.”

MORE INFO www.tormach.com

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One of leadership’s important responsibilities is to check in

In a world of manufacturing machines, engineering products, and working with metals and materials, it is difficult to remember that your largest company asset is actually human—which requires a different approach when taking inventory. There comes a time in business when the relationship of a boss to an employee can develop into something more personal, and now, more than ever, leadership needs to check in to make sure their humans are operating properly.

According to John Hopkins Medicine, 1 out of 4 adults (18 and older) suffer from some sort of mental health that is diagnosable. With potentially 25 percent of the workforce facing daunting depression, anxiety, bi-polar disorder, or something else, it is likely your plant floor is being affected. Furthermore, you add in the confinement of COVID-19 restrictions and lack of interaction and traveling, a person who might have mildly suffered from issues could now be experiencing symptoms tenfold. So, as a manager, company owner, or leader, what can you do that doesn’t involve you violating HIPPA laws or personal boundaries?

Here are some things to think about:

MAKE SURE YOUR STAFF UNDERSTANDS WHAT MENTAL HEALTH IS
Enable your leadership and managers to know the signs when someone might be suffering.

Knowledge is powerful. People working at your company might be the best engineers or operators in the world, but they are not psychologists. They might see an employee calling out more, taking longer breaks, or working slower and just think it is lack of effort. But maybe there is something else there that warrants a conversation to understand the signs. Training your leadership and employees with the tools to understand might make a difference, and it signals you care about this subject and encourages them to talk about getting help.

COMMUNICATE, COMMUNICATE, COMMUNICATE
Some believe communication at work should be limited to tasks at hand—otherwise it is time and money wasted. But did you know that “research shows that nearly 86 percent of employees treated for depression report improved work performance. And in some studies, treatment of depression has been shown to reduce absenteeism and presenteeism by 40 to 60 percent.” (“Workplace mental health: How to support employee mental wellness | Understood – For learning and thinking differences”)

So, financially, there is incentive to talk about what is going on with your employees to avoid bigger issues of lost productivity down the road. In addition, talking to your employees truly makes them feel seen and involved, and it creates a sense of importance to the team.

Todd Palmer, President of Extraordinary Advisors and speaker at the 2021 Annual Meeting said, “As a leader, if you only do one thing with your team … communicate. You have to relentlessly communicate, communicate, communicate. In the absence of information, employees will fill in the gaps of communication with their own narrative, which is often inaccurate and negative. By communicating, you are giving the gift of information and mental well-being. And with that gift, you calm the negative chatter inside the minds of your leaders and your teams.”

PUT YOUR MONEY WHERE YOUR MOUTH IS
Training and talking are great first steps, but without a call to action, some employees might still be lost. To finalize a real approach to handling mental health in your company, you need to offer resources. Include mental health in your health plan coverage. Allow people to know they don’t have to worry about the financial repercussions of getting help. Additionally, start an Employee Assistance Program (EAP) where you can post flyers around the office, supply numbers of hotlines to call, bring in healthcare professionals to talk to your team, use your newsletter or daily team emails to remind people to take breaks, feel safe at work and let them know they have confidential resources to get help.

Mental health issues are no secret, and the sooner your company stays on top of it, the better your employees will be, work, and the longer you will have them. Mental health is a leading cause of why people quit their jobs. Don’t be part of that percentage. Manufacturing is critical to our world, and the people that work for you are a part of that.
Join us for the Annual Meeting Online, March 18-19, 2021. Attendees at the Annual Meeting Online will experience an exciting program featuring cutting-edge educational content along with engaging and memorable networking opportunities—all from the comfort of your home or office.

We are all disappointed that we could not meet face-to-face for the 2020 Annual Meeting, and there is a pent-up demand to network with peers to catch up on how other companies are facing the new reality of life post-COVID-19 and make new business connections to keep the conversation going once the meeting is over. It might not look the same as our normal in-person years, but attending online might virtually be the best decision you make this year.

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- **When:** September 14–16, 2021.
- **How to Exhibit:** Contact Christine von Steiger, P: 703-706-8252, E: agmasales@ntpevents.com
- **More information:** motionpowerexpo.com

Q1 Gear Market Report is Now Available

“Under a faster recovery scenario, gear demand should increase 8.5 percent during 2021 rather than 4 percent under the baseline with no fiscal stimulation.”

This was just one piece of vital information from the Q-4 (December release) AGMA Gear Market Report. Imagine receiving more than 100 slides each quarter filled with graphs, charts, and economic indicators you need to understand where to pivot toward a successful path with information that includes pandemic outlook, global perspective, important policy updates, and trade-war information. This is what you get when you subscribe to the AGMA Gear Market Report.

This valuable report is only available to AGMA member companies. We have kept the 2020 discount subscription rate of $1,000/year for 2021. Sign up today to assure you receive the first report later this month. The Q1 report has been officially released and is ready for purchase.

https://www.agma.org/membership/statistical-reports/
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.

### MARCH
- March 11 — Powder Metallurgy Committee Meeting — WebEx
- March 25 — Nomenclature Committee Meeting — WebEx
- March 30 — Metallurgy and Materials Committee Meeting — WebEx
- March 31 — Bevel Gearing Committee Meeting — WebEx

### APRIL
- April 1 — IIoT Committee Meeting — WebEx
- April 8 — Cutting Tools Committee Meeting — WebEx
- April 14 — Plastics Committee Meeting — WebEx
- April 15 — Lubrication Committee Meeting — WebEx
- April 22 — Gear Accuracy Committee — WebEx
- April 27 — Nomenclature Committee — WebEx
- April 27 — Robotics & Automation Committee Meeting — WebEx
- April 29 — Metallurgy & Materials Committee — WebEx

### MAY
- May 6 — Market Intelligence Committee Meeting — WebEx
- May 13 — TDEC Meeting — WebEx
- May 20 — Lubrication Committee Meeting — WebEx
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Material pre-treatment as a function of performance

Grain refinement is a noted benefit on gear tooth forming, heat treatment, and PHT finishing and recent advances further reduce induced stress on parts.

This article is not intended to go deep into the metallurgy of pre-treatment, nor will it discuss the nuances of the machining or heat treatment of alloy steels typical of gear steel. I will try to develop a logic assessment of the benefit, thus justify the cost adder of buying material in an optimum condition prior to any machining. The old saying “you only get out as good as you put in” applies to gears as well. We know this from our efforts to develop the best geometry for the application, or microgeometry to address noise (NVH) issues or even material and process specification to reduce cost. Preparation of a material prior to use takes many forms; some are surface preparation prior to coating (e.g. plating or painting, etc.) or the task may entail creating a surface finish that promotes the next step manufacturing process such as the correct surface texture for a press fit or plating through plasma-transferred wire arc (PTWA, basically the process involves blowing a fine mist of molten steel at high speed onto a precisely defined “rough” surface and then honing that surface into a perfect cylinder bore). This article discusses the benefit of grain refinement on gear tooth form machining, heat treatment, and PHT finishing (i.e. grinding and/or super-finishing).

Grain refinement theory is based on the relationships between grain size and nucleate particle size and potency, nucleate density, and the constitution of the alloy. It is an important material strengthening mechanism because it increases both fracture toughness and strength at low temperature. As an example of the benefit of grain refinement, we can look to the finite element method (FEM). The objective of the FEM is to discretize the solid model of the part to be analyzed into small pieces and then solve a series (generally a very large number of) simpler equations and sum the individual results back into a predictive model of the original body. Taking the discussion of this technique a bit further, the number, size, and shape of each element directly relates to the convergence of the model to an accurate solution in a reasonable amount of computational time. The “solution” of a finite element analysis (FEA) requires convergence of all the individual element models to within a specified limit. Convergence thus requires that there is only a small difference in strain energy between the individual element solutions, and that the difference is less than the requisite convergence limit. The variation in strain energies is only manifest at the element boundaries (or grain boundaries in actual materials) as discontinuities (the interior of the mathematical element model is considered continuously varying). Differences in the solved-for strain energies then constitute the strain, thus stress, and finally deflection of the entire model. The larger the difference in discontinuity of strain energy at any given point along the element boundary, the less accurate the solution.

Now let us map this over to an actual alloy steel material. It is common knowledge that materials with smaller grains have greater ratios of surface area to volume of the crystal, which means a greater ratio of grain boundary to dislocations. Grain boundaries are ubiquitous defects in metallic alloys governing a range of properties, such as tensile strength, fatigue resistance, fracture toughness, strain hardening, brittleness, conductivity, or corrosion. Grain-boundary segregation of alloy (impurity) elements, such as phosphorus, arsenic, antimony, and others, decreases the grain-boundary cohesion, which can substantially increase the temperature of the ductile-brittle transition in low-alloy structural steel.

A grain is a single crystal, within which the atomic lattice and its orientation are continuous. Adjacent grains of the same phase with different orientations are separated by an immaterial surface called a grain boundary. The two crystal lattices extend regularly right up to the boundary. Grain boundary dislocations are linear defects with all the characteristics of lattice dislocations. The more grain boundaries that exist, the higher the strength becomes. Why, the boundary between two grains (grain boundary) is a defect in the crystal structure of the alloy and is created during the cooling process from liquid to solid. Grain boundaries are associated with a certain amount of energy, referred to as strain energy within the lattice. The more grain boundaries and the larger width or gap between these grain boundaries, the more energy is stored in the metal. We also know that heat-treat distortion is the release of strain energy (induced stress due to multiple sources such as shearing during the cutting process, cold working the metal prior to heat treat, etc.) so the more stored energy to be released, the greater the distortion.

The smaller the grain size and grain boundary dissimilarities, the stronger the material. Slowing the movement of grain dislocations also strengthens the material. There are any number of ways to reduce the dislocation movement. These include alloying and strain hardening. Smaller grains have greater ratios of surface area to volume, which means a greater ratio of grain boundary to dislocations. The more grain boundaries that exist, the higher the strength becomes.

Recent innovations in grain refinement have been related to semisolid processing where control of melt temperatures and the use of melt shearing technologies have been able to improve the properties of castings. Ultrasonic treatment and electromagnetic stirring are attracting renewed interest and may provide a way to grain refine alloys without the use of grain refiners. We also use a technique of H-band grain refinement. The “H” indicates the material meets hardenability according to ASTM A304. Grain-boundary strengthening (or Hall–Petch strengthening) is a method of strengthening materials by changing their average crystallite (grain) size. It is based on the observation that grain boundaries are insurmountable borders for dislocations and that the number of dislocations within a grain influence how stress builds or accumulates in the adjacent grain, which will eventually activate dislocation sources and thus enabling deformation in the neighboring grain. So, by changing grain size one can influence the number of disloca-
Grain refinement theory is based on the relationships between grain size and nucleate particle size and potency, nucleate density, and the constitution of the alloy. It is an important material strengthening mechanism because it increases both fracture toughness and strength at low temperature.

Dr. William Mark McVea, P.E., is President and Principal Engineer of KBE+, Inc. which develops complete powertrains for automotive and off-highway vehicles. He is the Principal Engineer with Kinatech, a joint venture with Gear Motions / Nixon Gear. He has published extensively and holds or is listed as co-inventor on numerous patents related to mechanical power transmissions. Mark, a licensed Professional Engineer, has a B.S. in Mechanical Engineering from the Rochester Institute of Technology, a Ph.D. in Design Engineering from Purdue University.
The importance of contact ratios

How to calculate the contact ratios for various styles of gearing.

It is expected that when we flip the switch on a device that it will power up and some motion will occur. In the example of the desktop printer that we all have in our home office, we expect it to go through a warmup cycle that involves the device moving all of its internal parts in preparation of printing your document or image file. This moving occurs because the motor drives the gears, which, in turn, manipulate the working of the printer. If the motor is energized but the gears do not mesh, the printer cannot perform to your expectations. One of the driving factors in establishing the amount of load that a gear pair can transmit is the contact ratio.

The contact ratio is the numerical determination of the number of teeth on each gear when any gear set is in mesh. It accounts for the teeth that are sliding into the mesh, the teeth that are sliding out of the mesh, and those that are in full contact when the gears are engaged.

The transverse contact ratio ($\varepsilon_0$) for spur gears is calculated using the following formula:

$$\varepsilon_0 = \sqrt{r_k^2 - r_g^2} + \sqrt{r_k^2 - r_g^2} - a \sin \alpha_0$$

where:
- $r_k$ = tip diameter (mm)
- $r_g$ = reference radius (mm)
- $a$ = center distance (mm)
- $\alpha_0$ = working pressure angle (degrees)
- $\alpha_0$ = reference pressure angle (degrees)
- $m$ = module

When the working pressure angle is set to 20 degrees and module is set to 1, the values are calculated in Table 1.

The transverse contact ratio ($\varepsilon_0$) for helical gears is calculated using the following formula:

$$\varepsilon_0 = \sqrt{r_k^2 - r_g^2} + \sqrt{r_k^2 - r_g^2} - a \sin \alpha_{bs}$$

where:
- $r_k$ = tip diameter (mm)
- $r_g$ = reference radius (mm)
- $a$ = center distance (mm)
- $\alpha_{bs}$ = working pressure angle (degrees)
- $\alpha_s$ = reference transverse pressure angle (degrees)
- $m_s$ = transverse module

The transverse contact ratio ($\varepsilon_0$) for straight tooth bevel gears is calculated using the following formula:

$$\varepsilon_0 = \sqrt{R_{vk}^2 - R_{vg}^2} + \sqrt{R_{vk}^2 - R_{vg}^2} - (R_{vi} + R_{vo}) \sin \alpha_0$$

where:
- $R_{vk}$ = tip diameter on the back cone for an equivalent spur gear (mm)
- $R_{vg}$ = reference radius on the back cone for an equivalent spur gear (mm)
- $R_v$ = back cone distance (mm)
- $r_0 = 0.5m$
- $\delta_0$ = reference cone angle (degrees)
- $h_k$ = addendum at outer end (mm)
- $\alpha_0$ = reference pressure angle (degrees)
- $m$ = module

When the reference pressure angle is set to 20 degrees and module is set to 1, the values are calculated for straight tooth bevel gears produced in the Gleason® system in Table 2.

The transverse contact ratio ($\varepsilon_0$) for spiral tooth bevel gears is calculated using the following formula:

$$\varepsilon_0 = \sqrt{R_{vk}^2 - R_{vg}^2} + \sqrt{R_{vk}^2 - R_{vg}^2} - (R_{vi} + R_{vo}) \sin \alpha_0$$

where:
- $R_{vk}$ = tip diameter on the back cone for an equivalent spur gear (mm)
- $R_{vg}$ = reference radius on the back cone for an equivalent spur gear (mm)
- $R_v$ = back cone distance (mm)
- $r_0 = 0.5m$
- $\delta_0$ = reference cone angle (degrees)
- $h_k$ = addendum at outer end (mm)
- $\alpha_0$ = reference pressure angle (degrees)
- $m$ = module
- $\beta_m$ = mean spiral angle (degrees)

When the reference pressure angle is set to 20 degrees and module is set to 1 and the spiral angle is set to 35 degrees, the values are calculated for spiral tooth bevel gears produced in the standard system in Table 3.

Using the tables and formulas, you will be able to determine the proper contact ratio for most styles of gearing.
### Table 1

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<th>25</th>
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<td>1.802</td>
<td>1.808</td>
<td>1.817</td>
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\[ e_n = \frac{\sqrt{r_{h1}^2 - r_{p1}^2} + \sqrt{r_{h2}^2 - r_{p2}^2}}{\pi \cos a_0} \]

### Table 2

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### About the Author

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

X-rays are a helpful tool for checking the soundness of welds and effects of corrosion, and to follow the life of engine components.

In this article, we will be discussing the use of radiography (X-rays) for the detection of flaws. In the previous articles on nondestructive testing (NDT), we discussed magnetic particle inspection, eddy current inspection, ultrasonic inspection, and dye penetrant inspection.

X-rays were discovered on November 8, 1895, by Wilhelm Roentgen at the University of Wurzburg. He was working in his laboratory and was examining a vacuum tube called a Crookes tube, which is a precursor to a modern cathode ray tube. This Crookes tube was covered in black cardboard so that no light would emanate from the tube. He discovered that as the Crookes tube was energized, a piece of cardboard coated with barium platinocyanide would fluoresce. As he moved the cardboard closer to the tube, the barium platinocyanide would fluoresce at a greater intensity.

This discovery would not only revolutionize medicine, but also industrial nondestructive testing.

The second discovery that affected the modern world with a direct influence on modern radiography was the discovery of gamma rays by Marie and Pierre Curie. They observed that thorium was like uranium, in that it gave off the same sort of rays. Mixtures of bismuth and barium were also like uranium. After years of extraction, the couple discovered polonium and radium. The term radioactivity was coined.

This work was the foundation for the modern nuclear reactors that produce the industrial gamma ray sources of Iridium-192 and cobalt-60.

THEORY

In modern radiography, there are either gamma ray sources or X-ray sources. X-rays emanate from an electron tube, while gamma rays originate from a source such as cobalt-60. There is the part to be examined, and the method of capturing the radiograph. Finally, interpretation of the radiograph must be performed.

The penetration of an X-ray or gamma ray in a material is expressed in terms of a “half-value.” The value is defined as the thickness of a specific material that will reduce the radiation intensity to one-half the value of that entering the part [1][2]. This half-value is affected by the following:

- **Energy.** The more energetic the radiation source is, the greater the thickness the rays can penetrate. This means that more energetic radiation sources will have greater half-values.
- **Material Type.** As the material density increases, the half-value decreases. Metals such as tungsten have low half-values, while lighter metals, such as aluminum, have much greater half-values.
- **Thickness.** As the thickness of a material increases, more scattering and absorption will occur. This reduces the amount of radiation that can pass through the metal.

This is illustrated in Figure 1 for X-ray energy and in Figure 2 for gamma-ray sources.

The concept of half-value explains why X-ray radiography is so effective at detecting discontinuities. If a material has pores or porosity, the X-rays will readily pass through the porosity or pores. This will result in a higher exposed region on the X-ray film, which results in a darker area on the film. The same is true for more dense materials, such as a tungsten inclusion in an aluminum TIG weld. The higher density tungsten would prevent or slow X-rays, while the less dense aluminum would readily pass them. This would result in a lighter area on the processed X-ray radiograph.

EQUIPMENT

Industrial X-ray equipment can come in different sizes, shapes, and energy. Most equipment is classified according to the energy produced. Energy production of 125kV to 400kV are the most common, with energies below 125kV considered to be low powered. Those systems above 400 kV are high powered.

Gamma ray equipment consists of the source and the exposure device. The exposure devices contain the source in an S-shaped tube that is securely shielded. Most commonly, the sources are cobalt-60 or Iridium-192. Compared to an X-ray tube, the energies are much higher. Cobalt-60 produces energies equivalent to a 1.25MeV X-ray system. Iridium produces energy equivalent to a 460 kV system [3].

![Image of half-value layers for different X-ray energies and materials](image1)

**Figure 1:** Half-value layers for different X-ray energies and materials [2].

![Image of half-value layers for different gamma ray sources and materials](image2)

**Figure 2:** Half-value layers for different gamma ray sources and materials [2].
high energy and small size make this the preferred method for field radiography. However, unlike X-ray sources, the gamma ray sources cannot be turned off. Managing radiation safety is always a priority.

The actual radiation source is small, being that a pellet of that is 1.5 mm in diameter. This pellet is sealed in a stainless-steel capsule by welding. A pigtail is attached to the pellet capsule, allowing it to be lowered (exposed) or raised. Shielding can be lead or depleted uranium. The amount of shielding will vary by source but is typically 500 pounds of shielding for a cobalt-60 source and 45 pounds for an Iridium-192 source [4].

SAFETY CONSIDERATIONS
Radiation can damage living tissue. Radiation absorption is a function of time, distance, and shielding. Time reduces the total exposure to radiation — the shorter the exposure the better. Radiation exposure also follows an inverse-square law. If you can double the distance between the source and the person, you reduce the exposure to 1/4.

It is important that personnel involved with X-ray and gamma-ray radiography be properly trained. It is critical that they wear film badges or other radiation sensing devices (such as a dosimeter).

APPLICATIONS
The primary application of radiography is the examination of the soundness of welds and castings. However, many other different product forms are examined by radiography. The degradation of components in the nuclear power industry is one example, due to corrosion or other damage. Airframes and engine components, during initial manufacture and during the life of the components, are often X-rayed. Composites and engine components are examined at routine intervals.

Historical objects are often examined by X-ray to validate artists or to examine if there are other images or paintings below the surface. One recent examination of the Liberty Bell was compared to previous radiographic analysis to see if damage had progressed.

There are also the numerous and very common medical applications to detect broken bones, presence of cancer, and other similar applications.

CONCLUSIONS
In this article, we have described the basics of radiography. Please refer to the references or online references if you wish to learn more about radiography or applications of radiography. There are many aspects of radiography that were not covered in this short article.

If there are any suggestions for future articles, or comments about past articles, please contact the editor or the writer.

REFERENCES


LUBRICATION AND ITS ROLE IN GEAR-FAILURE ANALYSIS
It’s important to employ best practices in order to identify gearset problems before they fail.

By LAWRENCE LUDWIG JR. and MARY BECKMAN

When gears fail, it is most often due to fatigue and overloading. The most common form of distress and failure is actual breakage, but other modes of distress include surface fatigue known as pitting, normal and abnormal wear, and plastic flow.

What distress and failure look like depends on the type of gear. Gears that are through-hardened — which exhibit consistent hardness all the way through the gear — will have defects that look different from those that are hardened only on the surface. Surface-hardened, also known as case-hardened, gears have a thin layer that is hardened with softer metal underneath.

The first signs of gear failure are wear or pitting in the dedendum just below the pitch line where the protruding teeth of one gear fit into the second gear, as shown in Figure 1.

To counter this problem, original equipment manufacturers (OEMs) can increase the hardness of the gear, the gear’s face width, or its pinion pitch diameter. Alternately, OEMs can improve the geometry of the gear.

The acronym LETS-C represents the four factors that contribute to gear failure and reduce gear life:

- Load.
- Environment.
- Speed.
- Contamination.

FEATURES AND FAILURE

Some kinds of design features factor into distress and failure.

Hertzian strength, or beam strength, refers to the ability of a gear tooth to withstand repeated loadings. It is a measure of the load-carrying ability of a pair of gears. It has to be greater than the maximum dynamic load of the gear. Fatigue occurs when a gear is pushed beyond its capacity.

Thermal rating refers to the recommended maximum speed, reduction ratio, and horsepower of the gearset. If the gear drive is used above those recommendations, the gear drive will start overheating.

This information can usually be found on the drawings, in the user manual, or on the plates of the gearbox.

Backlash is a design feature that can affect lubrication. It is the distance between the back of one tooth and the front of the next mating tooth, as shown in Figure 2.

The distance allows the lubricant to coat the gear teeth. Without a good film of lubricant, the gears will overheat, create noise, suffer tooth wear, and possibly fail. A rule of thumb for an appropriate amount of backlash is as follows:

- Backlash = 0.04/diametral pitch of gear.
- Diametral pitch = the number of teeth/the pitch diameter.

Clearance also is needed for lubricant to flow properly between the gears. It is the distance between the top of one tooth and the base of the tooth on the other gear. It is a function of the height of the tooth and also is the amount by which the dedendum in a given gear exceeds the addendum of its mating gear.

Classes of lubrication-related failures:

- Hertzian fatigue, both micro and macro.
- Wear.
- Scuffing, also known as scoring (or surface fatigue).

Different schools of thought break down gear failure into varying numbers of modes, as shown in Figure 3. For example, in this chart, tooth fracture occurs when the gear has been severely overloaded and failed.

Surface fatigue is a failure of gear material that has been under repeated surface or sub-surface stress.
beyond the material’s endurance limit. It indicates that Hertzian stresses are occurring when a gear and a pinion mesh. These stresses are above the beam strength of that gearset.

Surface fatigue forms include:

- Pitting.
- Scoring.
- Case crushing.

**Pitting**

Pitting is the most common failure mode for gear teeth. It’s due to repeated loading and contact stresses exceeding surface fatigue strength of the material. Pitting can begin as soon as gears are put into operation.

Pitting comes in three types: initial, also known as corrective; destructive; and normal. All of these forms of pitting can take macro or micro forms. Macropitting refers to pits larger than 1 mm in diameter. Micropitting, also known as gray staining, includes pits that are smaller than 10 microns in size. Micropitting causes the gears to look like it has white or gray frosting on the surface.

Initial pitting is caused by local areas of high stress due to uneven surfaces on the gear teeth. They are small pits less than 1 mm in diameter that can develop in a relatively short period of time. Pitting usually occurs in a narrow band at the pitch line or just slightly below the pitch line. It appears most prominently on through-hardened gears, occurs in localized areas, and tends to redistribute load by removing rough areas with a high number of asperities.

Destructive pitting, also known as progressive pitting, results from surface overload conditions that initial pitting did not smooth out in the gearset. If tooth surface hardness is within specified values, system overloads are usually the cause of destructive pitting.

Destructive pitting starts below the tooth pitch line in the dedendum. It increases progressively in both the size and number of pits. It can eventually form fatigue cracks.

Ways to fix problem pitting include reducing the drive load, using a higher viscosity or different type of lubrication, upgrading the gearing or increasing drive size.

Figure 4 shows an example of macropitting in the dedendum of a pinion on the main hoist of a power shovel. Failure was caused by inadequate lubricant viscosity. The lubricant was much too light, at least two grades below what was recommended by the OEM. The image shows that much of the surface was undermined by subsurface cracks.

Figure 5 shows an example of micropitting. Gear tooth surfaces must be illuminated at different angles to observe micropitting.
Using intense direct lighting works better than diffuse fluorescent lighting.

Figure 6 lists different factors that influence micropitting. Ways to control it include having smooth surfaces on the gear teeth, operating under appropriate conditions, and using lubricants designed to inhibit micropitting. Lubricants with a low coefficient of traction such as a PAO- or PAG-based oil will help reduce surface fatigue. Choose lubricants wisely because you don’t want to compromise other desired characteristics of your oil such as good wear and scuff protection or compatibility with seal materials.

**SPALLING**

Spalling describes a large area where the surface material has broken away from the tooth. It can appear as overlapping or interconnected large pits. With surface-hardened gears, it generally appears as loss of a single (or several) large areas.

Spalling is caused by high-contact stresses where the edges of initial pits break away and rapidly form large holes; for example, when micropits coalesce to form large craters. On the teeth in Figure 7, cracks have grown from the spall and reached the core/case boundary. The cracks continue under the topland and exit on the backside of the gearing, creating a hole all the way through the tooth.

**CASE CRUSHING**

A type of spalling, case crushing, is associated with heavily loaded case-hardened gears. Case crushing appears as long longitudinal cracks on the tooth surface, which can cause pieces of the tooth to subsequently break away. Case crushing occurs suddenly on only one or two teeth of the pinion or gear. These cracks differ from pits because they not only extend below the hard case, but can go clear through as shown in Figure 8.

Failure may be due to insufficient case depth, insufficient core hardness, or high residual stresses. In many cases, failure is due to too much loading.

**WEAR**

Wear describes loss of material from the contacting surfaces of a gear. Common causes of gear tooth wear include metal-to-metal contact from poor lubricating film, abrasive particles working their way into the gears, and chemical wear due to the composition of the gear oil and its additives.

Varying degrees of wear include:
- Polishing or light, which occurs slowly.
- Excessive, such as destructive wear, which causes tooth shape to change and impairs meshing action.

Three types of wear modes include adhesive, abrasive, and corrosive wear, with subcategories that include:
- Scuffing.
- Polishing.
- Scratching.
- Welding.
- Furrowing.
- Fretting corrosion.
- Cavitation.
- Erosion.

In adhesive wear, highly attractive forces of atoms occur on each of two contacting, sliding surfaces. Teeth touch each other at random asperities, forming a strong bond. Metal particles are actually transferred across the contacting surfaces. Transferred fragments fracture or fatigue away, forming a wear particle.

Scuffing is a severe type of adhesive wear that causes transfer of metal from one tooth surface to another due to welding. Scuffed areas have a rough or matte structure. Damage occurs in the addendum, dedendum, or both in the direction that sliding is occurring. Under magnification, scuffed surfaces appear rough, torn, and deformed.
 Abrasive wear is sometimes called cutting wear. It occurs when hard particles make their way between the gears and slide or roll under pressure across the tooth surface. The hard particles can be dirt, castings, scale, or even wear debris. Corrosive wear is deterioration of the gear tooth due to chemical or electrochemical reactions. Chemical wear gives the tooth a stained or rusty appearance. Etched pits may appear as well. Unlike other types of wear, corrosive wear can be found on the entire tooth surface.

Common causes of corrosive wear include the chemical action of active ingredients in the lubricant such as sulfur, the presence of moisture or foreign materials in the lubricant, and the extreme-pressure additives added to the lubricant that react with the gear teeth.

**BREAKAGE**

Breakage is the ultimate type of failure. Breakage leads to a disabled drive and frequently to damage of other components such as shafts or bearings by pieces of the broken teeth. Breakage is the result of high overloads from impact or static. Misalignment of the teeth also can lead to tooth breakage. Fatigue fractures are the most common type of breakage, which arise from cracks at the root fillet that slowly progress.

**LUBRICATION SHORTCOMINGS**

Lubricant issues can cause a variety of distress. Scoring and galling are generally caused by oil film breakdown, whether due to contaminants in the oil or too light of a viscosity, which, in turn, allow metal-to-metal contact and high-operating temperatures.

Particulate contaminants present in the lubricant can cause abrasive wear. Pitting can sometimes indicate corrosive materials within the lubricant or improper type of gear lubricant being used, such as fuel oil in place of gear oil.

**EQUIPMENT TO USE FOR A GEARBOX INSPECTION**

- Toothbrush for contact patterns
- PT-650 Tooth Marking Grease for no-load contact patterns
- DYKEM layout lacquer for loaded contact patterns
- 6-inch medium mill bastard file for recording graphite contact tapes
- Drafting pencil with 2H lead for recording graphite contact tapes
- Swiss army knife with scissors for recording contact tapes
- 0.03 mm and 0.04 mm shims
- Felt-tip paint marker
- Ear plugs
- Sweatband
- Toolbelt
- Metric/inch tape measure
- Tweezers
- Spatula
- Telescoping magnet
- Leatherman “super tool”
- High-intensity LED flashlight
- Fiber-optic attachment for LED flashlight
- 6-inch metric/inch scale
- 3.5-inch magnifier
- 2-by-3.5-inch telescoping mirror
- 30X Panasonic Light Scope microscope
- Torque wrench
- Dial indicators with magnetic bases
- Inspection forms
- Lubricant sampling equipment
- Baggies and tags for specimens
- Micrometers
- Borescope
- DSLR camera with close-up flash
- Sound meter
- Vibration probe
- Digital thermometer
- Infrared thermometer or infrared imaging camera

**TROUBLESHOOTING AND INSPECTIONS**

First, it is important to note proper lubrication and lubrication practices help prevent gear failure. Most gear failures result from insufficient or interrupted lubrication, including such events as an insufficient supply of lubricant, using the wrong type of lubricant, contamination, or foaming. Selection of proper lubricant is based on gear type; load, input power and reduction ratio; operating speed; and ambient and operating temperature.

Although you should always follow the OEM’s recommendations, the American Gear Manufacturers Association provides standards in AGMA 9005-E02 and AGMA 9000-F16. These documents lay out what type of gear lubricant should be used where and recommends lubricant viscosities based on gear speeds and loads.

**TROUBLESHOOTING**

To troubleshoot failures, take a root cause analysis approach using a team and working with your customer’s engineering and reliability staff. Then, you will need to gather different types of data while using appropriate methods of inspection.

**GATHERING DATA**

- Use an inspection form or appropriate document.
- Record type of failure(s) that occurred.
- Interview operators.
- Record evidence; take pictures.
- Review background information: look at service history and maintenance records.
- Review gear-drive assembly drawings and other drawings that may provide insight.
METHODS OF INSPECTION

- Begin with a visual inspection. Walk around and look through inspection ports.
- Take temperature measurement, either infrared, RTD probe, or thermography.
- Do vibration analysis.
- Inspect filters.
- Use magnetic debris collectors.
- Measure gear backlash and shaft endplay.
- Record tooth contact patterns using dye penetrant.
- Do lubricant analysis.
- Document everything.

Figure 9 provides a list of items you will use to inspect a gearbox. For the visual inspection, first take a walk around and look for signs of overheating, corrosion, contamination, oil leaks, and damage. Also, look for evidence of movement such as cracked paint or fretting corrosion on bolts, structural fasteners, and interfaces. Inspect breather and check shaft seals.

For the inspection ports, check to see if bolts are tight and the cover is properly sealed. Only qualified personnel should be allowed to open the inspection port using proper lockout and tagout procedures. Observe the condition of the gears, shafts, and bearings, and examine the gears with magnetic particle inspection equipment.

Signs of overheating include:
- Smoke from shafts, seals, or breathers.
- Discolored or burnt paint on housings.
- Tempered colors on unpainted surface.
- Low oil level in sight glass or dipstick.
- Foaming present in sight glass or coming out of the breather.
- Dark color oil.
- Foul or pungent odor or acrid smell.
- Water in sight glass or sludge on filter elements.
- Blueing on metal chips on magnetic plugs, chip detectors, and filters.

Create an overheating detection checklist that includes:
- Visual signs of overheating.
- Record operating temperatures from gearbox thermometers or from temperature probes, infrared thermometer, or infrared imaging taken at zero percent, 50 percent and 100 percent load; shoot the probe diagonally across housing — if 5°C (41°F) difference, this is sign of misalignment.
- For pressure-fed systems with oil cooler, measure temperature at gearbox oil inlet and outlet, as well as cooler water inlet and outlet.
- Inspect internal gearbox components.
- Measure gearbox sound and vibration and compare to allowable limits.
- Take oil samples for analysis.

GEAR BACKLASH AND SHAFT ENDPLAY

Measure gear backlash by mounting a dial indicator so it is similar to a pinion tooth profile. Block the gear to prevent its rotation. Slowly and gently rock the pinion through the backlash.

Also, measure shaft endplay by mounting a dial indicator at the end of a shaft and move the shaft in the axial direction. In most cases, this requires a fixture with a ball bearing on the central shaft that allows pushing and pulling the shaft while it is rotated to seat the bearing rollers.

GEAR TOOTH CONTACT PATTERNS

Contact patterns can reveal gear-mesh misalignment. Optimally, examining them should be done during commissioning of a gear drive and regularly during use, once every year or two. You also should examine them before disassembling a gear drive for repair or inspection.

To do so, run contact pattern tests under unloaded and loaded conditions. As always, gather evidence — record, document, and photograph gear-contact patterns.
To examine unloaded patterns, thoroughly clean and paint the teeth on one gear with a soft marking compound such as a tooth-marking grease. Roll the teeth through the mesh so the compound transfers to the unpainted gear. For example, turn pinion by hand while applying a light load to the gear shaft by hand or a brake. Lift the pattern from the gear with scotch tape (#845, book type, two inches wide) and mount on paper to form a permanent record.

Figure 10 shows the marking of an unloaded gear pattern transferred to scotch tape. The image shows the contact is wandering from center, to the left end of the gear face. Misalignment is occurring.

To examine loaded patterns, paint several teeth on one or both gears with a thin coat of machinist’s layout lacquer such as Dykem. Run the gears under load at 25 percent, 50 percent, 75 percent, and 100 percent of full load. Inspect the patterns after running about one hour at each load. Optimum contact patterns will cover nearly 100 percent of the active face of the gear teeth under full load. Photograph the pattern and lift pattern from the gear with scotch tape and mount on paper to form a permanent record.

Figure 11 shows the pattern of a gear at 50 percent load (left) and full load (right).

Published profiles will show you what to look for, as in Figure 12. For example, (a) shows what the pattern looks like if the pinion is wobbling.

**LUBRICANT ANALYSIS**

It's also important to analyze oil samples from a failed gearbox in the laboratory and compare it to an unused sample. Such analysis might reveal whether the oil meets the OEM specification, whether it was contaminated or degraded and whether it is representative of the service oil.

Figure 12: These patterns demonstrate different kinds of irregular wear. (Courtesy: Schaeffer Manufacturing Co.)

It’s important to analyze oil samples from a failed gearbox in the laboratory and compare it to an unused sample. Such analysis might reveal whether the oil meets the OEM specification, whether it was contaminated or degraded and whether it is representative of the service oil. (Courtesy: Shutterstock)
Lubricant analysis tests to perform:
- Visual inspection.
- Odor.
- Crackle test on a hot plate to see if it contains moisture.
- Viscosity at 40 C ASTM D445.
- Spectrometric analysis ASTM D5185 or D6595.
- FTIR.
- Karl Fisher ASTM D6304.
- Acid Number ASTM D664.
- Ferrographic Analysis.
- Particle Count ASTM D7647.
- RULER Method (Linear Sweep Voltammetry).

SAMPLING PROCEDURE
Take an oil sample from as close to the gearset as possible by using a sample port. A sample port such as a Minimess made by Hydrotechnik GmbH has a 12-inch tube extension that can be mounted in the drain and can terminate where you choose. A rule of thumb for installation is to keep the end of the tube at least two inches away from any internal static or dynamic surface. Flush the port and tube at least 10 times before taking sample for analysis, about 3 to 4 ounces of fluid.

If taking samples by draining the oil reservoir, take at least three samples. For the first sample, drain the oil through a screen to capture any large wear debris or fracture fragments that might be entrained. Let any free water drain completely before capturing sample. For the second sample, take near the middle of drain. Estimate oil level in the gearbox from the sight gauge or from direct measurements. Take the third sample near the end of the drain. This sample might capture less-dense contaminant fluids.

DOCUMENT EVERYTHING
It’s important to document the entire team’s work. Describe all important observations in writing. Attach sketches, photographs, and oil analysis reports where needed. Identify and mark each component, including gear teeth and bearing rollers. Mark all bearings, including inboard and outboard sides.

Describe components in a consistent manner. Progress through the parts in the same sequence. Concentrate on collecting as much evidence as possible. Do not form conclusions until all the evidence is considered and documented.

REFERENCE

ABOUT THE AUTHOR
Lawrence Ludwig Jr. presented this article as a webinar on October 24, 2018. He is chief chemist/technical director for Schaeffer Manufacturing Co. in St. Louis, Missouri, and is a member of STLE, ASTM, ASME, and SAE, as well as a member of the NSF International’s Non-Food Compounds Registration Steering Subcommittee and NLGI’s Food Grade Lubricants and Bio-based Lubricants Working Groups. Freelance writer Mary Beckman created the article based on Lawrence Ludwig Jr.’s webinar. Reprinted with permission from the April 2019 issue of Tribology and Lubrication Technology (TLT), the monthly magazine of the Society of Tribologists and Lubrication Engineers, an international not-for-profit professional society headquartered in Park Ridge, Illinois, www.stle.org.
SELECTING A WORM GEAR LUBRICANT

Without a sufficient film of lubrication separating metal-on-metal surfaces, high-load and high-temperature gears risk adhesive wear. (Courtesy: Nye Lubricants)
Viscosity, load, material compatibility, noise emissions, component life, and the recommended service temperature range of an application should all be considered prior to selecting a worm gear grease.

By BRIAN KINKADE

To compete in the marketplace, engineers across all industries are being tasked with increasing gearbox efficiency. Modern designs therefore must achieve high-power transfer without generating noise or excess heat. Gears have been pushed to design limits as they are required to run at higher speeds, under heavier loads, and for longer periods of time.

Lubrication is a common and effective solution when tackling these design challenges as they can reduce temperatures, wear, and noise. Along with new materials and improved manufacturing processes, synthetic lubricant technology has helped to achieve these higher industry expectations. But for sophisticated worm gear designs with advanced performance requirements, not just any grease will get the job done.

There is no “one-size-fits-all” lubrication solution for worm gears. A grease should be carefully selected to withstand the specific operating conditions of an application. If conditions such as temperature and speed are not carefully considered, the grease may not adequately protect a component from wear and corrosion, and can even accelerate the process. Worm gear lubrication in particular presents unique challenges to design engineers who must consider the high sliding contact forces found in the gear assembly.

Viscosity, load, material compatibility, noise emissions, component life, and the recommended service temperature range of an application should all be considered prior to selecting a worm gear grease.

VISCOSITY

Viscosity is a critical property to consider when matching a grease’s base oil to specific operating conditions. If viscosity is too high, excessive power will be required to actuate or rotate the device.

Worm gears undergo more sliding motion than rolling motion. Rolling motions will migrate grease around the entire gearbox to ensure all components, including the contact zone, are sufficiently lubricated. Repetitive sliding motions will push the grease away from the contact zone.

For this reason, greases with a lower base oil viscosity are recommended to ensure the lubricant can migrate effectively to all areas of the gearbox under sliding conditions. PAO-based lubricants offer a better viscosity index (how much the viscosity changes with temperature) than mineral oil base products. While choosing the correct base, oil viscosity is paramount;

TEMPERATURE

The predominantly sliding contact of the worm gear generates significant friction and high operating temperatures in the assembly. This is a problem for designers who wish to maximize gearbox efficiency without giving off too much heat. When a grease cannot withstand high temperatures, it will oxidize and leave behind several byproducts such as acids. These acids attack the metal surface and lead to increased wear and corrosion of the gear.

Increased viscosity at low temperatures can cause an increase in starting torque applied to worm gear assembly. Lowering starting torque requirements can enable reduction in the size and weight of the gear motor and sometimes allow for the use of plastic materials in the design.

A grease for worm gears should be able to withstand operating temperatures of up to 125°C. PAO-based lubricants offer reduced volatility and a lower pour point. These two properties improve both the high- and low-temperature capabilities as they lower the evaporation and increase the grease’s functionality in colder environments.

LOAD

Without a sufficient film of lubrication separating metal-on-metal surfaces, high-load and high-temper-
Understanding the difference between lubrication regimes is critical in selecting the right grease for an application that will protect a component and prevent wear. There are three distinct types of film — boundary, mixed, and elasto-hydrodynamic — that are determined by the amount of contact between the surfaces.

Due to the sliding contact of worm gears resulting in high friction, worm gears operate predominantly under boundary lubrication conditions. During boundary lubrication, opposing surfaces meet with little or no oil film separation. In this regime, damage is prevented by extreme pressure (EP) additives that promote sliding rather than welding of surface asperities. Lubricants with EP additives have greater film strength to reduce friction and protect a gear from wear.

Many engineers will not select a grease with an EP additive because they often contain active sulfur, which can soften, etch, or corrode yellow metals. If this is a concern, consider using an EP additive with inactive sulfur that prevents the corrosive attack of the gear surface. Inactive sulfur forms a soft slippery chemical layer on the surface, which reduces friction and wear without compromising the protective qualities of the EP additive.
the metal surface that protects against wear.

**MATERIAL COMPATIBILITY**
Worm gears come in a variety of sizes from power steering units to small DC motors and typically transmit higher torque ratios; therefore, typical worm and wheel materials can vary anywhere from stainless steel, to nylon, to even some yellow metals (brass, bronze, etc.).

Many applications, such as electric power steering systems, use a combination of plastic and metal components within their gear assembly. It is important to select a grease that is compatible with all the materials in an assembly. Incompatible lubricants can penetrate plastics and cause several adverse physical and chemical reactions that affect its mechanical properties.

First, plastic can absorb oil and swell. Second, oil can extract solubles from plastic and shrink it. Finally, chemical interactions can affect the molecular structure of the plastic where a slight chemical change may lead to loss in mechanical performance such as embrittlement.

The lower the viscosity of the base oil, the greater the possibility that it can penetrate plastics. Esters should be approached with caution as they have been known to attack certain plastics and elastomers. With so many different variations of plastics and elastomers, compatibility testing is always recommended to ensure it will work properly in a specific application.

**COMPONENT LIFE REQUIREMENTS**
Some applications require what we like to call “Lube for Life” lubrication. In applications where servicing is impossible or difficult, such as a closed gearbox application, a grease or oil must be able to lubricate the gear for its entire life expectancy. Life testing data should be requested for such applications.

**NOISE**
If a worm gear makes noise, it can negatively affect how users perceive the quality of the application, even if the application is working properly. Friction often presents itself to the customer in the form of noise and vibration. Applying a lubricant between sliding surfaces reduces frictional vibration to minimize noise emissions. A grease can even be tested to prove its “quietness.”

The right worm gear grease will reduce temperatures, extend component life, and reduce noise to ultimately improve gearbox efficiency and help achieve design goals. Nye Lubricants, a subsidiary of the FUCHS Group of companies, is a leader in the formulation of specialty lubricants for demanding gear applications.

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**ABOUT THE AUTHOR**
Brian Kinkade is market development manager at Nye Lubricants where he engages in customer outreach to ensure engineers are equipped with the tools to select the best lubricant for their application. Prior to Nye, Kinkade worked for many years marketing and selling engineered products to original equipment manufacturers. Kinkade holds a Bachelor of Science in Electrical Engineering from Rensselaer Polytechnic Institute and a Masters in Business Administration from Clark University. He can be reached at bkinkade@nyelubricants.com.
POWER SKIVING WITH INTEGRATED CUTTER RESHARPENING

As compared to the typical cutter resharpening process, the new on-board unit in the Gleason 300PS is remarkably fast and simple. The machine’s axes position the cutter to a grinding wheel. The integrated cutter sharpening unit then executes the necessary grinding strokes while the cutter performs the infeed and the indexing from tooth to tooth, all performed automatically and based on the cutter geometry that exists after a certain number of gears have been cut. (Courtesy: Gleason)
Power Skiving – a viable alternative to hobbing and broaching – is establishing new quality and cost benchmarks with integrated resharpening, which revolutionizes the manufacturing process and current tooling concepts.

By DR. EDGAR WEPPELMANN

Gear manufacturing by Power Skiving takes the traditional approach: After a cutter has reached its maximum wear, the operator changes the cutter, adjusts the cutter data, cuts the next workpiece, transfers it to the inspection room, waits for the first part inspection, and – if necessary – corrects the process by adjusting the machine parameters before proceeding with serial production.

Because Power Skiving is much faster than the shaping process, cutter changes usually happen several times per day and require more frequent operator action. Additionally, this procedure requires resources for cutter management and handling used cutters, sending used cutters to refurbishing (resharpening and recoating), returning cutters into the production flow and on the machine(s). Furthermore, there is a great cutter inventory required to bridge the time cutters are out for refurbishing. Note that while “one-way” wafer cutters for gear shaping process have been in use for some time, such cutters do not offer benefits to today’s Power Skiving process. The more frequent cutter changes of the much faster Power Skiving Process do not lend themselves to a Wafer Concept.

THE REVOLUTIONARY IDEA: ON-BOARD CUTTER SHARPENING

By adding the capability of resharpening cutters on the Power Skiving machine, Gleason has taken a evolutionary step forward in raising the economy and quality of Power Skiving applications. This new development enhances Power Skiving results in virtually every significant area.

The fully-integrated, on-board sharpening unit is available for the vertical series of Gleason Power Skiving Machines up to 600 mm in diameter. The cutter face can now be resharpened fully automatically in the machine after it has cut a certain number of gears — without any operator involvement. The cutter geometry is adjusted automatically, considering the removed stock and the serial production is continued without further interruption. Recoating the cutting face is not required because the original coating on the flanks sufficiently protects the cutter teeth.

The frequency of cutter changes is greatly reduced: A single cutter can stay on the machine for several days or weeks before it is completely used. The time used in the past by the operator for a cutter change is instead used for three to four automatic cutter grinding cycles with a reduced stock removal per grinding cycle to keep the cutter constantly sharp for a high and constant gear quality.

Additional time is saved since first-part inspection and machine corrections after cutter change are no longer necessary because the same cutter stays in production. This also minimizes cost and required capacity in the inspection room.

Cutter management and handling logistics for ordering new cutters in time to ensure a continuous production is also greatly reduced. Required cutter inventory is much less as well, because there is no longer the need to circulate cutters through an external re-furbishing cycle.

FOR ALL APPLICATIONS

Integrated cutter resharpening can be applied to spur and helical step sharpened cutters. The process can be integrated in all soft-cutting processes using HSS or carbide cutters and to the hard skiving process as well where carbide cutters are mandatory. An inexpensive standard grinding wheel technology is used. The grinding wheels don’t need to be dressed as they remain sharp due to a self-sharpening effect from the grinding process. When carbide cutters are used for soft or hard skiving, the savings from avoiding the external refurbishing are even higher.

The Gleason 300PS. (Courtesy: Gleason)
The productivity and cost-per-piece benefits of Gleason’s Power Skiving process make it a viable alternative to shaping and, in many cases, to other soft machining processes such as hobbing or broaching. (Courtesy: Gleason)

ger of damaging expensive carbide cutters by manual handling is greatly reduced as the cutters stay much longer in the process without being touched. The productivity of the Power Skiving process is not jeopardized by having no coating on the cutter face because re-sharpening now happens more frequently compared to the cutter life of the current process with external cutter re-furbishing.

CLOSING THE LOOP
The new on-board cutter sharpening process works seamlessly with Gleason’s Closed Loop system to exchange data directly with the gear metrology machine for automatic profile corrections on the production machine. The machining process is supported by dedicated technology software to calculate the process and provide designs for required tools and workholding. For an even more comprehensive picture, Power Skiving tool design can be verified within KISSsoft’s gear and transmission design software. Together with KISSsoft, Gleason offers a comprehensive suite of software solutions to make Power Skiving simple and reliable, with a complete Closed Loop from design to the optimum, application-tailored gear.

ENTERING NEW FRONTIERS
Typical applications for Power Skiving are internal ring gears, spur and helical gears in soft and hardened state, used in: automotive, light and heavy trucks, agriculture and construction equipment, aircraft and robotics, as well as many other industrial applications, typically served by job shops. Now, Power Skiving becomes increasingly employed in the hard finishing of higher quality gears in electro-mobility and robotic applications. Gleason Power Skiving machines with integrated cutter resharpning ideally support these requirements for quieter and more precise gears, with lower direct and indirect tool cost.

CONCLUSION
For the past decade, Gleason has been building Power Skiving machines at its Gleason-Pfauter facilities in Ludwigsburg, Germany. Today, the productivity and cost-per-piece benefits of Gleason’s Power Skiving process are widely recognized and make it a viable alternative to shaping and, in many cases, to other soft machining processes such as hobbing or broaching. As a result, the series of Gleason Power Skiving machines has grown to include different sizes for internal and external gear cutting and finishing, up to 800 mm in workpiece diameter. Today, with new integrated cutter resharpning, Gleason has added significantly to the Power Skiving capability.

ABOUT THE AUTHOR
Dr. Edgar Weppelmann is manager of Application Engineering at Gleason-Pfauter Maschinenfabrik GmbH.
GET GEAR SMART

In print and online, we are your trusted source for information and technical knowledge about the gear manufacturing industry.

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AIMS Vice President Mark Gearding, left, and President Dave Delph work with a new Summit 10.10.10 machine. (Courtesy: AIMS Metrology)
AIMS Metrology is an original equipment manufacturer that builds its own CMM models, which, in turn, benefits its customers by providing a ‘one-stop shop’ and a CMM supply company.

By KENNETH CARTER, Gear Solutions editor

When customers come to the experts at AIMS Metrology for their inspection and measurement requirements, they can count on one thing: The solution will be a team effort.

“We attack every project as a team,” said Mark Gearding, vice president and co-owner of AIMS. “It’s not just one person. We have a cross-trained group of engineers, programmers, and service technicians able to meet a customer’s CMM needs from design-build to aftermarket support.”

AIMS Metrology does this by offering quality machines with a history of making the precise measurements expected by each and every customer.

EQUIPPED FOR RENISHAW TECHNOLOGY
AIMS is an original equipment manufacturer that designs and produces its own 5-axis Revolution Series CMM line — the mobile shop floor HB, the lab-grade LM, and its newest multisensor Summit 10.10.10 — in house. Its CMMs have been engineered around Renishaw technology. This includes probe heads, touch probes, scanning probes, incremental encoder scale systems, change racks, styli, MODUS software, and more. AIMS is also ISO/IEC 17025:2005 certified by the ANSI-ASQ National Accreditation Board.

“With different applications and requirements from different customers, we really look at each opportunity with our engineering group,” Gearding said. “In many cases, if not all, customers who come to us for measurement, no matter what that feature or characteristic requirement is, we run it through the engineering group. Then we invite that customer into our facility for a product demonstration.”

A customer will bring a part or a print to AIMS, where the company would use one of its 5-axis Revolution machines to inspect the features, according to Gearding.

“We show them the capabilities of our machines using the Renishaw probe head — that’s either a 3-axis scanning head or a 5-axis scanning head — that allows us to get down, in some cases, where it’s very difficult if not impossible for other CMM manufacturers to get into,” he said. “We treat every opportunity that way.”

THE EQUATOR 300
Beyond the CMM machines offered by AIMS, the company also produces a mobile device called the Equator 300, according to Gearding.

“An operator can pick this up and move it from station to station or from plant to plant even,” he said. “It is a comparative device like a gauge. It gives the customer, the end user, the ability to measure, in this case gears, very quickly. Cycle time can be an issue for customers, and the Equator gives that customer that requirement or the need for throughput.”

The Equator can also cut the cost of scrapping parts. Its high speed enables operators to move from ordinary sample inspection to inspecting 100 percent of all the parts. It can also quickly switch between parts with short cycle time, which improves process capability.

AIMS is capable of supplying a customer’s every measuring need; all a customer needs to have is a part, even if it’s just a 3D representation, according to Gearding.

“What we require from the customer is a part print highlighting the features that are required to be inspected,” he said. “Then we come up with what is the best solution. We bring the customer to our facility to view that part being measured on the predetermined technology that we feel is the best solution for their application.”

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THE SUMMIT 10.10.10

Not only can AIMS meet a customer’s measuring needs, but it does so with equipment manufactured and supported locally, according to Gearding, including the recent development of its Summit 10.10.10 machine.

“The Summit machine gives a large measuring divide, which transmission cases require,” he said. “This shop floor CMM is measuring a volume of a meter by meter by meter. With that, we’re able to measure the transmission cases for various gear characteristics. But we’re able to use the REVO 5-axis scanning head, which gives us multisensors like the RVP—a video probe that can satisfy some of the gear characteristics.”

Gearding emphasized there’s no machine like the Summit in development.

“There’s no other machine out in the industry like it with the capabilities of the measuring bite of that meter-cubed, as well as the utilization of the REVO technology that takes us into that arena for the gear and spline requirements,” he said.

EXPANDING AND EVOLVING

AIMS has been in business for more than 12 years. In that time, the company has expanded and evolved, according to Gearding.
“We sell a lot of our machines through distribution channels,” he said. “We have some strong distribution channels up on the East Coast and down South and now here in the Central region. We grew the company in earnest, as well as through applications and our engineering group.”

In particular, Gerdging is especially proud of the relationship it has developed with Honda.

“We have several machines at the Honda transmission plant, and they use those to measure the transmissions, the gear features, with either the Summit machine or the lab machine,” he said. “They use the REVO technology when it comes to that measurement. So, we’re there in the transmission plants.”

MODUS SOFTWARE
A large part of AIMS’ success lies with the company’s MODUS software, the CMM software that is used on every AIMS machine, according to Gerdging.

The MODUS platform supports AIMS’ Revolution CMM line and its 5-axis measurement capabilities. A configurable user interface allows native DMIS programs to be developed offline; the drawing of geometry, embedded dimensions, and tolerance data from CAD, feature construction, and part alignment. It includes full support for I+DME compliant metrology controllers — including Renishaw’s UCC range of universal CMM controllers, CAD-driven offline programming with on-screen probe path verification, high integration with CATIA® (versions 4 and 5), Siemens® NX™, Pro/E®, and Solidworks® CAD/CAM solutions.

“The MODUS gear package is constantly being developed,” Gerdging said. “MODUS is utilizing the Dontyne feature for its modules. So, we feel like the development of MODUS, using the Dontyne modules, is advantageous when it comes to gear characteristics or features.”

LOOKING TO THE FUTURE
As the industry grows and expands into other areas, particularly electric vehicles, Gerdging expects the inspection of gears to become an even larger part of what AIMS has to offer.

“I think as the software is further developed and the sensors are brought out to be supported by the REVO, I just see that part of the business growing,” he said. “We’re pretty excited about it, especially the further development and the utilization of Dontyne software when it comes to MODUS.”

Gerdging considers AIMS to be a small business, but a business that has the potential to offer many advantages to its customers.

“We have a good core of engineers on staff,” he said. “We just acquired a group that extends our service footprint, although our focus has always been: Whatever we sell, we support to the highest level. In many cases, no matter what the application is, if it’s a turnkey with customers, you’re seeing more and more of those requirements because companies are lacking individuals with those skill sets.”

Simply put, AIMS Metrology can offer a total package, according to Gerdging.

“We provide the programs with the machines to measure a manufacturer’s parts, as well as the tooling to support those parts on our machines,” he said. “And now we’re taking it to an even higher level, and that is through automation. Our machines are now at that level at a variety of different corporations.”

The Equator 300 is a portable device that can cut the cost of scrapping parts. (Courtesy: AIMS Metrology)
Forest City Gear has expanded the capabilities of its quality assurance department with the addition of a Zeiss ACCURA® coordinate measuring machine.

The next-generation bridge-type Zeiss ACCURA® is Forest City Gear’s fourth CNC inspection system. (Courtesy: Forest City Gear)

Forest City Gear adds Zeiss ACCURA CMM for CNC inspection

Forest City Gear has expanded the capabilities of its quality assurance department with the addition of a Zeiss ACCURA® coordinate measuring machine.

The next-generation bridge-type Zeiss ACCURA® is Forest City Gear’s fourth CNC inspection system, and is particularly well-suited for very fast, complete analytical inspection of all types of high-precision fine- and medium-pitch cylindrical gears. A variety of interchangeable Zeiss sensors provide a high degree of flexibility and faster calibration, approach, and scanning for lead, involute, pitch, surface finish, and other critical features across a wide size range.

The system also features a particularly compact and ergonomic design, making it ideal for Forest City Gear’s fast-expanding, busy quality assurance room. The Zeiss ACCURA’s bridge, for example, is made of steel and aluminum, making it extremely rigid, yet slim and compact. The reduced weight of the moving parts improves the dynamic rigidity and speed of the machine.

“The added capacity of the Zeiss ACCURA has now enabled Forest City Gear to move its existing Zeiss CONTURA® CMM to meet the quality requirements of its new, stand-alone gear blanking facility,” said Forest City Gear quality assurance lead Amy Sovina. “The ACCURA couldn’t have arrived at a better time, freeing up the CONTURA so we could put it in close proximity to the blanking operation and thus eliminate the travel time for inspection of blanks. The Zeiss ACCURA checks all the metrology boxes. With quality and throughput requirements never higher in all the industries we serve, this system is the perfect addition.”

MORE INFO www.forestcitygear.com

Siemens has new Sinumerik CNC machine tool control

With Sinumerik One, the first digital native CNC, Siemens is driving forward digital transformation in the machine tool industry. The new controller works with software to create the machine controller and the associated digital twin from one engineering system and thus contributes to the seamless integration of hardware and software. Thanks to its seamless interaction between the virtual and the real world, including high-performance hardware, Sinumerik One is setting new standards in terms of productivity, performance and digitalization. It is the future-proof machine tool controller in the increasingly digital world of manufacturing. Both machine tool builders and CNC machine users benefit from the universal digital twin for the product, production and performance.

With Sinumerik ONE, machine tool builders can virtually map their entire development processes — significantly reducing the product development phase and time-to-market for new machines. The virtual preparation of machine commissioning can also reduce the duration of actual commissioning considerably. The virtual model of the
Mapping the development process with Sinumerik ONE reduces product development and time-to-market. (Courtesy: Sinumerik)

Machine opens new possibilities for builders and users alike. Machine concepts and functions can be discussed and planned even before real hardware is available. Realistic simulation provided by Sinumerik ONE enables CNC machine users to simulate the programming of workpieces and the setup and operation of machine tools completely on the PC. Even training can be carried out using the digital twin instead of training on the actual machine.

The innovations in software and in hardware of Sinumerik One, including the possibility of creating a universal digital twin for product and production, significantly reduces machining time. The CNC system with integrated Simatic S7-1500F PLC is available in both a control cabinet-based and panel-based version. Sinumerik One perfectly fits into the Totally Integrated Automation (TIA) Portal and makes a highly efficient engineering framework available for machine tool builders. With Safety Integrated, the new Sinumerik ONE supports the consistent Siemens industry standard for safety. With IT security integrated in the CNC by design, Sinumerik ONE implements the multi-layer Defense-in-Depth-Concept.

With Create MyVirtual Machine and Run MyVirtual Machine, the new CNC comes with software to create the machine controller and its digital twin from one engineering system. As a result, the universal digital concept of the digital twin, powerful hardware and integrated IT security make Sinumerik ONE a forward-looking CNC, which is driving digital transformation in the machine tool industry.

Siemens drives forward digital transformation in the machine tool industry with a brand-new generation of Sinumerik CNC.

MORE INFO usa.siemens.com

Klingelnberg to present machine, software solutions at CIMT

Now in its 17th year, the China International Machine Tool Show (CIMT) will be in Beijing April 17-21, 2021. Klingelnberg will again be present as an exhibitor, in Hall W3, Booth A202, where it will showcase innovative new developments and improvements to existing machine and software components. In particular, visitors can look forward to live demonstrations of the Klingelnberg Precision Measuring Center P 40.

The precision requirements for components and assemblies are steadily on the rise. To meet these demands, as many measurement tasks as possible should be combined into a single sequence — ideally directly on the shop floor rather than in the measuring room. The precision measuring centers in the P-Series do just that. They integrate all coordinate and gear measurement tasks, as well as geometric and roughness measurement tasks, on one machine, which can be set up directly in the production environment.

Combining different measurement tasks on one machine is a true leap forward in terms of quality assurance. It saves on tool...
ing and setup times, eliminates the need for repeat alignments on the measuring machine and significantly reduces throughput times. Particularly for high-precision components produced in large quantities, this presents interesting potential: Due to their possible interchangeability, they must be determined with stable, high levels of precision. The P-Series precision measuring centers systematically follow the approach of processing as many measurement tasks as possible on one machine. They execute the entire process in a single automated sequence directly on the shop floor. Particularly when producing large series of axially symmetrical drive elements with their many GD&T features, it is important to monitor the process in real time and in the production environment, to the extent possible.

The P-Series has proven itself in just such an environment. In the last 10 years alone, more than 500 configurations have been successfully installed. And Klingelnberg precision measuring centers are used as a reference around the world, not just by countless customers, but also by renowned metrology institutes.

In addition, Klingelnberg has systematically advanced optical metrology and introduced a new white light measurement system with sensor technology that is ideally suited to measurements in the sub-micrometer range. This will allow the tactile pitch measurement to be replaced by optical measurement, significantly reducing measurement times in serial measurement applications.

Second-generation BEA 16 machining unit with new drive, control concept

Following its successful launch, Suhner is presenting the BEA 16 spindle machining unit with an all new drive and control concept.

The objective of this new development was the integration of the latest servo drive and control technology from Bosch Rexroth. Software developed additionally allows the user to program six different basic cycles without prior knowledge of CNC.

By visualizing these six cycles — drilling, combined drilling (drilling and thread cutting with the one tool), thread cutting, drilling with chip removal, drilling with jump function, undercutting — the unit has become extremely easy to program.

Plus, should the required machining cycle not be found among the standard selections or prove too complex, the unit can be switched to sentence programming.

The BEA 16 machining unit itself is a precision device from the Suhner spindle machining unit series that has been designed for gruelling continuous use in multiple shift operations. The BEA 16 has a drilling capacity of 16 mm diameter in 450 N/mm² steel. The max feed path is 140 mm, and the max speed is 500 RPM.

Rising production piece numbers and greater workpiece complexity with all-round machining are leading to a renaissance of the so-called special machine. However, modern special machines are no longer being as purely single-purpose solutions, but rather for whole part families.

These require different machining cycles, feed speeds, feed paths, and rotating speeds, and, of course, must allow fast retooling. And it is these requirements exactly that the BEA 16 will meet to the full.

THK celebrates 50 years of innovations in linear motion components

As pioneers in linear motion products, THK has introduced innovations in high-quality, precision motion components for the past five decades.

In 1971, THK was established in Meguro-ku, Tokyo, under its first name, Toho Seiko Co., Ltd. In 1972, THK became the first company in the world to develop a method of linear motion with rolling contact and began manufacturing and selling the commercialized result: Linear Motion (LM) Guides. In 1977, THK’s Kofu Plant, the first full-scale LM Guide production plant, was established.

This was THK’s first step in expanding production facilities. From there, THK took operations worldwide and expanded to North America and Germany. As THK set out on growing globally, it did so with a spirit of innovation and the determination to solve customer dilemmas with cutting-edge solutions. The product line expanded to include ball splines and ball screws, LM guides, actuators and cross-roller rings, a commitment to innovation led to the development of THK’s patented caged ball design. Consisting of a plastic structure that provides a pocket in which the metal balls roll and stay separated, this design reduces wear and friction, retains...
lubricant that provides longer service life for the bearings and gives the customer superb noise reduction during operation.

Innovative products, along with knowledgeable sales, engineering, and mechatronics departments, have made THK the world leader in linear motion components. In fact, in the last ten years alone, THK has sold enough LM Guides that if lined up would circle the globe at the equator.

Pioneers in linear motion guides since 1971, THK continues that same spirit in 2021. Recently, THK introduced a variety of innovations to meet the needs of customers in an ever-changing world. Their products can be found in robotics, manufacturing machinery, medical/surgical devices, packaging, semiconductor manufacturing, and more. “We are proud of all we have accomplished over the past 50 years,” said Ed Johnson, vice president of sales, THK America, Inc. “We are the components that go inside of what you build, and we are pleased that so many of our customers have honored us as a valued partner. We all have the need to move forward and whether you measure that movement in sub-microns or in meters, THK will continue to listen to your needs and provide the solutions to exceed them. The only limitation is your imagination, because if you can think it, we can assist you in designing and building it.”

THK manufactures the widest range of linear motion products, including LM guides, ball screws, mechanical actuators and ball splines, cross-roller rings and more. All THK products have been designed and manufactured to meet the strictest requirements. THK’s experienced global engineering team can provide customized linear motion solutions from their standard linear motion products as well as from mechatronics products for the most demanding applications.

MORE INFO www.thk.com

Mazak INTEGREX i-H multi-tasking center integrates automation

Newly designed from the ground up for fully optimized machining and easy automation integration, the INTEGREX i-H Series brings together the latest advancements in manufacturing to help shops achieve multi-tasking excellence. The spindle, turret and tool/jaw magazine feature innovations that improve ergonomics and throughput. For full Done In One® productivity, second turning spindles (S) and lower turrets (T) are available as options.

The series’ sheet-metal enclosures have been redesigned with flat fronts that simplify maintenance and improve access for peripheral equipment such as bar feeders, articulating robots, or gantry loaders. Large-capacity tool magazines and an automatic chuck jaw changer may be added to support automatic operation over extended periods of time.

The INTEGREX i-H Series also features Mazak’s Mazatrol SmoothAi CNC, the next generation of Smooth Technology. In addition to the conversational programming power of Mazatrol, the Mazatrol SmoothAi control leverages the power of artificial intelligence and machine learning algorithms to power innovative tools like Smooth Ai Spindle, Smooth CAM Ai, Mazatrol TWINS and more.

Series characteristics include:
- Range of milling spindle specifications.
- Available second spindle for “Done In One” processing.
- Full C-axis contouring.
- Parallel-type lower turret for long tool lengths and less chip accumulation.
- NC tailstocks support long, heavy workpieces.
- Tool storage capacities from 38 to 112 tools.
- Auto jaw changers for both spindles.
- Automation-ready design accommodates bar feeders, gantry loaders, etc.

MORE INFO www.mazakusa.com

InspecVision Planar high-speed measurement system

Exact Metrology, a comprehensive 3D metrology service provider and hardware sales company, represents Planar from InspecVision. This 2D-inspection machine allows manufacturers to simply and quickly verify product quality by performing 2D inspection, CAD comparisons, and reverse engineering in seconds.

Planar is ideal for shop floor use, requires minimal operator input, and increases production throughput across a wide range of applications. These include flat and folded/formed sheet metal components, gaskets and seals, laminations, O-rings, paper acetate and electronic drawings, and other opaque and semi-transparent flat materials.

A standard feature on every Planar system is 2D reverse engineering. Existing parts can be reverse engineered quickly, creating dxr or dwg CAD files. The software allows the user to edit and clean the data such as standardization of hole sizes and clean edges and eliminates the need for hand measurement and CAD programming. Physical parts or even paper, acetate, or electronic image files can be reverse engineered to create CAD files. Furthermore, reverse-engineering processes can also be carried out in 3D using optional 3D modules. For full 3D capability, users simply add Opti-Scan 3D, while the SurfScan module extends Planar to 2.5D.

Opti-Scan 3D is a non-contact white light scanning system that uses a high-speed, high-resolution camera and an LED DLP projector to scan the surfaces of an object. Patterns of light are beamed from the projector onto the part, recorded by the camera and used to create a 3D point cloud of the scanned surface. The Opti-Scan 3D outputs the ultra-high resolution points into a number of different file types which can be used in virtually any 3D inspection or reverse engineering software package.

SurfScan integrates seamlessly with the Planar 2D automatic inspection software to allow accurate inspection of both the part’s 2D shape and its 2.5D features with a sin-
**Exact Metrology offers Raytech measuring tables**

Exact Metrology, a comprehensive 3D metrology service provider and hardware sales company, sells Raytech measuring systems. These are shop-floor dimensional measuring machines such as the single axis and the 3-axis table for industrial manufacturers. The company offers machines for measuring parts for cutting, bending, punching, waterjet cutting, laser cutting, drilling, and tapping. Custom machines are also available.

The single axis table is ideal for checking flat sheets with straight edges and square corners. It features reduced setup time for production machines, reduced scrap rates, and reduced backlog of parts for inspection. In addition, it integrates with SPC software for quality tracking and reporting, reduces operator-to-operator variation, offers long-term durability and simple operation. Squareness gage allows users to check sheets for perpendicularity of the edges or check edge camber, while diagonal blocks allow the user to check corner-to-corner squareness on sheets. All single axis tables come standard with interchangeable probe tips. Heidenhain readouts and scales used on the single axis tables are designed for use on machine tools and are well suited for use on shop floor gage. The edge lift gage allows users to edge waves in sheets.

When parts are more intricate or bulkier than flat sheets, then the three-axis table is recommended. It is suitable for checking laser and waterjet cut parts, sheet metal parts with many features, and parts that are bent and formed. The 3-axis table includes flexible metrology software, sealed Heidenhain encoders, low-maintenance linear bearings, and a versatile Renishaw touch probe. Furthermore, it has the ability to integrate with SPC software for quality tracking and reporting and reduces operator error. As with the single axis table, it offers long-term durability and simple operation. Features include a Renishaw indexing probe for flexible probing and reduced operator-to-operator inconsistency. It also includes a standard readout system with a simple yet durable color touch screen, serial output for SPC, multiple points of error correction, and multiple point feature measurements. The PC-based system allows for the full capability plus additional reporting capabilities, as well as greater program storage capacity.

MORE INFO  www.exactmetrology.com

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**Big Kaiser’s smallest Smart Damper boring head options**

Big Kaiser Precision Tooling has released two smaller sizes of the EWN Smart Damper precision boring heads, which eliminate vibration in deep-hole finish boring with a patented damping system. The additions make it the first time the EWN Smart Damper has been available in diameters below 1.260 inches, down to 0.787 inches. The CK1 head has a length of 3.937 inches and the CK2 4.921 inches.

Big Kaiser’s modular CK/CKB system allows for versatility in the length of tooling combinations, up to a maximum of 10 times diameter and can run on nearly every major spindle interface. All tools are coolant-through and have three different insert holder options per head size. The tried-and-true EWN analog head features a dial with Ø0.0005-inch/div setting accuracy (0.0001 inch w/ Vernier).

The integral design of these Smart Damper heads shortens the distance from the damping mechanism to the cutting edge, which is the source of vibration. This produces higher damping effects to the tool assembly to minimize the chatter or vibration, thus achieving better surface finishes and improved metal removal rates.

MORE INFO  www.us.bigkaiser.com

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**Product Showcase**

The Planar 2, left side view. A standard feature on every Planar system is 2D reverse engineering. (Courtesy: Exact Metrology)

ggle click. The SurfScan is a high-resolution projector which mounts onto the existing Planar vertical column. The projector shines structured light on the part which is then imaged by the Planar’s camera to create a 3D scan of the upper surface of the part. The point clouds created by the system can then be loaded into free and readily available 3D inspection software for comparison against a 3D solid CAD model. Point clouds are also compatible with Geomagic Control, Control X, Polyworks, etc.

InspecVision Planar offers fully automated one-click inspection with machine sizes ranging from 500m to 3000mm. The machine is scratch resistant, features no moving parts, has simple calibration and minimal maintenance, requires minimal training, and offers rapid return on investment.

MORE INFO  www.exactmetrology.com

Big Kaiser’s two smaller sizes of the EWN Smart Damper precision boring heads eliminate vibration in deep-hole finish boring. (Courtesy: Big Kaiser)
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With a community storefront, your company also receives a premium listing in the annual Buyer’s Guide published each November. Premium listings feature graphic treatments to draw more attention to your company.

For information on how you can participate in the GearSolutions.com community storefront, contact dave@gearsolutions.com.

Dave Gomez – national sales manager
800.366.2185 x 207
Mazak recently gave a preview of a multi-tasking machine running the software. What type of machine was unveiled? 

Well, concerning gear machining, it would be the INTEGREX i-630V AG.

How will this machine help with gear manufacturing?

The INTEGREX i-630V, as a standard multi-tasking machine, features turning and milling capabilities for what Mazak refers to as “Done In One” part processing. But we also offer another version of that machine, which is called the INTEGREX i-630V AG HYBRID Multi-Tasking Machine. The AG stands for “Auto Gear.”

So what do you get with this machine? For gear processing, there are some mechanical enhancements to the machine that allow the spindles to synchronize at a much higher RPM. And that would be for power skiving applications. The machine also comes with software modules that allow the user to automatically create the program on the machine to cut the gear teeth. There are three separate machining modules. The first one is SMOOTH Gear milling. The second one is SMOOTH Gear skiving, and the third is SMOOTH Gear hobbing.

SMOOTH Gear is the name we use for the software that resides on the machine control. That’s a big benefit to our customers because they don’t need an offline CAD/CAM system to create a program for parallel axis gears. The user could create the turning program to turn the blank at the machine’s MAZATROL SmoothAi control. And when they want to machine the gear teeth, they can open up the software modules, which basically consist of a graphical user interface. The user would select the menu key, for example, SMOOTH Gear milling, and the graphical user interface pops up on the screen. There are a series of fields into which you enter information such as gear data, cutting conditions, and some tooling information. The control will take all that information and create a program in the background that will cut that gear tooth.

What makes the software unique when compared to what’s been available?

Let’s consider hobbing, for example. We’ve been gear hobbing using a gear hobbing operation on multi-tasking machines for a number of years. But in the past, we would have, let’s say a G code that would synchronize the milling spindle to the turning spindle. Those programs were typically written by hand. You would have to be fairly savvy to create such a program by hand with no syntax errors. It’s a tedious process to create a program that way, but using the SMOOTH Gear software on the control, you just simply enter in the information, and the control will develop that program in the background.

You input your depths of cut and your feed rates, and the machine will automatically take care of retract positions and so forth. It’s extremely user-friendly.

So, the software is intuitive?

To a point. Using our SMOOTH Gear software, the control will take care of the toolpath such as: your start position, your end position, and your retract. It handles tilting the B-axis, which is all-important and complex when you write the program longhand and have to figure it out for yourself. Now, the software takes care of some of the guesswork.

One last yet important feature of the SMOOTH Gear Hobbing and Skiving software is the “Escape” function which enables the user to safely retract the cutter away from the workpiece and safely stop the spindles if needed. This is particularly useful during process prove-out.

Anything else about the software you’d like to discuss?

I think gear machining can be rather intimidating to those who aren’t very familiar with it. SMOOTH Gear Cutting software prompts you for what it needs. In its data fields, it’s asking you: How many teeth are you cutting? Is it OD or ID? How long is the tooth? And so forth. You just enter in that information that’s typically found on your part print, and the software will create the tool path required to cut gear or spline teeth. It’s very user-friendly, and there are graphics with each data field along with the description. For example, when you go to the field of helix angle, there’s a graphic that displays on the screen describing/showing graphically what the helix angle is.

It is also important to mention Mazak’s SMOOTH Gear Check software.

What SMOOTH Gear Check does is check the phase of a gear tooth. In other words, you can find the orientation of the tooth space in terms of the degrees about the C-axis. We can use SMOOTH Gear Check to find the tooth space using an RMP600 Renishaw probe, like a standard touch probe. Once you’ve located the tooth space, you can set your work offset.

SMOOTH Gear Check can also scan the lead and profile of the gear tooth with the use of a scanning probe, like a Renishaw OSP60. Simply enter the gear data from the print and the software will create the machine motion to scan the length of a tooth flank and will scan the active profile of the tooth. Upon completion of the scan, you can select to review the results, and a window will pop up. In that window, it looks very similar to what you would see on a gear inspection chart. You can determine the amount of lead error and/or profile error without having ever taken the part off the machine.
2000 Gleason Pfauter Model P800 CNC Gear Hobber, Siemens Controls

2006 Liebherr Model LFS 800 6 Axis CNC Gear Shaper (2 available)
The Mitsubishi ZE26C Gear Grinding Machine: Precision Gears for Precision Systems

- Optimized for Electric Vehicles & Robotics
- Greater Structural Rigidity
- Shorter Non-cutting Time
- Lower Running Costs
- Smarter Industrial IoT remote monitoring - DIASCOPE

Born from the widely acclaimed ZE-B series, the all new ZE26C has been specifically designed to meet the exacting demands of the electric vehicle and robotics industries.

Featuring increased rigidity of the column, table and grinding wheel head—coupled with revamping of the spindle structure—the ZE26C produces finished gears with enhanced grinding precision and stability. By increasing cutting speed and reducing non-cutting time by roughly 50%, the ZE26C maximizes high-volume production capability and promotes lower running costs. The expanded wheel width provides longer wheel life and supports the use of combination grinding/polishing wheels for improved gear surface finish, making the ZE26C a compact and operationally efficient machine that’s responsive to in-factory needs. To learn more about how the ZE26C has been optimized for the evolving needs of the industry, visit [www.mitsubishigearcenter.com](http://www.mitsubishigearcenter.com) or contact sales at 248-669-6136.