INDUSTRIAL GEAR LUBRICANTS FACE FORMULATION CHALLENGES

COMPANY PROFILE

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INDUSTRIAL GEAR LUBRICANTS FACE FORMULATION CHALLENGES

Moisture, temperature, viscosity, filtration, and base oil are just some of the factors needed to be considered.

By LAWRENCE LUDWIG JR. and NANCY McGUIRE

DUAL-SCREW H-FRAME BROACHING MACHINES

The BMS Dual-Drive is an electromechanically powered, table-up vertical broaching machine for all types of internal broaching applications.

By MATT EGRIN

STREAMLINING SAFETY FOR HIGH-SPEED/SMALL-FOOTPRINT MILLING MACHINES

High torque retention knobs are a vital anchor for safety between machine and spindle for high-RPM mills.

By JOHN STONEBACK

SKILLED TECHS, EXPERT ENGINEERS, PRECISION TOOLS

COMPANY PROFILE When it comes to broaching, General Broach Company is able to find the best machine and best tool design to fit the customer’s need.

By KENNETH CARTER
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KissSoft offers course on generating tooth data in GDE format.

GOMTA names Scott Knoy to succeed Walter Friedrich as president.

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.

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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. The Society of Tribologists and Lubrication Engineers is sharing a recent paper from Lawrence Ludwig Jr., chief chemist/technical director for Schaeffer Manufacturing Co. In the article, Ludwig shares his expertise on selecting an industrial gear oil and why it’s important to know the properties of the formulation’s components in order to get the best performance.

In addition to lubrication, our March issue is also focusing on broaching. An article from Matt Egrin, president of Broaching Machine Specialists, discusses the advantages of a dual-screw H-Frame broaching machine. And our company profile shines a spotlight on General Broach Company. In that article, I talked with General Manager Larry Stover and how they tackle their customers’ broaching needs.

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.

2019 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!

Kenneth Carter, editor
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editor@gearsolutions.com
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KissSoft offers course on generating tooth data in GDE format

The VDI has been working on defining an exchange format for toothing data in Germany for quite some time now. Cylindrical gear data can now be exported in this new format, which is known as GDE or Gear Data Exchange. When generating data in GDE format with detailed data on profile diagrams, tooth trace diagrams, and tooth form, individual points are calculated in order to generate the profile and tooth trace diagrams. This also calculates the points for the particular tooth form.

Subsequently, you can generate a report that documents the points for the diagrams and the tooth form points. As a result, the GDE format allows the toothing data to be passed on and transferred electronically, from the design department to production to quality assurance.

From May 7 to 10, 2019, KissSoft is offering the training course Cylindrical Gear Design, Analysis, and Optimization. Using practical, illustrative examples, you will learn more about how to operate the program and use the input screens for the different calculation modules in KISSsoft, enabling you to integrate the software into your project with no issues.

MORE INFO www.kisssoft.ag

GMTA names Scott Knoy to succeed Walter Friedrich as president

After 27 years as president of GMTA (German Machine Tools of America), formerly American Wera, Walter Friedrich recently appointed Scott Knoy as his successor to the presidency of GMTA.

Friedrich was one of the first three employees when GMTA (American Wera at the time) started in January of 1991. Previously, he worked as a project manager for Liebherr Machine Tool for four years and completed vocational training in tool-making and NC programming while working for 12 years at Pittler (now DVS Group) in Germany with whom he moved to the United States in 1983. On January 30, he spoke with the company’s board of directors and decided to step down. The change was effective on February 8, 2019.

Since joining GMTA on July 1, 2005, Scott Knoy has contributed greatly to the growth of the organization. GMTA is a leading supplier of machine tools, laser welding systems, and parts washers to the automotive power transmission, gear, and other markets in North America. Friedrich is confident that Knoy is fully prepared to handle all his new responsibilities.

“From day one, Scott has proven his commitment, determination, and knowledge of the automotive and gear industries. I’m sure he will continue the company’s expansion,” Friedrich said.

Knoy said, “I am honored and excited to begin this new chapter as GMTA’s president. My objective is to make sure that GMTA continues to serve our customers’ needs, while looking for new opportunities.” Knoy is a graduate of the University of Michigan and has a master’s degree from Lawrence Technological University.

Walter Friedrich will maintain an active role in the company as senior adviser and board member.

MORE INFO www.gmtamerica.com
Klingelnberg to honor employees for 25, 40, and 50 years of service

At the start of each year, Klingelnberg’s executive management recognizes colleagues who have worked at the company for 25, 40, or 50 years in a ceremony dictated by tradition. On February 1, 2019, this year’s anniversary celebration was once again held at Kleineichen Haus in the German town of Hückeswagen.

Eleven award recipients commemorated their many years of service and commitment to the company during a pleasant evening meal shared with Klingelnberg’s executive management. Awards were given to eight employees for completing 40 years of service and two employees for 25 years of service – as well as one employee now in his 50th year of service to the company.

“Whether employed in production, technology, or in our commercial operations, each one of these employees has contributed significantly, through their commitment and performance, to positioning our company as an international brand in the mechanical engineering industry,” said Group CEO Jan Klingelnberg. “We are extremely grateful for this and are delighted to have another opportunity each year to celebrate the accomplishments of our long-serving employees.”

The CEO said, “I am particularly pleased today to honor our employee Hans-Jürg Spiess, because Mr. Spiess already has a full half-century of Klingelnberg history behind him.” In 1968, Spiess began his training as a technical draftsman (machinery designer today) in the area of gear cutting at the Oerlikon Bührle AG machine tool factory. In the early 1970s, Spiess studied mechanical engineering at the Technikum Winterthur (now the School of Engineering at ZWAH University of Applied Sciences) in Switzerland. In 1975, he graduated with distinction as a mechanical engineer with a major in process engineering. Spiess subsequently worked as a mechanical engineer and project manager in various technical departments and was promoted in 1989 to the position of technical expert and development engineer. To this day, he has remained faithful to the division whose line of business was ultimately acquired by Klingelnberg in 1993 and continues to work as a development engineer in the mechanical design department at the company’s headquarters in Zurich (Switzerland). Klingelnberg expressed thanks in his speech: “It’s always the employees who make a company. So, we are all the more proud of the fact that we still manage to foster such long career trajectories in our company – something that has become quite rare in these fast-paced times.”

Klingelnberg marks an eventful previous year

A successful initial public offering was not the only event to shape the company’s history in 2018 – a well-received market launch of the Höfler Speed Viper cylindrical gear grinding machine for high-productivity generating grinding and the establishment of a new company division, the Digital Unit, were further keys to success this past year.

Anniversary celebration at Hückeswagen, Germany (©Klingelnberg)
One aim of the Digital Unit is to promote concepts such as Smart Tooling, a digital identification system for tools and work holding equipment, with a view to becoming a pioneer in modern, software-driven production processes.

Klingelnberg is paving the way in Industry 4.0, as evidenced by the “Best of Industry Award” recently received for the company’s cyber-physical production system. The trade journal MM Maschinenmarkt bestowed the honor in June 2018, presenting a total of 31 nominated companies in nine categories.

And last but not least, with its entry into the robotics industry, Klingelnberg has launched an initiative to expand its business outside the gear industry. Klingelnberg’s cycloid measurement option for precision measuring centers provides a reliable solution for monitoring high production standards.

MORE INFO www.klingelnberg.com

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APMI International names two members 2019 Fellows

John L. Johnson and Joseph Tunick Strauss have been named 2019 Fellow Award recipients by APMI International and will be honored at POWDERMET2019.

APMI International’s most prestigious award recognizes APMI members for their significant contributions to the goals, purpose, and mission of the organization as well as for a high level of expertise in the technology, practice, or business of the industry. The 2019 Fellow Award recipients will receive elevation to Fellow status at POWDERMET2019: International Conference on Powder Metallurgy & Particulate Materials during the industry luncheon on Tuesday, June 25.

Joseph Tunick Strauss: For more than three decades, Joseph Tunick Strauss, engineer/president, HJE Company, has strived to advance the powder metallurgy (PM) industry through engineering and ingenuity. He was the first to commercially offer turn-key small-scale high-performance gas atomizers and publish on the use of elevated temperature gas for atomization. Strauss formally introduced PM to the jewelry industry and continues to develop press-and-sinter and metal injection molding (MIM) technologies for them. He helped unite the PM and additive manufacturing (AM) communities and assisted in the formation of the AMPM conference. Strauss is a member of many professional technical societies, has served on the APMI Board of Directors, and has been on the Metal Powder Industries Federation (MPIF) Conference Committee for many years. He has received many awards including the MPIF Distinguished Service award in 2013. Strauss reviews technical articles for several technical publications including the International Journal of Powder Metallurgy.

John L. Johnson: Vice president, Elmet Technologies, Johnson has dedicated more than 20 years to research and development of processes and products for the PM industry, including pioneering rapid prototyping of metals via selective laser sintering for desktop manufacturing. He has authored or coauthored more than 100 technical papers...
and, as an editorial committee member, reviewed more than 200 technical articles for various journals including the International Journal of Powder Metallurgy. Johnson has served on many committees and association boards including the APMI Board of Directors and the MPIF Technical Board. He has been a co-chairman of the Tungsten, Refractory and Hard Materials Conference and continues to organize numerous special interest programs for the annual POWDERMET conferences. While wrapping up his Ph.D. at Pennsylvania State University, Johnson was a recipient of the 1993 CPMT/Axel Madsen Conference Grant in the early years of the program.

Established in 1998, the Fellow Award recognizes APMI members for their significant contributions to the society and high level of expertise in the technology of powder metallurgy, practice, or business of the PM industry. Fellows are elected through their professional, technical, and scientific achievements, continuing professional growth and development, mentoring/outreach, and contributions to APMI International committees. APMI International is a non-profit professional society that promotes the advancement of powder metallurgy and particulate materials as a science. Its purpose is to disseminate and exchange information about PM and particulate materials through publications, conferences, and other activities of the society.

MORE INFO www.apmiinternational.com

**Canada research council joins Fives to develop technology for aerospace**

As the aerospace industry in Canada and around the world continues to increase its use of automated composite manufacturing techniques to produce large aircraft components, the industry is eager to find solutions to manufacture reliable, safe, and cost-effective composite structures. The National Research Council of Canada (NRC) and Fives are working together to improve the efficiency of manufacturing composite parts. They are developing an advanced profilometer that will provide faster and more accurate part inspection.

Based on an innovative optical technology, the advanced profilometer for composite placement shows considerable advantages over existing inspection technologies used for the same purposes. This groundbreaking in-process inspection technology will help manufacturers meet strict standards by providing superior measuring information without limiting the process functionality. These faster, better measurements will speed up manufacturing processes, reduce the risk of errors, and help composite manufacturers be more competitive.

Fives has already started the last testing stage of the next-generation profilometer with customers and expects to begin commercializing the technology before the end of 2019. The NRC and Fives will continue to work together to advance this technology and bring innovative manufacturing solutions to the aerospace industry.

Manufacturing makes up nearly half of the economy.
Canada’s aerospace sector. Canada is home to more than 700 aerospace companies employing more than 85,000 skilled professionals. The aerospace industry contributed $12.6 billion to Canadian Gross Domestic Product (GDP) in 2017.

The NRC’s aerospace manufacturing technologies center supports industry, particularly the aerospace sector, in developing, demonstrating and implementing next-generation, cost-effective manufacturing methods.

Fives designs and supplies machines, process equipment, and production lines for various industrial sectors and is a major supplier of composite manufacturing equipment to the aerospace industry. The engineering group employs close to 8,700 people in about 30 countries, mainly in Canada, the United States, and Europe. The Metal Cutting and Composites group that worked on this project has more than 1,100 people globally.

“The National Research Council of Canada (NRC) is proud to work with Fives to advance the profilometer technology, pioneered by a multidisciplinary NRC team. Our expertise, paired with Fives’ forward-thinking methods, will help achieve the original vision of developing an innovative, high-impact solution that enhances the efficiency of automated composite manufacturing and facilitates the digital transformation of the process,” said Iain Stewart, president, National Research Council of Canada.

“This is an exciting project for Fives as it demonstrates our commitment to advancing state-of-the-art composite application technology with productivity-driven innovations, for both new and existing installations,” said Steve Thiry, president and CEO, Fives Machining Systems Inc.

“We have a strong history of supporting innovation. By joining with the National Research Council of Canada, we are once again contributing to the evolution of cutting-edge technologies for the aerospace and defense industries,” said Erik Lund, president and CEO, Fives Lund.

The National Research Council of Canada (NRC) is the government of Canada’s largest research organization. It is a key part of the Innovation and Skills Plan and of Budget 2018’s commitment to supporting Canada’s researchers to build a more innovative economy. To help position Canada as a global leader, the NRC is increasing its collaboration with regional ecosystems and with universities, polytechnic institutions and colleges, and establishing collaboration centers across the country.

As an industrial engineering group with a heritage of more than 200 years, Fives designs and supplies machines, process equipment and production lines for the world’s largest industrial players in various sectors such as steel, aerospace and special machining, aluminum, automotive and manufacturing industries, cement, energy, logistics, and glass. The effectiveness of its R&D programs enables Fives to design forward-thinking solutions that anticipate industrials’ needs in terms of profitability, performance, quality, safety and respect for the environment.

MORE INFO www.fivesgroup.com

Motion Industries to acquire automation and robotics company

Motion Industries, Inc., a leading distributor of maintenance, repair, and operation replacement parts and a wholly-owned subsidiary of Genuine Parts Company (GPC), announced it has entered into a definitive
agreement to acquire Axis New England and Axis New York (“Axis”), an automation and robotics company based in Danvers, Massachusetts. Execution of the transaction was set for March 1, 2019, subject to the satisfaction of customary closing conditions.

Founded in 1994, Axis New England serves the Northeast U.S. from its locations in Danvers, Massachusetts; and Rochester, New York (Axis New York). With expertise in advanced machine automation, the company will continue its focus on motion control, robotics, and machine vision. Areas of specialty include precision components, electro-mechanical assemblies, and fully engineered automation systems.

Todd Clark, Axis president, said, “Motion Industries is a great cultural fit for us. We are pleased to join the Motion team and excited about the growth opportunities this will afford the company and our employees. Our customers and suppliers can expect the same partnership, support, and service as we continue our focus on delivering high-value solutions.”

“We are very pleased with the addition of this well-established company, which will operate as part of Motion’s Automation Solutions Group,” said Randy Breaux, President of Motion Industries. “Acquiring Axis is in keeping with our strategic intent and complements our growth in the area of industrial plant floor automation. We welcome the Axis employees to the Motion Industries family, and we look forward to the contributions they will make to our company in upcoming years.”

With annual sales of more than $5 billion, Motion Industries is a leading industrial parts distributor of bearings, mechanical power transmission, electrical and industrial automation, hydraulic and industrial hose, hydraulic and pneumatic components, industrial products, safety products, and material handling.
Hexagon Manufacturing Intelligence expands Canadian footprint

Hexagon’s Manufacturing Intelligence division announced it has expanded its footprint into western Canada with a new office in Calgary, Alberta. The new location and staff will serve the region’s diverse range of manufacturing industries including aerospace, oil & gas, advanced composites, MRO, agriculture, bus and rail, machinery, wood products, and more. The facility will accommodate business offices and a training room, with ample space to offer seminars covering Hexagon’s most innovative metrology and manufacturing technologies including laser trackers, articulating arms, scanners, CMMs, software, and automated solutions. The regional office resides at the state-of-the-art Hexagon Calgary Campus, which opened in September 2018. The spacious 160,000-square-foot, Silver LEED-rated facility, also the area headquarters for other Hexagon divisions, is at 1120 68th Ave. N.E., Calgary, Alberta, Canada T2E 8S5.

Heading the regional office, Alberto Silva will serve as a sales engineer for West Canada, covering Manitoba through British Columbia. Silva’s background includes the oil and gas industry and the manufacture of rotating machinery. He applies more than 20 years of technical sales and consulting expertise to finding solutions for complex problems and making processes work better for the customer. Silva holds a bachelor’s degree in mechanical engineering, as well as a Master’s of Business Administration degree in marketing from SE Louisiana University.

“We are excited to now locally serve the growing manufacturing industries of western Canada,” said David Hill, commercial operations manager – Canada, Hexagon Manufacturing Intelligence. “The Smart Factory movement is opening people’s eyes to the benefits of dimensional measurement throughout the product development cycle. Hexagon leads the way in advancing portable and stationary metrology products, as well as the automation of measurement processes for inline, online and near-line applications. From entry-level products to the most sophisticated measurement solutions, we can offer personal consultations and application knowledge to help manufacturers take pivotal steps toward the future, large or small.”

MORE INFO www.hexagon.com
MC Machinery welcomes Jeff Grim as Southeast regional sales manager

MC Machinery recently announced that Jeff Grim has joined the sales team as a Southeast regional sales manager. Based in Florida, Grim will oversee operations and be responsible for supporting current customers while developing new partnerships within the SE region and the state of Indiana.

“I am proud to work for such a well-respected company like MC Machinery,” Grim said. “The atmosphere is so positive, and the people that work here are very good at what they do. I look forward to working with customers and helping them find the best MC Machinery solution for their needs.”

Grim comes to the team with several years of experience in the industry. In 1983, he started in a high-end shop in Indiana where he ran wire EDMs for almost 15 years. Grim then moved into the sales side selling EDMs, high-speed machining centers, and waterjet machines as a dealer in Indiana.

“Jeff’s experience in operating EDMs helps him understand what users are looking for,” said Alan Hallman, North America sales manager, EDM/Machining. “We are thrilled to have him onboard and are confident in his skill set and industry knowledge.”

MORE INFO www.mcmachinery.com

Klingelnberg to present Industry 4.0 solutions at CIMT 2019

Since its inception in 1989, the China International Machine Tool Show (CIMT) has evolved, according to show organizers, to become a leading platform for the international machine tool industry in China, and in the entire East Asian region. Organized by the China Machine Tool & Tool Builders’ Association (CMTBA), the show is one of the four largest international machine tool trade shows in the world. Machine manufacturer Klingelnberg will be presenting its innovative Closed Loop concept for cylindrical gears — a pioneering Industry 4.0 solution — at booth A105 in Hall W1 from April 15 to 20. With its entry into the robotics industry, Klingelnberg is also launching an initiative to expand its business outside the gear industry. Klingelnberg’s cycloid measurement option for precision measuring centers provides a reliable solution for monitoring high production standards.

Focused on highly effective generating grinding in large-series manufacturing, the Höfler Speed Viper Cyclical Gear Grinding Machine draws on the successful concept...
of the well-established Viper 500 series of Höfler Cylindrical Gear Grinding Machines. Four different machine models are available to suit individual requirements: Speed Viper 300 and 180 in a single-spindle configuration, and Speed Viper 180 and 80 in a dual-spindle configuration. Speed Viper is designed for maximum workpiece diameters of 80, 180, and 300 mm, depending on the model. The Speed Viper dual-spindle concept achieves the shortest auxiliary times and therefore fulfills the productivity requirements of the automotive industry. With an outside diameter of 320 mm and a width of 200 mm, the grinding worms ensure a long tool life while minimizing auxiliary times for tool changes.

An automatic tool clamping system with an integrated balancing unit also contributes to shortened tooling times. With a partial or full automation system, the Speed Viper can also be equipped with an automation interface that meets the VDMA 34180 standard.

The Speed Viper platform is optimally designed for the Industry 4.0 manufacturing environment. Thanks to a broad array of applications and software, Klingelnberg’s cyber-physical production system centralizes production control, leading to a standardization of results achieved on different machines and even in different plants.

Designed for use in Closed Loop processes, the P 26 Precision Measuring Center stands for quality management of gearing with scope for future development, and is designed as a compact unit suited to a workpiece diameter range of up to 260 mm. The machine and software concept is optimized for the measurement of complex drive components using a technology that replaces up to six conventional measuring methods: gear measurement, general coordinate measurement, form and position measurement, roughness measurement, contour measurement, and optical measuring technology.

This guarantees maximum measuring accuracy and reproducibility. Klingelnberg’s P series is one of the most widely used standards in the industry and serves as a reference for metrology institutes.

With the cycloid measurement option, Klingelnberg now offers a reliable solution for monitoring the high production standards of the robotics industry. Cycloid transmissions enable high reduction ratios and are used to transmit forces in robot arms. As the need for high-precision robots increases along with increasing levels of automation, the combination of precision measuring centers and gear grinding machines for cycloids ensures continuous improvement in production quality.

Klingelnberg solutions are close to the market and the user – and also include a comprehensive range of services and software solutions. CIMT visitors will have an opportunity to experience these in action at Klingelnberg’s booth A105 in Hall W1.

MORE INFO www.klingelnberg.com

PMTS 2019 will have new venue, new exhibitors at show in Cleveland

The Precision Machining Technology Show (PMTS) is celebrating its 10th show by moving to a new venue and a new city for the first time since the inception of the show in 2001. The move to a new city has attracted additional interest in the show, which is currently on-track to be the largest PMTS in history, up nearly 10 percent in exhibitor growth.

PMTS has continually grown and evolved
over the years to bring more value, education, and technology to PMTS attendees and PMTS exhibitors, and moving to Cleveland is part of the evolution of the expansion of PMTS.

“We are excited to bring the show closer to a wider manufacturing audience and about some of the new interest we’re seeing in terms of exhibitors. In fact, of our nearly 270 current exhibitors, 50 are new to PMTS 2019, so we’re looking forward to how that expansion translates to new attendees,” said Allison Miller, director of events, Gardner Business Media, Inc.

Here is a partial list of new exhibitors:

- Cucchi - BLT America, booth 5067.
- Hurco Companies, Inc., booth 3066.
- KSI Swiss, booth 3046.
- Milltronics, booth 5057.
- Pro Ultrasorics, booth 2095.
- Rathbone Precision Metals, booth 7104.
- Strausak Inc., booth 6099.
- Tipton Machinery, booth 2033.
- Titan Metallurgy, booth 4101.
- Toyoda Americas Corp., booth 10083.
- Tipton Machinery, booth 1071.

The PMTS registration is open, and people can register for free when they use code REG. With PMTS registration, people will receive access to the show floor featuring more than 290 exhibitors, free educational sessions, live machining demonstrations, and networking events.

MORE INFO www.PMTS.com

Mahr makes multiple hires, opens new facilities across U.S.

Mahr Inc., a leading provider of dimensional metrology solutions, closed a record year of success in 2018 — including adding multiple key hires, opening new facilities across the United States, and introducing a number of innovative products.

The company added 30 new employees in 2018, including a number of senior level positions. Strategic hires included: Chris Wichern, product manager for 3D Surface Metrology; Brad Frost, national distribution manager; Dan Cavaleri, customer resource center manager; Rebekah Bruhn, health, safety, environmental and quality manager; Doug Klein, regional sales manager; Michael Plante, project manager – Engineered Solutions; and Tim Prentice, district sales manager, as well as many others within its assembly, manufacturing, quality, and accounting departments.

Additionally, the company expanded across the United States with new facilities and a demo center located in Greenville, South Carolina. Additionally, a new customer center in Wixon, Michigan will be opening in the first quarter of 2019.

“I’m really pleased with the overall performance of last year, between winning significant orders and generating growth,” said Brett Green, VP of Sales Americas/CEO and president of Mahr Inc. “As we look ahead to 2019, our new customer centers will play a key role as we continue to roll out a regional structure, which focuses on being local to our customers.”

2018 was also a record year in terms of new product releases from Mahr, including:

- MarSurf CM Systems: Innovative confocal technology with high-precision 16-bit HDR technology that delivers high-resolution 3D surface topography data — enabling new insights into surface structures and processing.
- MarSurf CD Series: The CD series takes contour measurement to never-before-seen
levels of speed, flexibility and precision, allowing users to improve the manufacturing quality of workpieces with faster throughput, higher accuracy and flexibility for a broader range of workpieces.

Micrometer 40 EWri-L: Part of the expanded range of Mahr’s Micromar 40 series digital micrometers, the Micromar 40 EWri-L micrometer features a high-speed measuring spindle positioning, allowing for making measurements 10 times faster than a standard micrometer when numerous different dimensions need to be measured on one workpiece.

Cockpit Software: An interactive new MarWin-based gaging software that allows users to configure and implement simple to complex gaging solutions quickly and cost effectively. The system is designed to meet the ID, OD, length, and simulated form measurement needs of today’s manufacturing environment where speed to implementation, long- or short-runs or quick changeovers are becoming the industry standard.

Precimar Optimar 100: A proven solution for testing dial and digital indicators, test indicators and dial comparators, with image processing for the automated testing of measuring equipment. The automated procedure saves time and replaces the exhausting and error-prone reading by the operator.

Mahr Inc., a member of the Mahr Group, has been providing dimensional measurement solutions to fit customer application needs for more than 150 years. The company manufactures and markets a wide variety of dimensional metrology equipment, from simple and easy-to-use handheld gages to technically advanced measurement systems for form, contour, surface finish, and length. Mahr Inc. is also well known as a producer of custom-designed gages and a provider of calibration and contract measurement services.

Solar Atmospheres of Western PA names regional sales manager

Solar Atmospheres has announced the addition of Timothy C. Fish to its sales team, as regional sales manager at Solar Atmospheres of Western PA.

As an Integrated Marketing Communications graduate of Duquesne University, Fish has honed his sales and marketing skills during the course of his diverse career in the metals industry. Fish brings a wealth of forging and materials knowledge while most recently serving as a strategic account manager at Ellwood City Forge.

Bob Hill, president of Solar West, said, “We feel extremely fortunate to be adding Tim Fish and his talents to our sales team. Tim’s prior sales experience within the power generation and aerospace arenas brings a wealth of knowledge to Solar Atmospheres of Western PA. Tim’s professionalism will cultivate new and exciting opportunities for our company today and in the future.”

Fish will use his experience and leadership skills to maintain and promote sales for Solar in the Midwest region.
2018 AGMA Technical Committee Activity

Thanks to our many hardworking volunteer committee members, AGMA Technical Committees have had another successful year in 2018. After an eight-year development project that featured volunteers from more than 30 different companies attending at least one meeting, we’ve published a completely new information sheet, AGMA 945-A18, Splines – Design and Application. One revision project was wrapped up and published in 2018, ANSI/AGMA 9001-C18, Flexible Couplings – Lubrication, while three revision projects were completed by their committees in 2018 but will be published in early 2019, ANSI/AGMA 6025-E19, Sound for Enclosed Helical, Herringbone and Spiral Bevel Gear Drives; ANSI/AGMA 6001-F19, Design and Selection of Components for Enclosed Gear Drives; and ANSI/AGMA 6101-F19, Design and Selection of Components for Enclosed Gear Drives (Metric Edition).

In addition, eight documents were reaffirmed in 2018, which is the process of our committees reviewing the documents for continued relevance to the industry and technical accuracy.

DOCUMENTS REAFFIRMED IN 2018

- AGMA 909-A06, Specifications for Molded Plastic Gears.
- AGMA 914-B04, Gear Sound Manual.
- AGMA 939-A07, Austenitized Ductile Iron for Gears.

Like a well-designed machine that doesn’t break down, the expert knowledge, meticulous attention to detail, and consensus-building skills of our volunteer members who work hard to develop the standards often go unnoticed in the background. The benefits of their work, however, are front and center to the gear industry and gear users every day. In 2019, a sampling of the work AGMA technical committees will be continuing is:

- A new revision of AGMA 923, Metallurgical Specifications for Steel Gearing, which will add a third grade to through-hardened gears and update the rest of the document to the latest industry practices. Information sheets such as this will help improve quality of raw materials by providing detailed guidelines on required specifications set by gear designers.
- A completely new information sheet titled AGMA 916, Face Gears with Intersecting Perpendicular Axes, offering the latest knowledge and best practices on the subject, will help companies save costly research and development costs of “reinventing the wheel.”
- Another brand-new information sheet titled AGMA 944, Mechanisms of Powder Metal Gear Failures. Having a go-to source to define these gear failures will save time for companies doing failure analyses which will help the bottom line.
- The new standard titled AGMA 1107, Tolerance Specification for Form Milling Cutter, provides guidelines and requirements, which will help manufacturers and users of such tools by reducing redundancy and improving interchangeability.
- A new revision of ANSI/AGMA 6006, Standard for Design and Specifications of Gearboxes for Wind Turbines will update the information to the latest industry practices.

A full listing of AGMA technical committees, including a scope of their activities, can be found in the Technical Committees section of the AGMA website, www.agma.org. For additional information about AGMA technical committees, standards, and information sheets, please contact the AGMA Technical Division at tech@agma.org.

For all the valuable contributions of our committee members that help the gear industry and gear users everywhere, we thank you!
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Learn what is required for the design of an optimum gear set and the importance of the coordinated effort of the gear-design engineer, the gear metallurgist, and the bearing system engineer. Investigate gear-related problems, failures, and improved processing procedures.

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Subject matter experts will be providing the most up-to-date information in 45-minute presentation/Q&A sessions. Topics in the Know Your Business Track (business intelligence track) will include: cybersecurity, blockchain, workforce and supply chain. Presentations in the Be Prepared for the Future (emerging technology track) will include IoT, 3D-printed metal, robotics, and electric drive technology.

For the full press release or more information, visit: https://motion-powerexpo.com/

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The AGMA Foundation Scholarship Program is open to students interested in a career in the gear industry, and/or a career in power transmission as it relates to the gear industry. Applicants must be currently enrolled, or recently accepted, as a full- or part-time student in a nationally accredited program. Annual scholarships are awarded to students at the Technical/Associate, Undergraduate, and Graduate-school levels. Preference is given to applicants with current or recent experience working in the gear and/or power-transmission industry.

For more information, please visit: agmafoundation.org/our-work/scholarship-program/

U.S. ECONOMIC AND GEAR INDUSTRY OUTLOOK

Financial markets entered the new year facing increased volatility, but will that slow growth? Economic data has been mostly good, especially jobs numbers. A slowdown does not imply that a recession is on the horizon. Hear the latest economic data affecting the gearing industry.

AGMA’s economists from IHS Economics will review current market conditions and present their outlook for the general economy, key sectors, mechanical power transmission, and the user markets for your products.

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Magnetic particle testing and evaluation of AMS AQ test samples

Better understanding the sampling, inspection, processes, and reporting steps necessary to complete an “Aircraft Quality” test per AMS standards.

Aircraft quality (AQ) testing of steels per AMS 2300, 2301, 2303, and 2304 requires specialized sampling and specimen preparation prior to final evaluation using fluorescent magnetic particle inspection. Last month’s Materials Matter column provided insight into the sampling and test specimen preparation, and this month, we conclude our discussion of the AMS AQ standards and look at the inspection, evaluation, and reporting requirements.

Each of the four AMS 23XX standards has slightly different quality requirements. The original AMS 2300 standard issued in 1959 is specified for the highest-quality materials produced using steels that are re-melted using VAR or ESR steelmaking practices. In 1995, the AMS 2304 standard was adopted that has essentially the same quality requirements as AMS 2300 but does not require re-melt steelmaking. AMS 2301 was adopted in 1960 and is intended to qualify steel produced by conventional steelmaking techniques and requires a lower quality level as compared to AMS 2300 and 2304. AMS 2304, issued in 1967, is similar in quality level to AMS 2301 but is specifically for martensitic corrosion-resistant steels.

Despite the differences in quality levels between the four AMS standards, the method of inspection is the same for each. All the AMS standards use magnetic particle inspection performed in accordance with ASTM E1444 entitled “Standard Practice for Magnetic Particle Testing.” The ASTM E1444 standard is a broad document that details every type of magnetic particle inspection that you might encounter, including the various types of magnetization, field directions, wet and dry particles and visual or fluorescent examination methods. The AMS standards require only one very specific type of magnetic particle inspection: circular, wet, continuous method. Per ASTM E1444, “Direct magnetization is accomplished by passing current directly through the part under examination.” By passing current through the part, a circular magnetic field is induced as illustrated in Figure 1.

Application of the direct current must be controlled per the AMS standards to be 800 to 1200 amperes per inch of diameter (32 to 48 amperes/mm). The “continuous” method requires that the liquid particle suspension be streamed over the test sample simultaneously with, or slightly before, energizing the part. The suspension must contain the required concentration of particles and be gently sprayed or flowed over the area to be examined. ASTM E1444 contains the details on the required particle density of the suspension, along with the corresponding testing methods to confirm compliance.

The presence of a non-metallic inclusion at or near the surface of the test piece will cause a disruption of the magnetic field (flux leakage) that attracts the fine iron particles suspended in the suspension to the site of the inclusion revealing an “indication.” When using fluorescent particle suspension, the room lights are turned off and the sample is illuminated using an ultraviolet light to reveal the indications. Again, ASTM E1444 specifies the allowable ambient light and the intensity of the UV light source used for this inspection. The UV light must have a minimum intensity of 1000µW/cm² at the surface being examined (Figure 3). Next, the indications are measured, counted, and recorded (Figure 4).

Up to this point in the procedure, the steps and requirements are identical for all four of the AMS standards. The first apparent difference between the standards is the size of the indications that are considered relevant and must be measured and reported. Recalling that AMS 2300 and 2304 have the highest quality requirements, these standards require any indications of 1/64” or larger to be recorded. The lower quality requirements of AMS 2301 and 2303
Despite the differences in quality levels between the four AMS standards, the method of inspection is the same for each. All the AMS standards use magnetic particle inspection performed in accordance with ASTM E1444 entitled “Standard Practice for Magnetic Particle Testing.”

require recording indications that are 1/16” or larger.

After the relevant indications are counted and measured, the frequency (F) calculation can be completed. The frequency is simply the total number of relevant indications for each specimen divided by the surface area of the test specimens in square inches. The final reported “average frequency” (F) equals the total frequency rating of all test specimens from a heat divided by the number of test specimens.

Next comes calculation of the severity rating (S). This gets more complicated as the AMS standards provide a table of “Progression Factors” or weighting factors. It is recommended that you refer to the specific AMS standard for the complete severity rating details. How it works is each standard provides a table with a progression factor corresponding to a range of indication sizes. For example, in AMS 2300 and 2304, an indication with a length greater than 1/8” must be multiplied by 256. In the AMS 2301 and 2303 standards, an indication between 1/8” and 1/4” is only multiplied by 1 and an indication between 1” and 1.5” is multiplied by 16. The severity rating (S) for a sample is calculated by multiplying the number of indications within each size range provided in the table times the corresponding progression factor. You can start to see how significant the quality differences are between the two tiers of AMS standards. The sample severity rating (S) is determined by multiplying each indication by its corresponding progression factor and then dividing the result by the total surface area of the test specimen in square inches. The severity ratings are then totaled for all indications observed in the heat. The final reported “average severity rating” (S) equals the total severity rating of all test specimens from a heat divided by the number of test specimens. A final AMS test report is a frequency (F) and severity (S) number.

Once the frequency (F) and severity (S) results are completed, they must be evaluated against the AMS standards acceptance criteria to establish Pass or Fail criteria. Each of the four AMS standards has their own specific acceptance criteria. The simplest is AMS 2304, which specifies the maximum acceptable rating with the maximum frequency rating (F) of 0.25 and the maximum average severity rating (S) of 0.50. The other standards get more specific and have acceptance criteria that varies by steel carbon content and product nominal size.

This series of columns was intended to help the reader better understand the sampling, inspection, processes, and reporting steps necessary to complete an “Aircraft Quality” test per AMS standards. These standards can be purchased from SAE International (www.sae.org). The referenced ASTM E1444 specification governing the magnetic particle inspection process can be purchased from ASTM International (www.astm.org).

About the Author

Guy Brada is a metallurgical engineer with more than 25 years in the steel industry. He received his Bachelor’s and Master’s degrees in Metallurgical and Materials Engineering from the Colorado School of Mines. During his career, he has worked in steelmaking, the heavy forging industry, at an independent metallurgical test laboratory, and at a commercial heat-treater. He has authored seven steelmaking and steel product patents. Currently he is technical sales service manager for Ellwood City Forge the open-die forging division of the Ellwood Group.
Parallelism, perpendicularity, and misalignment

The proper alignment of gears in mesh is critical for their proper operation.

Sometimes around your 12th birthday, the trip to the dentist resulted in a discussion about the misalignment of your teeth and the need to see an orthodontist for braces. Although traumatic for the average teenager, braces were not the end of the world for the teeth themselves. When speaking about gear teeth, there aren’t any braces to correct misalignments that lead to premature wear and eventual failure.

The gears most vulnerable to misalignment failure are worm gear pairs. The first misalignment to review is the perpendicularity of the worm axis to the worm wheel axis. When they are properly aligned, the wear on the worm wheel tooth occurs in the center of the tooth. If the worm is not properly aligned, there will be wear on the opposite ends of the tooth flank as shown in Figure 1.

The second alignment to consider is that the worm axis is centered with the worm wheel axis. When properly centered, the tooth engagement will occur in the center of the tooth flank on both sides of the worm wheel tooth. If the worm is not properly centered, then the worm wheel will wear on the outer edge of the tooth on both flanks as shown in Figure 2.

Center distance is another consideration for not only worm gear pairs but also for spur and helical gear mesh. In order for the gear teeth to properly interact, there needs to be a minimal amount of clearance to permit the smooth engagement and disengagement of the teeth as they come in and out of mesh. Additionally, there needs to be sufficient clearance to permit lubricant to enter the tooth mesh. This clearance is known as backlash. When gears are spaced too close together, the backlash becomes too small, leading to binding of the mesh. If the gears are spaced too far apart, they will not engage at the proper point on the tooth flank. An example of the tooth engagement when setting gears at the proper center distance and at the improper center distances are shown in Figure 3.

One final mesh consideration for worm gear pairs is centering the worm over the worm wheel such that the proper engagement occurs. An example of this is shown in Figure 4.

Other types of gears also have alignment issues. One important tolerance for gear racks is the face width tolerance. This, along with
the total rack height tolerance and the flatness of the rack, are critical during assembly (Figure 5).

The pinion will not operate as desired and can prematurely wear if the face width of the pinion and rack are not exact. Additionally, there will be positioning errors if the rack straightness is not maintained during assembly.

For miter and bevel gears, there are three alignments errors to consider (Figure 6). These are mounting distance error, offset error, and shaft angle error. Similar to the errors of worm gear pairs, each of these errors will result in premature failure of the gears and a large increase in noise.

All of these misalignment errors can be corrected if you know how to interpret the wear patterns of the gear mesh. Unlike the braces you wore in high school, there are no worries about losing a rubber band in the middle of fifth period Spanish class nor of having to wear your night guard headgear or retainer.

ABOUT THE AUTHOR

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Tempering relieves thermal and transformational stresses from quenching, and makes hard, brittle martensite tougher.

Once a part has been quenched, it must be tempered. This accomplishes two things: First, it relieves the thermal and transformational stresses from quenching. Second, it transforms the hard, brittle martensite to the tougher tempered martensite. For high-alloy steels, it may also convert any residual retained austenite to tempered martensite or bainite.

Tempering is usually conducted in recirculating air furnaces. Depending on the temperature, nitrogen may be used to prevent surface oxidation of the parts. To prevent quench cracking, parts are usually placed in the temper furnace within approximately 60 to 90 minutes after quenching. In fact, in some specifications, the time between quenching and tempering is mandated to be less than 90 minutes. [1] In general, the higher the carbon content, the more critical it is to get the parts into temper immediately. If the carbon equivalent is greater than 0.52 percent (discussed previously), it is imperative that the parts are tempered as soon as possible. If it is not possible to temper the parts within 90 minutes, it is recommended that the parts be snap-tempered at 121° C (250°F) for two hours per inch of thickness.

The furnaces used for tempering are generally very simple and are typically a box furnace with a recirculating fan. The uniformity is good, because of the recirculation of the air and is typically around ±10 to 15°F around the setpoint. A typical tempering furnace used for tempering steel parts is shown in Figure 1.

Toughness increases as the part is tempered above 150°C. In general, as the toughness increases, the hardness decreases. For high hardness applications, the tempering temperature is kept low, usually between 150 and 200°C. The martensite partially decomposes and forms very fine carbide precipitates [2]. The precipitates that form are transition carbides of epsilon-carbide (ε-carbide) and eta-carbide (η-carbide) [3]. They are not cementite. There is a small increase in toughness, but the matrix remains hard.

When steels are tempered between 200 and 400°C, the martensite precipitates cementite (χ-carbide) and any retained austenite transforms to ferrite and cementite. These carbides are coarse and occur within the plates or laths of martensite. The retained austenite begins to transform above 200°C [4]. There is a slight decrease in toughness associated with tempering in the range of 250 to 400°C, called tempered martensite embrittlement.

Tempering above 400°C results in coarsening of cementite. The martensitic structure is also changed. The laths are now nearly completely ferrite because all the carbon has precipitated out as carbides (Figure 2). Hardness and strength fall rapidly as the tempering temperature is increased above 400°C. Toughness improves significantly. In alloy steels, fine alloy carbides may form. The formation of these fine dispersions of alloy carbides can overcome the softening effect of coarsening cementite carbides and result in an increase in hardness. This increase in hardness is called secondary hardening.

As indicated above, increasing the tempering temperature above 400°C can greatly increase toughness. However, if tin, antimony, or arsenic are present as impurities in the steel, then the steel may become brittle. This is called temper embrittlement. It is caused by the impurities segregating to the grain boundaries [5].

The tempering reactions in steel are summarized in Table 1. As the tempering temperature is increased, the hardness of the part will decrease. Generally, parts are tempered for one hour per 25 mm of thickness. Some highly alloyed steels require a double temper to increase toughness and ductility. The change in hardness for plain carbon steels as a function of tempering temperature is shown in Figure 3.

Certain alloying elements retard the rate of softening during tempering. The most effective elements are those that are strong carbide formers, such as chromium, molybdenum, and vanadium (Figure 4). Without these elements, Fe-C alloys will soften rapidly with increasing...
tempering temperature as shown in Figure 3. This softening is due to the coarsening of cementite with increasing tempering temperature. If the alloying elements are present in sufficient quantity, the carbide-forming elements slow the coarsening of cementite by reducing the diffusion of carbon. These carbide formers also form very fine carbides in the matrix that produce an increase of hardness at higher tempering temperatures. This hardness increase is called secondary hardening.

The presence of these alloying elements slows the process of tempering by retarding the diffusion of carbon. Therefore, it is often necessary to temper for a longer time. Tempering for two hours per inch of thickness is not uncommon.

Figure 4 shows the differences in retarding hardness for different alloying elements. The strong carbide formers do not show much effect until higher temperatures are reached. Nickel has a small effect on tempered hardness since it is not a carbide-forming element. Manganese has a small effect at lower temperatures, but at higher temperatures has a much stronger effect, due to being incorporated into carbides at elevated temperatures.

If the steel contains a significant amount of austenite stabilizers, such as nickel, austenite often remains at the tempering temperature. This can occur during martempering, or even normal quench and temper if the temperature after quenching is still above the martensite finish temperature. When this occurs, the retained austenite must be converted to martensite, or to bainite. This is accomplished by performing a double tempering operation. Often the second temperature is about 10°C or so below the first tempering temperature. This also allows the part to hit the desired hardness, by controlling the final tempering temperature, and adjusting it up or down, depending where the hardness was at the end of the first tempering cycle.

**CONCLUSIONS**

In this article, we have discussed the type of equipment used for tempering, and the various reactions that occur during tempering, as a function of temperature.

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

**REFERENCES**


INDUSTRIAL GEAR LUBRICANTS FACE FORMULATION CHALLENGES
Moisture, temperature, viscosity, filtration, and base oil are some of the factors that need to be considered.

By LAWRENCE LUDWIG JR. and NANCY McGUIRE

Gears transmit motion from one shaft to another or from a rotating shaft to a reciprocating element. Gears transmit power, change speed, change force (torque) or change direction. They operate under a myriad of operating cycles, loads, speeds and temperatures (see Gear Basic Terminology).

Gear lubricants increase the durability of equipment by preventing gear and bearing wear and preventing excess friction. Lubricants also carry heat generated by equipment away from the contact area. Gear lubricants can enhance the cleanliness of gears, bearings, and seals by preventing rust, corrosion, and other types of deposits from forming. They also can prevent air from being entrained in the lubricant and retard foaming of the lubricant. A properly functioning lubricant reduces power consumption and noise.

CHALLENGES AND TRENDS
Today's customers demand that equipment be more durable and reliable with longer drain intervals. Industrial gearboxes use new materials and surface finishes to provide more power with less weight, size, and manufacturing costs (Figure 1). However, modern gearboxes run hotter and, with less lubricant to cool the system, these gears experience increased thermal stress and higher loads on gear teeth and bearings.

Challenges to gear operation include the presence of large quantities of water or moisture, high operating and ambient temperatures, or environments that are highly contaminated with chemical vapors, dust, or dirt. Filtering lubricants can selectively remove some lubricant additives, and this must be dealt with accordingly. Fluctuations in speed and loading may cause speeds and loads to intermittently exceed the ratings for the gear. Certain gear types and applications require protection from micropitting.

TRENDS
Baseline performance requirements for gear lubricants are constantly changing. Today's gear lubricants must be stable against oxidation, viscosity changes, and thermal degradation under more stringent conditions. OEMs and customers require gear lubricants that provide increased thermal stability, cleanliness, and wear protection at higher power densities and operating temperatures. Other requirements include gear and bearing durability for extended service life, materials compatibility, improved energy efficiency, use of sustainable additives and base oils, extended drain intervals, and cost.

Factors that affect gear lubrication performance include the type of gear (Figure 2), its surface finish (rounder finishes require higher viscosity lubricants), its speed (higher speeds require lower viscosities), loading and transmitted power (heavy loads require higher viscosity), ambient and operating temperatures, materials compatibility, contamination, application methods (splash or circulation), filtration, and operating conditions.

A gear lubricant must have the correct viscosity at the operating temperature to distribute lubricant to all contact surfaces and form an elastohydrodynamic lubrication (EHL) film, but it also must exhibit adequate fluidity at low temperatures, especially at start-up. It must be chemically stable, show good demulsibility characteristics (expulsion of water), and provide extreme pressure (EP) and antiwear (AW) protection.

Several standards for classifying and providing specifications for gear lubricants ensure that each

<table>
<thead>
<tr>
<th>Same torque and power output</th>
<th>in 1950s</th>
<th>in 1960s</th>
<th>in 1970s</th>
<th>in 2000s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardening</td>
<td>Quenched + tempered</td>
<td>nitrided</td>
<td>case hardened</td>
<td>case hardened</td>
</tr>
<tr>
<td>Floor space</td>
<td>~ 6 m²</td>
<td>~ 4.5 m²</td>
<td>~ 2.5 m²</td>
<td>~ 2.0 m²</td>
</tr>
<tr>
<td>Weight</td>
<td>~ 2300 kgs</td>
<td>~ 1500 kgs</td>
<td>~ 800 kgs</td>
<td>~ 700 kgs</td>
</tr>
</tbody>
</table>

Figure 1: Gear drives are as much as five times smaller and lighter than they were 50 years ago. (Courtesy: Schaeffer Manufacturing Co.)
type of lubricant meets the minimum performance characteristics that OEMs require for their products and applications. The most-referenced specifications are AGMA 9005-E02, AGMA 9005 F-16 (the most current specification), and DIN 51517, which has parts for rust and oxidation (R&O), R&O antiwear and EP-type gear oils. Some OEMs are now requiring thermal oxidation stability tests such as the L-60-1 Thermal and Oxidative Stability Test ASTM D-5704 more frequently in their specifications for industrial gear lubricants.

BASE OIL SELECTION
Selection of a base oil depends not only on the equipment’s operating conditions (temperatures, loads and susceptibility to contamination) but also the types and amounts of additives that go into the formulation, as well as the types of gear, bearing, and seal materials with which the lubricant will be interacting. Biodegradability of the base oil is another consideration, especially for operations that are done in an environmentally sensitive area. The cost of a lubricant involves not only the cost of the base oil itself, but also the additive and production costs, any energy efficiency that the lubricant can provide and the drain intervals and service life of the lubricant.

The type of base oil has a significant effect on performance. Base oil choice affects overall base oil film thickness and viscosity, which, in turn, affects film thickness in the hydrodynamic and elastohydrodynamic regimes. The properties of the base oil determine the compatibility and solubility of various additive systems in the base oil and the responses of these additives during use. Base oil choice also affects thermal and oxidative stability, rheology at low and high temperatures, hydrolytic stability, tendency toward foaming, heat transfer, and compatibility with seals and other materials.

Petroleum-based (mineral oil) gear lubes use Group I and Group II base oils. Synthetic base oils include polyalphaolefins (PAO), esters, polyalkylene glycols (PAG), and Group III oils (with the use of polymers). Mineral and synthetic oils can be blended to form semi-synthetic (synthetic blend) bases.

Group I oils lack the antioxidant properties of Group II and Group III oils, but their performance is easily enhanced using additives. Group I oils hold additives better (solvency) than Groups II and III, have a lower cost, and are available in a wider variety of viscosity cuts.

Group II and Group III oils provide better thermal and oxidative stability and can work synergistically with carefully chosen antioxidant additives. Because these oils have decreased solvency, additives must be selected carefully. These base oils are useful for higher-temperature lubricants, and they are only available in lower-viscosity cuts (ISO 68 to 100). These oils may be blended with PAOs, polymers or Group I oils to increase the viscosity of the lubricant. Although Group II and Group III base stocks tend to cost more than Group I base stocks, their increasing availability is bringing their price down.

Synthetic base oils perform very well for low-temperature operations, but they also provide better thermal and oxidative stability at high operating temperatures. Synthetics offer better heat transfer characteristics, lower friction, higher shear strength and lower coefficients of traction than do mineral oils.

Base oil choice affects the coefficient of traction, which, in turn, influences the energy savings that a lubricant can achieve (Figure 3). The coefficient of traction is an indicator of a lubricant’s molecular resistance to shearing.

PAOs and PAGs have the lowest coefficients of traction, but syn-
Lubricant additives serve a variety of functions. Some additives modify properties of the base oil — they inhibit oxidation, corrosion, foaming, and water ingress. They also can act as pour point depressants and viscosity index improvers. Other additives — EP and AW additives, friction modifiers, detergents, dispersants, metal deactivators, and tackiness agents — can provide new properties to the lubricant. All of these functions require mixtures of additive components, and the systems of interacting components can become very complex.

Frictional modifiers reduce friction and wear during boundary and near-boundary lubrication conditions. These compounds consist of long hydrocarbon chains with a small polar functional group at one end. The polar groups anchor themselves onto a metal surface, leaving the hydrocarbon tails facing toward the interfacial area. Aggregates of these molecules function as a tough, wear-resistant polymer film. Frictional modifiers can act as AW additives, EP additives and oxidation inhibitors.

EP lubricants protect geared systems that operate under high loads and severe impact or reversing conditions. EP agents react chemically with metal surfaces to form a film that protects against metal-to-metal contact and adhesion. This protective boundary lubricant film fills in surface asperities to reduce friction, welding, scuffing, and scoring under high-speed/high-load conditions, low-speed/high-shock-loading conditions or high-temperature conditions. Typical EP agents include sulfur-phosphorus, borates and sulfur-phosphorus-boron.

Anti-wear additives reduce friction and wear under mixed-film and boundary lubrication conditions by preventing metal-to-metal contact and adhesion. These additives prevent galling, scoring and seizure of critical moving parts. Anti-wear additives form films on the surface either through physical adsorption or by chemically reacting with the metal surface to form a low-shear film at the point of contact.

Solid lubricants reduce friction and wear by forming thin solid films between rubbing and sliding surfaces. These lubricants remain in place even when high loads and pressures squeeze out liquid lubricants.

Rust and oxidation (R&O) inhibited lubricants are generally associated with applications requiring higher gear speeds and lighter loads. Rust inhibitors protect ferrous metal surfaces from oxidation, and corrosion inhibitors protect nonferrous metals from attack by acids. These additive compounds commonly have a polar functional group that attaches to the metal surface and a long hydrocarbon tail that extends into the interface and repels water or acids. Over-based detergent molecules also can neutralize acids, and dispersant compounds can surround water or acid droplets, preventing the droplets from coming into contact with the metal surface.

Antioxidants prevent the formation of acids, gums, resins, varnish and sludge that normally results from the process of oxidation. These additives can extend the life of a lubricant by a factor of 10-100 by scavenging free radicals or peroxides as they are formed during the oxidation process, preventing them from further reacting with the lubricant.

Demulsifiers promote the rapid separation of water from the oil; they enable small, stable water droplets to form bigger droplets that separate out and sink to the bottom of the oil reservoir where they can be drained. Demulsifiers have limited solubility in oil (typical formulations use only 200-400 ppm), and using too much can actually promote the formation of emulsions.

Anti-foam agents prevent the formation of stable foams and entrained air in a lubricant. These additives reduce the surface tension of oil-air droplets so that air can be quickly released from the oil. Removing air from the lubricant not only retards oxidation, but because air acts as an insulator, removing it helps the lubricant do a better job of channeling heat away from the gear system. Adding excessive amounts of anti-foam agents, however, can promote air entrainment, which may result in lubricant cavitation and gear pitting. Anti-foam agents have limited solubility in the oil, and filtration or other factors can separate them out from the lubricant.

Pour point depressants improve the flow properties of mineral base oils at low temperatures. These additives retard the formation of large needle-like aggregates of wax crystals by coating the surfaces of the crystals as they form, resulting in the formation of smaller, more rounded wax particles that do not retard the oil from flowing.

Viscosity modifiers (high molecular weight polymers) modify the way the oil’s viscosity changes with temperature. At low temperatures, the polymer molecules coil into small particles that offer little resistance to flow. At higher temperatures, the polymers uncoil to form fibers that restrict flow, preventing the viscosity from dropping too low. Viscosity modifiers must resist mechanical shear, and they must be chemically and thermally stable.

ADDITIVE INTERACTIONS

Gear oil additives interact with each other, the base oil, and the mechanical parts they contact. Additive solubility and compatibility, shear stability, materials compatibility, and filtration must all be taken into account.

Balancing additive chemistry with the base oil can reduce or prevent compatibility problems with seals. Seals often fail when they...
Viscosity can prevent the proper amount of oil from flowing to the contact zones, increase wear, and reduce service life. The OEM recommendations for lubricant viscosity are usually specified in centistokes (cSt) at 40°C (ISO Grading System), Saybolt Universal Seconds (SUS) at 100°F or by the AGMA Viscosity Grade. If no OEM recommendations are available, the correct viscosity may be determined using AGMA guidelines found in Annex B of AGMA 9005-E02 and 9005-F16 standards. Another way is to refer to tables based on an industrial gear drive’s horsepower rating, reduction ratio, the speed of the gear drive, and the type of lubrication method used. An alternative to using the tables is to calculate viscosity. One equation for determining kinematic viscosity at 40°C is:

$$v_{40} = \frac{7000}{V_1^{0.5}}$$

where $V_1$ = pitch line velocity of the lowest speed gear, feet per minute (fpm).

The AGMA guidelines for selecting lubricant viscosity are based on pitch line velocity (PLV) of the lowest speed gear set rather than simple shaft speed. PLV indirectly characterizes contact time between gear teeth, and it takes into account the size and rotational speed of the gear. High PLV values are associated with light loads and high speeds, and, conversely, low PLV values are associated with high loads and low speeds.

Information on calculating PLV can be found in References 1 and 2. Calculating PLV or use of equations may require the user to know the type of gear (Figure 4), number of teeth on the pinion and driven gears, gear ratio, pressure and gear helix angles, pinion speed (rpm), diametral pitch and operating, and minimum expected ambient temperatures.

Operating conditions will determine what type of lubricant is selected. For example, inhibited type oils (R&O and/or AW) should be used for light and moderate loads, whereas anti-scuff (EP) type oils are used for moderate and high loads. Solid lubricants or soluble molybdenum compounds also can improve load-carrying capabilities. Anti-scuff oils should never be used in drives that use internal backstops, sprag clutches, ratchet mechanisms or load brakes; the EP additives in these oils can prevent these braking mechanisms from engaging properly, which defeats their purpose as safety features.

Whether you select an industrial gear oil by looking up the manufacturer’s recommendation, calculate it from first principles or go with something in between, customized to meet the requirements of your operation, knowing and understanding the properties of the formulation’s components can help you ensure that you get the best performance for your needs.

**REFERENCES**


GEAR TERMINOLOGY  TOOTH PARTS

ABOUT THE AUTHORS
Lawrence Ludwig Jr. presented this article as a webinar on October 18, 2017. 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 Nancy McGuire created the article based on Ludwig’s webinar. Reprinted with permission from the September 2018 issue of 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.

“Gear terminology diagram” in this sidebar. (Illustrations courtesy: Schaeffer Manufacturing Co.)
ADVANTAGES OF A DUAL-SCREW H-FRAME BROACHING MACHINE

Figure 2
The BMS Dual-Drive is an electromechanically powered, table-up vertical broaching machine for all types of internal broaching applications.

By MATT EGRIN

Like any industry, in the machine-tool industry, the needs of the market drive new designs and the development of new technologies. Naturally, everyone wants machines to be less expensive to operate, to require less maintenance, and to be easier and safer to operate. They want a machine to take up less floor space and to produce higher quality parts. Broaching Machine Specialties (BMS) has developed a solution: the BMS Dual-Drive broaching machine.

The BMS Dual-Drive is an electromechanically powered, table-up vertical broaching machine for all types of internal broaching applications. The use of electromechanical drive technology is not new to BMS. The company has been building its Electro-Mate, electric drive table-up broaching machines since 1994 (Figure 1); however, the design of the machine has evolved from a single screw, “slide-and-way” construction to a dual screw H-Frame construction (Figure 2, at left).

H-FRAME ADVANTAGES

While this type of broaching machine design is not prevalent in the U.S., it has been in widespread use in Europe and Asia for decades. A major advantage of the H-Frame design is that it yields better part quality than can be achieved using the traditional, North American, slide-and-way type design. In slide-and-way construction, the moment created by the broaching force can cause deflection of the work table, resulting in parts with excessive face run-out or issues with perpendicularity. In the H-Frame construction, the moment arm that can result in degradation of part quality is eliminated. In this construction, the workpiece is on center between the two “prime movers,” and all the broaching forces are in line with the part centerline. Any deflection in the table is directly in line with the tool path, which does not show up as face-runout or problems with perpendicularity (Figure 3). A manufacturing engineer at an American helicopter manufacturing company had this to say about the quality they achieved with the Dual-Drive: “We had been getting 0.005” to 0.006” face run-out in our parts, but with the BMS Dual-Drive, that was reduced to 0.001”. We are actually broaching 10 different part numbers on the machine without any issues.”

FLOOR SPACE REQUIREMENTS

Like all electric drive broaching machines, absence of a hydraulic unit reduces the required floor space by approximately 50 percent, but with its compact, yet rugged, design, the BMS Dual-Drive reduces the floor space requirements even further. For example, the previous design of BMS’ 15-ton, 60”-stroke electric drive table-up machine required approximately 40 square feet of floor space, but, the same capacity Dual-Drive machine requires only 36 square feet of floor space. When compared to a hydraulic machine of the same capacity, floor space savings totals 37 square feet.

The table-up design yields even more floorspace savings because it does not require a pit or operator platform, thereby decreasing the floor space requirements.
even further and allowing cells to be more easily reconfigured. The floor-loaded design also simplifies part handling because parts are loaded and unloaded at floor level and frees up additional floor space for part dunnage or other production equipment.

OTHER ADVANTAGES

The Dual-Drives’ electric drive offers many more advantages including:

Better Part Finish and Tool Life: Powered by planetary roller screw drives, there is virtually no backlash or vibration of the cutting tool in the Dual-Drive machine. In typical broaching operations, the forces change continually throughout the cutting stoke, as the number of cutting teeth engaged in the part varies when the teeth enter and exit the workpiece. In a hydraulic machine, due to the compressibility of hydraulic oil under pressure, the broach tool will vibrate as the cutting forces change. This results in a degradation of part finish and tool life. Tool vibration is virtually eliminated in the Dual-Drive and, depending on the application, tool life can improve as much as 30 percent.

More Comfortable Plant Environment: Because the Dual-Drive has no hydraulics, the machine doesn’t get warmer as it operates. Cooler operation means less heat is dissipated into the plant environment, which results in happier and more productive machine operators.

Consistency and Reliability: The performance of hydraulically powered machines can be affected by the temperature of the hydraulic oil in the reservoir. The response time of the hydraulically powered slides may be different when the oil is cold versus when the oil is warm, causing the operator or set-up technician to have to adjust the stroke limits or cutting speeds. The Dual-Drive operates consistently and reliably, regardless of the time of day, the temperature of the plant, or how long it has been cycling.

Ease of Set-Up: As the machine is powered electrically, both the machine stroke and speed are programmed into the servo drive, and both can be easily changed through the touch of a button, rather than the manual adjustments of limit switches or valves as required in a hydraulically powered machine.

Quieter Operation: Rotating pumps and hydraulic oil coursing through pipes and cylinders make for a loud machine. These “noise makers” are eliminated in the Dual-Drive and noise level limitations are met easily.

SAFETY

Every moving axis of the Dual-Drive is completely enclosed within the machine guarding. The access door is automatic and fully interlocked.
to the machine cycle, ensuring that the machine cannot cycle in auto mode until the doors are closed and the operator is fully clear of the work area. An additional level of safety is added to the door itself with a safety edge that causes the door to open if there is any obstruction between the two horizontally-sliding panels. (Figure 4)

Safety during tooling changeover was also addressed by BMS. All Dual-Drive machines come complete with a pre-programmed “maintenance” mode accessed through the touch of a button on the HMI. When in maintenance mode, the machine automatically moves into a preset position allowing for the broach pullers to be easily accessed for changeover and for other maintenance tasks to be completed under the machine slide. The slide is automatically held in position with a static brake, but redundancy is provided with an insertable, interlocked safety support bar placed under the slide assuring it remains in the “maintenance” position and achieves 100 percent safety when servicing the machine.

Even further safety during maintenance is offered because the safety support bar is stored in a docking station on the machine itself and interlocked with a switch assuring the machine doesn’t operate until the bar is safely returned to storage. (Figure 5)

**EASE OF MAINTENANCE**

The Dual-Drive has integrated shed plates directing chips to a central location for efficient removal with a chip conveyor and coolant washes plumbed directly into the bottom of the broach pullers. In less sophisticated broaching machines, keeping the broach pullers free of chips requires regular attention, but the continual washing of the pullers in the Dual-Drive ensures the pullers remain chip-free, resulting in less maintenance and greater machine uptime.

Further reductions in maintenance and downtime are realized through the use of the BMS “Posi-Lock” series of broach pullers and retrievers. Gone are the springs that fatigue and fail resulting in broken and damaged broach tools and machine crashes. The “Posi-Lock” series of pullers and retrievers are pneumatically actuated and electrically interlocked to ensure the broach tools are properly engaged and locked in the pullers and retrievers at the appropriate times during the machine cycle, thus eliminating “dropped,” damaged, and broken tools and machine crashes that can result in damage to the machine.

**ECONOMICALLY SOUND**

Not only does the Dual-Drive significantly lower initial capital expenditure costs for new broaching equipment (a new Dual-Drive costs no more than a remanufactured machine of similar capacity), but it significantly reduces the cost of ownership by lowering operating costs. Unlike a hydraulically powered machine in which the electric motor is constantly running — even when the machine is idling, the motors on the Dual-Drive only run when the machine is in motion, which results in an annual electricity savings of approximately 50 percent.

The machine requires no hydraulic oil, so not only is the cost of consumable hydraulic oil eliminated, but the costs incurred for disposing of depleted hydraulic oil is also eliminated.

The cost of maintenance is also reduced, as the machine has fewer moving parts than a hydraulically powered machine. The Dual-Drive has no hydraulic valves, pumps, pipes, or fittings to maintain, and the auxiliary machine motions are powered either electrically or pneumatically. The result? No leaks to fix and no slippery floors to clean.

**ABOUT THE AUTHOR**

Matt Egrin is president of Broaching Machine Specialties. For more information, go to www.broachingmachine.com.
STREAMLINING SAFETY FOR HIGH-SPEED/SMALL-FOOTPRINT MILLING MACHINES

High Torque retention knobs provide a myriad of safety benefits between machine and spindle for High RPM Mills. (Courtesy: JM Performance Products)
High torque retention knobs are a vital anchor for safety between machine and spindle for high-RPM mills.

By JOHN STONEBACK

Safety in design is critical to CNC milling operations end products as well as to the machine’s profitability. As the trajectory of today’s new milling technology trends toward machines producing extremely high speeds/high-RPM within a smaller overall footprint, potential safety issues can’t be ignored. Loose tools moving fast could present the potential for a lot of damage to the machine and workpiece.

Indirect costs can run the gamut from damaged facilities to equipment. Currently, there are no defined guidelines to address the potential hazards that small footprint/high-RPM machines being introduced into the marketplace may present.

Everyone is looking to get more production per square inch and increase efficiency via heavy duty, multi-axis machines doing precision milling and using less space. The daunting obligation and responsibility for both industry and machine builders is to keep machine operation as safe as possible, while achieving the consensus goal of optimizing mill productivity.

HIGH TORQUE / MILLING SAFETY EVOLUTION

Without proper tools, milling machines can be a potentially dangerous threat at the forefront of this evolving safety climate. The retention knob is the main interface between the machine and the spindle and when exposed to severe conditions, failure of a standard retention knob can result in a tool breaking loose during a cutting operation. A tool, holder, or knob breaking loose from the spindle at such high speeds and RPMs produces a projectile that can damage the spindle, tool, holder, workpiece, and workholding apparatus.

Recognizing the potential for machine spindle interface failure that these small footprint/high RPM machines represent, Fairport Harbor, Ohio’s JM Performance Products, Inc., a leading manufacturing innovator of CNC mill spindle optimization products since 2009, is leading the way of this safety evolution via its patented High Torque retention knobs. In addition to solving the critical “loose-tool” factor and preventing toolholder deformation, the patented design delivers inherent safety benefits that are vital to progressively addressing this velocity-driven safety dilemma.

Most standard retention knobs are still being designed and manufactured to the standards put in place over 40 years ago. Most standard retention knobs are still being designed and manufactured to the standards put in place over 40 years ago. Extensive testing by JMPP has proven that standard design retention knobs often expand the toolholder, leading to excessive vibration, chatter, and mill harmonics. In addition to affecting finishes, tolerances, and tooling life, this vibration and chatter, caused by a lack of concentricity, can be damaging to the spindle and the draw bar of the mill. With the advent of today’s very fast, very powerful, small footprint machines, this damage can directly result in the high-risk, red-flag safety dangers associated with a tool breaking loose during a cutting operation. In essence, it’s a disaster waiting to happen because if anything breaks loose, it would essentially be like a missile coming off the machine.

Any industry that depends on high-speed precision milling, whether for roughing simple and exotic materials to complex geometries and micro parts, is going to face these tooling safety issues. By correcting the design flaw in the tooling, which is tool holder expansion, JMPP’s High Torque knobs overcome a myriad of issues industry-wide in terms of production, time, tooling, and safety.

One key factor in retention knob failure is the material strength—and JMPP is proactively migrating its 30- and 40-taper retention knobs from the traditional 8620H material to 9310H material, in order to ensure the knobs’ durability and strength. The 9310H material offers 40 percent higher tensile strength than the 8620H material. Additionally, JMPP has reviewed the cross-sectional strength of the knobs and identified a design flaw. To correct this flaw, JMPP is modifying the size of the coolant holes in many of its 30- and 40-taper knobs to increase this cross-sectional strength.

In addition to evolving material strength on knobs to optimize safety and overall production, JMPP also laser marks its parts, providing dating on each knob. The laser marked date-in-service feature, which includes a unique serial number for traceability, shows how long the knob has been in service.

This ensures safety as retention knobs are a perishable, consumable part—a typical retention knob is good for one to three years on a machine, depending
on how long the machine runs per day. The operator can simply enter the unique identifier serial number to show how long a knob has been in service and when a tool change should be made. Inspection of retention knobs during tool changes can reveal signs of diminished draw bar force. With spindle replacements costing $20,000 to upwards of $80,000, maintenance is critical.

RESPONSIVE HIGH-TORQUE/HIGH-RPM ENGINEERING
Brother Industries, Ltd. (Brother: Nagoya, Japan), is a leading multinational manufacturer of CNC drilling and tapping centers for the automobile, aerospace, and medical industries. Brother identified the need to modify the standard used to manufacture their retention knobs, including the material tensile strength, to make them stronger to meet the machine’s manufacturing demands.

Using Brother’s modified spec for its BT30 retention knobs, JMPP quickly responded by introducing the JM25084ACHTHS (with coolant hole) and JM25084AHTHS (without coolant hole). These knobs incorporated all of Brother’s dimensional and radius requirements along with JMPP’s High Torque patented design features and higher tensile material.

JMPP’s engineering team is the only retention knob manufacturer of record to progressively respond to Brother’s unique modification challenge with a customized solution, based on Brother’s revised specs and material, and incorporating Brother’s High Torque standard tolerances and design features.

After engineering modified the design which makes the knobs stronger for high-RPM machines, used in the manufacture of small diameter parts, JMPP directed customers to use the JM25084AHTHS and JM25084ACHTHS instead of the current JM31109A, JM31109AHT, and JM31109AHT. Brother provided a print that notes changes to the knob on four dimensions and a material change not covered in MAS-P30T-2(30 degrees).

JMPP has provided more than 10,000 of the modified High Torque retention knobs to customers for their uniquely demanding high-RPM machines, in addition to more than 10,000 more of their standard High Torque knobs already in use.

MEETING SAFETY ISSUES HEAD-ON
The Brother example is part of a continuing trend of manufacturers being progressive in trying to push capacity while also thinking about safety. JMPP is also focusing on bringing safety issues to the forefront with leading manufacturers like Kitamura and its ultra-compact (6’ wide x 9’7” deep) MyCenter 30 taper horizontal machine, which offers the world’s fastest rapid/cutting rates of 2,362 RPM on all axes. Given its crazy speeds and size of tooling, JMPP views this as the ideal example of the trending combination that would benefit from its High Torque retention knobs, specifically their High Torque/High Speed JM32621HTHS.

Since everyone is “squeezing size” as they strive to produce larger envelope parts on smaller machines, certain safety considerations must be addressed in this equation. Almost every kind of hazard can be found in a machine shop, and JMPP strives to be proactive in its approach to design, manufacturing, and key issues such as how to safely increase speed rates that are facing the industry.

The industry must recognize the potential for machine spindle interface problems that these small-footprint/high-RPM machines represent. JMPP’s high torque retention knobs have design elements that will meet those issues head-on.

ABOUT THE AUTHOR
John Stoneback is the president of JM Performance Products.
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SKILLED TECHS, EXPERT ENGINEERS, PRECISION TOOLS
When it comes to broaching, General Broach Company is able to find the best machine and best tool design to fit the customer’s need.

By KENNETH CARTER, Gear Solutions editor

G
eneral Broach Company General Manager Larry Stover freely admits that “broachable” isn’t a word, but it still sums up what the company is all about.

“We are going to provide a quality product that is going to lower the cost per part,” Stover said. “We specialize in pot broaching especially. I know a lot of gear companies now are going to hobbing and shaping and even skiving, but the way we design our pot broaches, the cost per part is driven down considerably because we get so many more parts per sharp and parts over the life of the tools. That’s where we really shine — when we’re doing internal straight-form gears, because we don’t do helicals. We design our tool for the maximum tool life to give the customer the most sharps over the life of the tool. And, really, what that does is it adds value because our whole mindset is to drive their cost per part down.”

BROACHING OPTIONS

Some of the services General Broach Company offers is broach tooling, broaching machines, and production broaching, according to Stover. Those broach tools include internal pole pull broaches, pot broaches, and blind spline broaches.

“We invented that process back in the 1970s,” he said.

In fact, an entire range of broaching tool services to the metalworking industry are available from General Broach, according to Stover. Experienced design engineers operate the newest CAD and internally developed software programs. General Broach engineers ensure customer satisfaction throughout the entire process of creating, producing, and using its broaches. General Broach’s in-house staff of engineers are available for consultation at every turn of a project.

Some of General Broach’s in-house capabilities combine skilled technicians, experienced design engineers, and precision CNC machine tools, he said.

MANY SERVICES, ONE TOWN

And the company adds even more to its arsenal of advantages by having all of its divisions together in one town, according to Stover.

“We’re actually under two buildings, but they’re just 200 yards apart,” he said. “We’re able to work closely together, which helps when we’re doing a turnkey project. We have five different design engineers — three for broach tooling and two for machines and fixtures. They utilize 3D NX CAD systems. They’re able to perform FEAs and do force calculations. We’re able to pick the best machine and best tool design to fit the customer’s need. I would say that’s our niche.”

Identifying a customer’s need first involves a risk analysis where a broaching percentage of a potential job is determined, according to Stover.

In other words: How “broachable” is it?

“We’ll do that, and then many times we might meet as a team to discuss it and to see the best way to approach it,” he said. “If we believe that we can do it and be successful, we’re going to quote them a package to do so, and then we’ll stand behind it. We stand behind our designs and our turnkey solutions.”

PATENTED SERVICES

One advancement that Stover is particularly proud of is a recent patent General Broach Company received on a pot broach and finish shave ring guiding system design.

“It basically allowed us to cut customers’ run-out tolerances in half, and because of that, it’s taken a lot of headaches away from the customer, and it makes pop pot broaching a whole lot easier,” he said.

Stover said he has watched General Broach
“We design our tool for the maximum tool life to give the customer the most sharps over the life of the tool. And, really, what that does is it adds value because our whole mindset is to drive their cost per part down.”

Company grow through his 40 years with the company, but it actually opened its doors in 1942 in order to serve the growing automotive industry.

“At one time, we were split where part of our division — the machine division — was in Detroit, and the rest of it was down here in Morenci, Michigan,” he said. “It moved to Morenci in 1964 out of Detroit. Since 2005, it’s all been located in Morenci. Because of that, we’ve been able to work closer together on projects. And we’ve seen many innovations through the years on broaching — whatever style of broaching it is. We’ve been awarded several patents through the years. We were one of the first broach companies to achieve ISO certification. Now we’re one of the few in the whole country that’s AS9100 certified for the aerospace industry. There are not a whole lot of broach companies that are AS certified. We do a lot of work for the aviation industry.”

GROWING WITH THE FUTURE

And as tolerances get tighter and tougher, Stover expects General Broach Company to be up to that challenge.

“You have to be able to provide tools that are going to be able to work in stable and unstable environments in some cases,” he said. “We’ve upgraded our equipment. Our quality program that we run here allows us to grind closer tolerances. We are more aware of where we have to be. If a company orders several tools, we make sure that one tool to the next to the next to the next, is they’re alike. Once a customer has his machine dialed in and his parts are coming out and his heat treat is making it grow to the right size and everything, our broaches are similar. That’s what we strive to do.”

MORE INFO

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

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Big Kaiser simplifies accurate retention force measurement

Big Kaiser has developed Dyna Force, a device for measuring the retention force of machine tool spindles.

Insufficient retention force of the spindle clamping mechanism could lead to reduced rigidity and vibrations, loss of machining quality, poor surface finish, and shortened tool life. By ensuring that the retention force is at the correct level, cutting performance remains consistent, providing high-quality machining results.

“The Dyna Force makes regular measurement of the retention force easy and accurate, preemptively mitigating the risk of machine damage or poor machining quality resulting from a low force on the spindle,” said Jack Burley, vice president of sales and engineering.

The lightweight and compact Dyna Force includes a digital display, cable, and robust storage case. (Courtesy: Big Kaiser)

The Wilson UH4000 series is a robust universal hardness tester, that tests Rockwell, Vickers, Knoop, and Brinell hardness scales within the selected tester load range. Its sturdy design will withstand the toughest of production environments. The tester has a sturdy steel casting frame to ensure durability in production and workshop environments. The hardness test process is controlled by the industry leading DiaMet software, the most intuitive hardness control software on the market to make testing easy, repeatable and automatic. With this software integration, it is an ideal tester in QC and Process Control applications, whether it tests large or small manufactured components in the lab or directly on the production floor.

The testers feature a closed loop loading cycle for best accuracy, faster testing cycles and a new eight position turret to hold desired combination of indenters and objectives. It has a large 300 mm x 400 mm T-slot stage with high weight capacity, enabling the testing of heavy and large parts non-destructively. An optional clamping tool is available to ensure stability during the test process; both manual and automatic stage movement options are also available. Other features include:

- Small parts can be handled with precision by using the anvil adapter/extension and the 80mm flat anvil, or other anvils with a 25mm diameter anvil pin.
- The clamping device can be activated and deactivated by the software, depending on the need.
- The ring light for accuracy in Brinell measurements improves the overall repeatability of soft Brinell indents.
- The motorized vertical stage movement is automatic or can be moved with a safety clutched mechanical handle.
- The red target laser cross helps position test locations and indents for big parts.
- The workspace illumination ensures full visibility for test piece placement underneath the turret.
- Automate Rockwell “fast mode” by using the clamping device on sample.

The UH4000 Series is designed for rugged environments and suits testing in the automotive industry, metals production and large components like: Castings and forgings, flat or cylindrical work pieces, steels,

Buehler UH4000 series universal hardness tester for high-volume labs

Buehler has announced its latest addition to the world-renowned Wilson hardness testing range, the new UH4000 Series Universal Hardness Tester. This tester comes in two key configurations: UH4250 Hardness Scale 0.5-250 kgf and UH4750 Hardness Scale 3-750 kgf.

The lightweight and compact Dyna Force includes a digital display, cable, and robust storage case. (Courtesy: Big Kaiser)
heat-treated materials, cemented carbides, ceramics and plastics, and carbon testing. To obtain a quote or for more information on the UH4250 or UH4750 please contact your Buehler sales representative.

Buehler is well established as the world’s leading manufacturer of materials preparation and analysis instruments and consumables. Buehler also engineers and manufactures the complete Wilson hardness testing equipment line, accessories and ISO-certified blocks.

The company partners with leading industries including automotive, aerospace, electronics, metals, medical device, energy, and other manufacturers. In addition, many universities and research and development centers use Buehler equipment in their materials laboratories. For custom solutions, education or training, contact the Buehler laboratory team in your region.

Buehler, an ITW Company, is a premier manufacturer of scientific equipment and value-added consumables for use in materials analysis with offices in nine countries, sales distribution in more than 100 countries, and more than 45 solutions centers. Buehler was founded in 1936 by Swiss immigrant, Adolph I. Buehler, who saw a need for metallographic sample preparation equipment and optical inspection instruments for the steel and automotive industries in the United States.

Buehler maintains its legacy of industry partnership with affiliations such as the ASM international, American Society for Testing and Materials and International Metallographic Society, the American Ceramic Society, and more. In 2019 Buehler celebrates 75 years of partnership with ASM International. The company also contributes to the study of material science through the endowment of the ASM Francis F. Lucas Metallographic Award since 1946 and the International Metallographic Society’s Pierre Jacquet Award.

In 2006, Buehler was acquired by ITW, a developer and processor of engineered components, industrial systems and consumables and became a part of the Test and Measurement Division which also includes Instron, North Star Imaging, Brooks Instruments, Magnaflux, Loma Systems, and Avery Weigh-Tronix. ITW is a global, Fortune 200 company with 51,000 employees across 56 countries.

MORE INFO
www.buehler.com
www.itw.com

Emuge introduces advanced line of Turbine End Mills

Emuge Corp., a leading manufacturer of high-performance taps, drills, end mills, and other rotary tools, has introduced an advanced line of end mills featuring unique geometry designed specifically for the high-performance machining of turbine and bladed components. New Emuge Turbine End Mills offer unprecedented cycle time reductions and long tool life in challenging forms and materials, including titanium,

Universal hardness testers such as UH4750 are designed to perform several hardness scales with one machine, in most cases for higher loads (>5kgf) (Courtesy: Buehler)
nickel alloys, aluminum alloys, and more.

Complex shapes including wide sweeping radii and deep pocketed cavities present ample challenges for aerospace and turbine manufacturers. “We are very pleased to offer our customers a solution to meet the unique requirements for milling turbine parts, as well as for the die and mold industry,” said Dan Doiron, milling product manager, Emuge Corp. Mold applications include machining tire molds and plastic injection molds, among others.

Ideal for machining components with challenging geometries, new Emuge Turbine End Mills have a stable design including on the tools featuring a tapered flute construction. The end mills feature PVD-applied, highly hard and heat-resistant coatings, and a newly developed geometry that enables aluminum machining.

The Emuge Turbine End Mills Line includes a wide range of taper ball tools that feature a sub-micro grain carbide substrate and an HA cylindrical shank. The 3°, 4°, 6° and 8° taper ball tools have two and three flute designs, and the 17.5° has three flutes. Polished flutes in the 3°, 4°, 6° and 8° tools promote chip evacuation in aluminum alloys. Coating options for the taper ball tools include ALCR for additional tool life in titanium alloys, high temperature alloys, stainless steel and aluminum alloys, and TIALN for heat and abrasion resistance in a wide range of materials such as stainless steel, steel alloys, cast iron and other ferrous metals.

Taper Torus end mills include 3°, 4°, 6° and 8° sizes featuring two highly polished flutes, sub-micro grain carbide, and have a torus “cupped” radius end design for maximum step over lengths. ALCR coating is standard, and TIALN coatings are available.

A Long 8° Taper Torus style also features a torus cupped radius. The cutting flutes are tapered for increased efficiency in a range of designs from five to 15 flutes. The Long Taper Torus tools are TIALN coated for maximum tool life and include axial coolant through capability.

The Emuge Turbine End Mills Line includes a Torus long-length tool style which features variable flute spacing for low vibration milling. The tools are available in designs ranging from five to nine flutes and have a corner radii of 1.0 or 2.0 mm. Torus long length end mills are TIALN coated for maximum tool life and include coolant through capability.

MORE INFO  www.emuge.com

Hexagon launches fixed-fine blue laser scanning sensor

Hexagon’s Manufacturing Intelligence division today launched its first blue laser scanning sensor for creating point clouds. The HP-L-5.8 joins Hexagon’s comprehensive range of tactile and non-contact sensors for CMMs and is designed for companies who need a versatile, affordable, fixed-line laser sensor.

The HP-L-5.8 performs equally well when taking point cloud measurements from dark or shiny surfaces. Designed to be rugged and compact, it protects the sensor from collisions and vibrations and is ideal for use in areas where accessibility is restricted as well as on smaller CMMs.

“Increasingly our customers want to add the speed and wide measurement coverage of laser scanning to their CMM’s capabilities,”
said Christian Schorr, Hexagon’s product manager for Laser Scanners on CMMs. “The HP-L-5.8 meets our customers’ demand for an accurate, affordable laser scanner that turns a CMM into a multi-sensor machine that can switch easily between tactile probing or laser scanning in a single part program.”

The HP-L-5.8 is seamlessly compatible with Hexagon CMMs that use PC-DMIS 2018 R2 and subsequent versions of the software and works with an automatic indexing probe head or continuous wrist, making it easy to operate for users of tactile probing tools.

The HP-L-5.8 is available worldwide. More information is available from local commercial operations and dealers.

HP-L laser scanners deliver maximum performance for complex surfaces and workpieces made of materials that are difficult to measure. These flexible laser scanners turn every coordinate measuring machine (CMM) into an optical multi-sensor system. The main applications include checking the features and characteristics of sheet metal parts, and measuring freeform surfaces of castings or other components in the automotive and aerospace industries.

HP-L uses Flying-Dot Technology, providing an excellent optical dynamic range that is superior to conventional line scanners as the light intensity is automatically adjusted for point by point. This means that HP-L laser scanners are less sensitive to ambient light and surface changes, and generate point clouds of high quality and reliability. In addition, the line width can be varied from 24 mm to 124 mm as required. The point-to-point distance varies depending on the chosen line width.

Equipped with HP-L laser scanners, CMMs turn into multi-sensor machines, performing even the most challenging measurement applications by combining traditional tactile probing with optical measurements such as surface capture or optical feature measurement – all in one part program.

HP-L laser scanners fully conform to the latest ISO 10360-8:2013 standard. The measurements rely on traceable sphere and plane artefacts. Hexagon Manufacturing Intelligence also supplies the necessary artefacts – certified by an accredited laboratory – for on-site verification of sensor results, to provide the highest confidence in optical probing.

**MORE INFO** hexagon.com

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**Specialty grinder for large non-coplanar connecting rods**

C & B Machinery of Brighton, Michigan, has received an order from a major North American manufacturer of large construction and mining equipment to supply a specialty grinder for grinding the parallel faces of very large connecting rods. To meet the customer’s quality and volume require-
ment’s, C & B will be building a virtually new grinder using a Mattison 100C-5 base machine pulled from C & B’s warehouse of more than 40 similar grinding machines.

A remanufacturing process will bring this grinder to 2019 technology standards and designs. Applying servo-controlled ball screw feeds on all five vertical grinding spindles, position tracking on the rotary table to aid the new robotic load automation. A touch screen mobile pendant will give the operator a simple operation of the grinder with its new 5-axis Allen Bradly safety integrated controls system. Post process gauging will feedback to the AB control system to maintain consistent stock removal and final size at each grinding spindle.

The tooling design will accommodate two different customer connecting rods without any changeover. Both connecting rods are over 21" (548mm) long and are non-coplanar — meaning the crank thickness is different from the pin thickness as well the pin is non-symmetrical. The grinder will also have the ability to exceed the customer’s volume requirements if needed.

C & B Machinery is a builder of high precision grinding machines based in Brighton, Michigan. Grinding machines, including all tooling, fixtures, controls, and lubrication system is designed, manufactured and installed at the Brighton, Michigan, facility and fully supported after the sale by C & B Machinery’s qualified and trained service and support staff. C & B supplies machines for a global list of customers, with the majority of sales being in North America (NAFTA Region). It provides complete turnkey grinding cells for all U.S. automotive companies and their tier-one and two suppliers. Included in the customer base are also aerospace, bearing, heavy equipment, compressor, and oil & gas industries.

MORE INFO

www.cbmachinery.com

Sunnen brings BTA Heller division to St. Louis after acquisition

Last year’s acquisition of the premier deep hole tooling and systems manufacturer positioned Sunnen as a single-source for bore creation and finishing solutions, unique to the industry. Now, the company is moving the new division to the company’s long-time headquarters in St. Louis, Missouri. The move will allow further development of tooling, systems and processes for precision bore applications.

Sunnen Products Company is relocating its BTA Heller division to the Sunnen headquarters in St. Louis, Missouri. The move from Troy, Michigan, will be completed by March 31, with key personnel making the move. Sunnen’s acquisition of BTA Heller last year created a unique solution for shops looking for complete bore creation-to-finishing capabilities. Sunnen, the world’s largest vertically integrated manufacturer of honing systems for precision bore sizing and finishing, added BTA’s deep hole tooling and systems for primary hole generation. The move will facilitate further development of tooling, systems and processes, as the companies build on natural synergies to offer single-source bore creation and finishing solutions.

“Our companies complement each other very well,” said Chris Miltenberger, president and COO of Sunnen Products Company. “No other deep hole/BTA company has
Sunnen’s global presence for customer, technical, and post-sale support. The transfer of knowledge between the two companies has already created unique value propositions, and Sunnen’s strong sales and service network will deliver this expertise to our customers.”

Sunnen’s core technical competencies include automated and manual honing and lapping systems, custom system development and integration, abrasives, tooling, lubricants, and gaging. The BTA Heller acquisition expanded Sunnen’s industry leading honing expertise to include tooling for initial hole creation and other complementary bore sizing and finishing processes. Sunnen recently introduced the new SHD series skiving and roller burnishing system with tooling engineered and supplied by BTA Heller.

Sunnen employs 650 people worldwide, with offices, manufacturing and tech support facilities throughout Europe, the U.K., China, Brazil and India.

MORE INFO  www.sunnen.com

The new Sunnen SHD-series bore-sizing machine incorporates the BTA Heller skiving and roller burnishing tooling. Sunnen expects the acquisition of Troy, Michigan, based BTA Heller to create a company unique in the industry, combining years of both deep hole drilling and honing expertise. (Courtesy: Sunnen)

Dillon Top jaws grip any workpiece available as soft saws, hard jaws

Special Top Jaws from Dillon Manufacturing can be manufactured to grip a component ID, OD or a combination of both, to suit any workholding application. Available in soft or hard jaws, or full grip jaws, for virtually any chuck manufacturer, Dillon manufactures special top jaws from 1018, 1045, 4140, 8620, A-2, 6061 aluminum, and stainless steel. A comprehensive website provides complete details and includes an “easy quote” format with “fill-in-the-blanks” convenience. Dillon standard and custom chuck jaws and collet pads and jaws are ideal for high speed machining, as well as precision boring, tapping, drilling, and finishing across virtually all industrial markets.

Dillon custom, special, or modified hard, soft or full grip top jaws are manufactured with industry-best turnaround time, which saves time and money by reducing down-time.

Dillon Manufacturing, Inc. manufactures a complete line of standard and custom workholding solutions including chuck jaws, chucks, vise jaws, soft jaws, hard jaws, collet pad jaw systems, chuck lubrication, and more. All products are made in the USA and Dillon is ISO 9001:2015 registered.

MORE INFO  www.dillonmfg.com

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What are your duties at SONA BLW?

I have been with SONA BLW and its predecessor for more than 15 years in various functions. I started out as a technical project manager leading cross-functional teams, then went further to head the quality department responsible for design and manufacturing results and processes. I currently have the pleasure of supporting the customer with our sales team in the best way possible. We also integrated the marketing and new business development team, which is a lot of fun to work with as we are organizing our internet appearance, market analysis, participation in exhibitions, and business cases on potential new markets and customers. Throughout all these different responsibilities I have learned that you always need to put your customer at the center of your business and never compromise on your pursuit of excellence. Our owner and new CEO — Sunjay Kapur — captured this idea in our new tag line, “More torque per gram.” It perfectly covers our idea of serving the customer by providing a highly advanced gear design in a constantly more challenging environment.

What products and services does SONA offer?

SONA designs, manufactures, and tests components for the automobile industry covering the entire range from passenger car to commercial vehicles and even heavy-duty applicants. We have a vast production scope that includes forging and cold-coining press line, soft- and hard-turning equipment, broaching, grinding, milling, and heat treatment.

Our design team operates on an international level consisting of sales and engineering teams in the U.S., Europe, and India. This is our key advantage enabling us to provide quickly approved products, whether they are off-the-shelf or highly customized solutions. We have expanded our competence to designing and producing entire sub-systems such as differential gear boxes and pre-assembled components for brand new electric mobility applications.

Our customers value our willingness to contribute to design early on in the process. SONA BLW wants to be involved from Day 1.

What is SONA doing to advance the gear industry?

With SONA being the inventor of precision-forged bevel gears and mono-block speed gears, it’s clear we are all about gears and their key functional area — the toothing. This allows more torque while remaining within the existing dimensions or even shrinking the gears in order to minimize size and weight.

What achievements have you recently accomplished?

Throughout the last few years, a transformation in structure and ownership has been executed allowing SONA BLW to focus our attention, investments, and energies in the fast-growing Precision Forging business where we own the technology and have the potential to claim global market leadership. Our global key account management has been established and has joined forces with the new global set-up of our technology team. We had a record-breaking number of orders in 2017-2018. Personally, I am very grateful for being able to help new customers with their innovative electric mobility applications.

What are some of SONA’s proudest moments?

SONA BLW stands at a moment where we look back on a journey that started in Germany in 1773 and in India in 1995.

We are proudly serving more than 120 customers, delivering more than 130 million parts and 250,000 assemblies per year out of nine sites that generate an annual sales of more than 315 million euros ($350 million). This legacy will motivate and challenge us for years to come. We also are growing our business. New sites in Hungary and India are set up and aligned with the existing production network in Munich, Remscheid, Duisburg, Gurgaon, and Pune. We are moving from being a component supplier to a system provider.

Where do you see SONA in 10 years?

The entire automobile industry is facing major changes such as connectivity, autonomous driving, and electrification. Consequently, SONA BLW is striving to set a strong foundation with our existing scope of products and services by expanding into new markets, i.e. agriculture, and increasing its market share within the strategic partnerships with today’s customers leveraging design and cost leadership. In addition, SONA BLW continuously invests in R&D and works closely with innovative start-ups while being a preferred partner of OEMs and large Tier-1 suppliers. We have copper manufacturing applications for electric engines; our team in India has developed an electric axle; our European engineers have developed forged sun gears where the complete toothing is produced by only forming and not by using a machining operation for finishing.

At the end of the day, we need to listen to our customers carefully, understand their needs, and be the fastest and most committed partner we can. Our new management supports this approach, and our team is excited to face those challenges as one team, as ONE SONA.

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