DESIGN FEATURES OF WORM GEARING COMPOSED OF PLASTIC AND/OR POWDER-METAL COMPONENTS

COMPANY PROFILE

ATLANTA GEAR WORKS
TRUSTED TO GET IT DONE RIGHT... EVERY TIME

Cut teeth capabilities so good, even our competitors come to us.

Excellence without exception.

forestcitygear.com
GREAT IDEA!
Precision Products for Gear Manufacturing

Toolink Engineering, Inc.
www.toolink-eng.com
303-776-6212
New Genesis® GX Series takes gear grinding quality and productivity to an entirely new level, with single-tool setup, integrated automation, twist-controlled and polish grinding – and Closed Loop networking with GMS® inspection.

www.gleason.com/GX
DESIGN FEATURES OF WORM GEARING COMPOSED OF PLASTIC AND/OR POWDER-METAL COMPONENTS

The technology used in production of plastic gears, as well as powder-metal technology, both impose certain constraints on the design parameters of a worm and of a mating gear.

By STEPHEN P. RADZEVICH

TAKING DEBURRING TO THE NEXT LEVEL

Recent developments from Helios Gear Products increase the productivity of the company’s Tecnomacchine CNC gear deburring technology.

By GEAR SOLUTIONS STAFF

‘ANY MAKE, ANY MODEL, ANYTIME, ANYWHERE’

COMPANY PROFILE  Atlanta Gear Works designs, engineers, builds, rebuilds, and repairs heavy industrial gearboxes for some of America’s leading manufacturers with one main goal — to minimize or prevent downtime.

By KENNETH CARTER

MPT EXPO IS ALL ABOUT INNOVATION.

Learn about the research driving the next generation of innovation in mechanical, fluid power, electric, and hybrid technologies at the MPT Conference, AGMA’s Fall Technical Meeting, and other education seminars. And then experience it hands-on with new products and demonstrations inside the exhibit hall.

A PREVIEW AND DETAILS OF THE MPT EXPO » PAGES 21–28
Manufacturers of:

**Broaches**
- Spline Broaches
- Fine Pitch Gear Broaches
- Form Broaches
- Serration Broaches
- Bearing Cage Broaches

**Shaper Cutters**
- Disk Shapers
- Shank Shapers
- Hex and Square Cutters
- Special Form Cutters

**Inspection**
- Master Gears
- Go-No Go Gages
- Posiloc Arbors
- “Quick Spline” Software

Visit Our New Website at www.broachmasters.com
SELECTING MEDIA FOR OPTIMUM VIBE BOWL GEAR FINISHING

Choosing the best media depends on structure and shape of the tooth flank, and whether media components should be abrasive, non-abrasive, or a blend.
The many facets of additive manufacturing continue to grow

You’d have to be manufacturing stuff under a rock not to have heard how additive manufacturing and 3D printing are poised to be a game changer in the gear-manufacturing world.

Not only is it expected to change the way products are made, but also the way those products are distributed, according to a recent study from Carnegie Mellon University and the University of Lisbon.

The advent of 3D printing could throw out the need to keep stockpiles of spare parts in storage, where they wait to be needed.

With 3D printing, parts could be quickly manufactured on an as-needed basis, especially for non-critical parts, according to the research.

However, the study is quick to point out that, even though printing the parts may lower the cost of inventory, the machines needed to process a freshly created part are still quite expensive.

However, it is a fascinating look at how 3D printing is changing the way industries are formulating their business models.

Even though additive manufacturing is making inroads in gear production, specifically with spur gears made from powder metal or plastic, it’s still a process that can be costly when applied to worm gears.

In this month’s cover article, frequent contributor Stephen Radzevich shares his insights on how the design features of worm gearing made of plastic or PM metals can affect the parameters of the worm and mating gear.

Our August issue also covers deburring, and an article from Helios looks at the company’s upgraded CNC gear deburring machine and how it may revolutionize how gears are deburred.

A special bonus includes exciting details about AGMA’s Motion + Power Technology Expo coming up fast in October in Detroit. In eight pages, AGMA takes you through all the amazing topics that will be shared in dozens of daily sessions, including the annual Fall Technical Meeting where technical papers are presented. Many of those papers you’ll find reprinted in future issues of Gear Solutions.

There’s all that and much more in the August issue. I hope you find it as informative as I did.

As always, thanks for reading!
We have the world’s largest stock of used late-model Fellows Gear Shapers.

WE OWN WHAT WE SELL, AND WE KNOW WHAT WE’RE SELLING!
GMTA to present ‘Micro-Finishing’ tech at MPT Expo

With more than 300 exhibiting companies, the Motion + Power Technology Expo is the ideal show for gear, electric, and fluid power industries. GMTA is one of the exhibitors at the event in Detroit, Michigan, October 15-17.

GMTA will feature its Profilator® line of gear pointing, rounding, cutting, Scudding®, Hard Scudding®, deburring, and polygon machine tools for North America at Motion+Power Technology Expo. (Courtesy: GMTA)

GMTA will feature its Profilator® line of gear pointing, rounding, cutting, Scudding®, Hard Scudding®, deburring, and polygon machine tools for North America at Motion+Power Technology Expo. (Courtesy: GMTA)

Motion Industries names Jeremy Barton as VP of West Group

Motion Industries, Inc., a leading distributor of maintenance, repair, and operation replacement parts and a wholly owned subsidiary of Genuine Parts Company, has named Jeremy Barton to vice president of the company’s West Group, effective August 1, 2019.

Barton will lead Motion’s West Group operations with more than 20 years of experience garnered from serving in a variety of key roles within Motion Industries. He has worked as an industry sales manager (mining), and branch manager (Salt Lake City), as well as providing technical, sales, and operations guidance for the company’s growing industrial services platform in the West. In 2016, he was promoted to his most recent position as Mountain Division sales manager.
Barton obtained Six Sigma/Lean/5S certification in 2011, and holds various business management, technical & leadership certifications.

Kevin Storer, Motion Industries executive vice president of U.S. Operations, said, “Jeremy brings valuable experience and expertise to this position, and we are confident that he will succeed in leading the West Group. I know he’ll do an outstanding job driving our key field initiatives.”

Motion Industries President Randy Breaux said, “We are very happy with the selection of Jeremy as the West Group Vice President. Jeremy has earned this position through his leadership and performance over the past years. I am excited about the future of the West Group under Jeremy’s direction.”

---

MORE INFO www.motionindustries.com

MPT Expo sets conferences on business, emerging technology

The Motion + Power Technology Expo, formerly Gear Expo, has expanded its educational offerings as part of this year’s event October 15-17, 2019, at the Cobo Center in Detroit. For the first time, the event will offer an all-new MPT conference program with 16 sessions offered in two tracks: Emerging Technology and Business.

Attendees will learn from industry experts on the hottest topics including cybersecurity, supply chain, 3D printing, robotics, and much more. The event is produced by the American Gear Manufacturers Association (AGMA) and the National Fluid Power Association (NFPA), and will be co-located with the ASM Heat Treating Society Conference and Exposition.

“We are excited to be offering an outstanding conference program to run alongside our expansive exhibit hall. Attendees will have access to a great line-up of thought leaders who will share their knowledge of several important topics impacting the power transmission industry,” said Jenny Blackford, vice president, marketing, AGMA. “Attendees will be able to learn about the research driving the next generation of innovation at the MPT Conference, AGMA’s Fall Technical Meeting, and other education courses.”

The following conference sessions will be October 16-17:

**BUSINESS TRACK**

- Improve In-Transit Visibility to Reduce Supply Chain, presented by CalAmp.
- Economic Outlook and Trends within the Industrial Fluid Power Market, presented by Oxford Economics.
- Blockchain: The Future of Manufacturing, presented by SIMBA Chain.
- Effective Contract Negotiations: The Path to Commercial Success with Large OE Customers, presented by Rouse Contract Consultants, LLC.
- The Evolution of the Automotive Powertrain, presented by IHS Markit.
- Workforce Development Using a Farm Team Approach, presented by Scot Forge.
- Cybersecurity Hygiene in Motion, presented by (ISC)2 Central Florida Chapter.
- Hire Like Nobody’s Business, presented by Diversified Industrial Staffing.

**EMERGING TECHNOLOGY TRACK**

- Simplifying Industrial IoT for Discrete Manufacturers, by MachineMetrics.
- The Future of eMobility in the Commercial Vehicle Space, presented by Meritor.
- Processes and New Machines for 3D Printing Metal, presented by The Barnes Group Advisors.
- Standards for IIoT Interoperability, presented by MTConnect.
- Materials Challenges and Solutions in Additive Manufacturing, presented by QuesTek Innovations, LLC.
- Collaborative Operation in Industry Today, presented by FANUC America Corporation.

---

MORE INFO www.AGMA.org
www.motionpowerexpo.com

ANCA Tool of the Year winners to be announced live at EMO 2019

ANCA Tool of the Year Award 2019 celebrates the knowledge and imagination of cutting tool craftsmen, creating tools with the perfect geometry, profile, and finish that shape and build the world.

ANCA’s industry-first competition is back, with the 2019 winner to be announced live at EMO, Germany, September 16-21. Last year, the industry welcomed the opportunity to
show off its skills with almost 30 entries received from across the world being seen by more than 122,000 fans generating 3,000 comments and reactions on social media.

Pat Boland, ANCA co-founder, said, “I have great respect for our customers’ knowledge in designing and grinding quality cutting tools. Their skills drive our industry forward and most of ANCA’s new technology is born from a customer’s need to achieve something new.”

“We should celebrate the collective acumen of our industry and showcase the fantastic work that is conducted every day to build our world. I encourage all cutting tool makers to enter our competition and show off your talents,” he said.

The cutting tool industry has cultivated and refined its craft over the years to design beautiful tools, applying science to achieve a sub-micron surface finish and superior cutting performance. With 2,200 exhibitors and 130,000 visitors, EMO remains a key event in the cutting tool makers calendar and is the perfect opportunity to showcase the legends who are creating superior cutting tools.

Ralph van Hoorn, managing director at Van Hoorn Carbide and first-time judge, said, “Technology is moving forward faster than ever, demanding more and more of the tool grinders of today. Designing and grinding these great products demands for a combination of great ideas combined with technical knowhow and top-class machinery. Thanks to ANCA and their customers, revolutionary new ideas have come to practice making our technology move forward.”

ANCA will also launch the ToolRoom RN34 software package at Hall 6, Booth J35. ToolRoom plays a crucial role in enabling tool
grinders to design and execute high-quality cutting tools. Specializing in complex cutting tool geometries for the aerospace, die mould, and power generation industry, the latest package can design and manufacture complex tool geometries as well as balance them for optimal cutting conditions. New is the endmill cycles for ballnose and corner radius, tool balancing, and next-generation fluting cycles.

“All finalists from last year were of a very high standard and demonstrated a deep understanding for tool geometry as well as taking full use of ANCA’s software. We congratulate the winner, Contour360, and other finalists Daily Grind Industrial Tool, Acu Twist, Miltera, SAN Engineering, and Kazimieruk for their efforts,” ANCA’s Boland said.

Charles R. Day, vice president and general manager at Contour360 and winner of 2018’s competition said, “In the two years I’ve been with the Contour360° organization, I have told everybody who would listen (and even some who wouldn’t) how over-the-top this company’s toolmaking ability is! Steve Hutchins and Mario Ercolani are responsible for the submission and two of the most talented and capable toolmakers I have ever met. And they represent an entire organization of others just like them.”

To find the Tool of the Year, ANCA will hold a competition for customers to submit their favorite tool with the winners judged and announced live at EMO. The prize is a trip for two to ANCA headquarters in Melbourne, Australia, to see firsthand how the technology is created at ANCA and meet the team who are dedicated to finding even better solutions for our customers. The winner also receives a copy of the latest ToolRoom RN34 software release.

The competition will be based on the passion and the craft of tool making and celebrate the highly skilled tool grinding community.

Judging panel:
- Pat Boland, co-founder and managing director at ANCA.
- Ralph Van Hoorn, managing director at Van Hoorn Carbide.
- Thomson Mathew, product manager at ANCA.
- Alicona – measurement of surface finish.
- Zoller – measure profile and diameter.

MORE INFO machines.anca.com/Tool-Of-The-Year

Bourn & Koch parent company acquires CID Performance Tooling

Bourn & Koch, an American manufacturer of new precision machine tools, announced that its parent company, Alleghany
Capital Corporation, has acquired Coastal Industrial Distributors LLC, (doing business as CID Performance Tooling); and has formed a new holding company for its subsidiaries in the machine tool and consumable cutting tool sectors.

Headquartered in Saco, Maine, CID Performance Tooling (“CID”) is a leading manufacturer of high-performance solid carbide end mills. The new holding company formed by Alleghany Capital, called “Precision Cutting Technologies” will include Bourn & Koch, Inc. (“Bourn & Koch”), Diamond Technology Innovations, Inc. (“DTI”), and CID.

David Van Geyzel, president and CEO of Alleghany Capital, said, “This transaction furthers Alleghany Capital’s growth strategy in the machine tool and consumable tooling industries. While the formation of Precision Cutting Technologies will not change the management of Bourn & Koch, DTI, and CID, it places these companies under a single platform so that they can share resources and leverage their combined capabilities to provide an enhanced product and service offering to their customers. Alleghany Capital is pleased to welcome CID to the Precision Cutting Technologies group of companies and looks forward to supporting Bourn & Koch, DTI, and CID as they continue to serve their markets.”

Terry Derrico, president of Precision Cutting Technologies and Bourn & Koch, said, “We are excited to partner with Jay Lowery, founder and president of CID, as well as his experienced team, and believe that the employees, customers, and suppliers of all the companies within the Precision Cutting Technologies platform will benefit from this acquisition. CID enhances Precision Cutting Technologies’ portfolio of consumable cutting tools, while expanding our business in the aerospace, defense, and medical end-markets.

“With Jay continuing to lead the company post-transaction, CID’s day-to-day operations will not be impacted. However, we believe CID will be well positioned to accelerate growth and augment its geographic reach by leveraging the experience, capabilities, and support of Bourn & Koch, DTI, and Alleghany Capital.”

“Over the past 30 years, CID has become a leader in producing the highest quality custom tooling solutions for customers serving the most demanding end-markets,” said CID president Jay Lowery. “As we build on our proven track record of quality, innovation, and service, we are pleased to have found a long-term home for the company and are excited about the opportunities that will result from this transaction.”

MORE INFO
www.precision-cutting.com
www.bourn-koch.com

Growing Atlanta Gear Works launches new website, brochure

Atlanta Gear Works, a full-service gearbox engineering, manufacturing, and repair company, has launched a new website and brochure to accommodate its growing services and customer base.

Since its founding in 1988, the company has grown by serving leading manufacturers with innovative power-transmission solutions, high-quality products, and responsive service for its process-critical...
rotating equipment. Recent growth has caused an expansion of services and plant, with a 10,000-square-foot expansion planned.

“We’ve grown because we’re not just a gearbox manufacturing and repair company. We’re also a service company, and our new website and brochure do a better job of explaining that to our customers,” said Craig Massa, Atlanta Gear Works VP-sales.

Atlanta Gear Works offers a range of services including gearbox repair, custom gearbox engineering, and manufacturing, custom gearing, in-stock PIV parts and units, and field machining and services, all backed by 24/7 service and support.

“Our commitment to customers is to do whatever it takes to prevent and minimize their downtime,” said Atlanta Gear Works President Jack Conway. “We’ll repair any make, any model, anywhere, anytime.”

As part of its commitment, AGW has also greatly expanded its field services.

“We can save customers days of downtime by doing troubleshooting and repairs on their site,” Conway said.

Atlanta Gear Works field services include gearbox inspection and repair and a wide range of field machining, including line boring, hydraulic drilling and boring, and journal turning and repair. Available around the clock, its field services crews have been known to work overnight to get a customer up and running.

Atlanta Gear Works has a new brochure that emphasizes service as a large part of its offerings. (Courtesy: Atlanta Gear Works)
Lothar Horn, managing director of Paul Horn GmbH, sees a special connection with AMB.

“We have a close association with AMB and have grown continuously together. In 1982, we exhibited at the event as a small Swabian company,” he said. “Nowadays, we take part in AMB as the world market leader for precision tools. For us, AMB is like our own living room where we welcome our customers. It also clearly sets the standard as to what we want to present in terms of new products and innovations.”

Holger Hehl, area sales manager at Chiron-Werke GmbH & Co. KG, said AMB is definitely the centerpiece of machine tool construction and the ideal meeting point for the industry in southern Germany.

“Every world market leader presents their innovations here and we have a platform to show metal cutting in detail to customers and interested parties,” Hehl said.

Werner Gerstner, sales manager at Carl Zeiss AG, attended the first AMB in 1982 and is still impressed by the exhibition concept.

“AMB has always set standards and supported a large number of changes in technology,” he said. “Every important topic is examined here and exhibitors show their portfolio solutions relating, for example, to electric mobility, Industry 4.0 or the Internet of Things.”

Chris Mendicino

High QA appoints new positions to support growth

High QA, Inc., the developer of Inspection Manager™ Quality Management Software, has appointed Christopher (Chris) Mendicino to the position of vice president of Professional Services and Jim Moroz to the position of senior software support applications engineer. In their respective roles, Mendicino and Moroz are responsible for onboarding, installation, conducting basic and advanced training, assisting with software implementation to ensure all of its features and benefits are attained, and providing a full range of follow-up and support services. High QA’s customers work in a range of manufacturing industry sectors. The company created the new positions to accommodate increasing global product sales and to maintain its superior level of responsiveness that consistently receives high marks from customers. The recent growth is projected to continue at High QA as more manufacturers are automating their quality assurance processes. High QA’s customers work in a range of manufacturing industry sectors. The company created the new positions to accommodate increasing global product sales and to maintain its superior level of responsiveness that consistently receives high marks from customers. The recent growth is projected to continue at High QA as more manufacturers are automating their quality assurance processes.

“高 QA 预计任命新职位以支持增长

High QA，Inc. 是 Inspection Manager™ 质量管理软件的开发者，已任命 Christopher (Chris) Mendicino 为高级软件支持应用程序工程师，并任命 Jim Moroz 为高级软件支持应用程序工程师。在各自的职位上，Mendicino 和 Moroz 负责上机、安装、开展基本和高级培训，协助软件实施，确保所有功能和益处得到实现，并提供全面的后续支持和服务。High QA 的客户涉及各种制造业行业。公司新设这些职位是为了应对日益增长的全球产品销量，以及保持其响应速度，持续获得客户的好评。最近的增长已预计在未来继续推动 High QA 的发展，因为更多的制造商正在自动化其质量保证过程。”

Jim Moroz

Wendy Mendicino

High QA appoints new positions to support growth

High QA, Inc. 是 Inspection Manager™ 质量管理软件的开发者，已任命 Christopher (Chris) Mendicino 为高级软件支持应用程序工程师，并任命 Jim Moroz 为高级软件支持应用程序工程师。在各自的职位上，Mendicino 和 Moroz 负责上机、安装、开展基本和高级培训，协助软件实施，确保所有功能和益处得到实现，并提供全面的后续支持和服务。High QA 的客户涉及各种制造业行业。公司新设这些职位是为了应对日益增长的全球产品销量，以及保持其响应速度，持续获得客户的好评。最近的增长已预计在未来继续推动 High QA 的发展，因为更多的制造商正在自动化其质量保证过程。”

Jim Moroz

High QA appoints new positions to support growth

High QA, Inc. 是 Inspection Manager™ 质量管理软件的开发者，已任命 Christopher (Chris) Mendicino 为高级软件支持应用程序工程师，并任命 Jim Moroz 为高级软件支持应用程序工程师。在各自的职位上，Mendicino 和 Moroz 负责上机、安装、开展基本和高级培训，协助软件实施，确保所有功能和益处得到实现，并提供全面的后续支持和服务。High QA 的客户涉及各种制造业行业。公司新设这些职位是为了应对日益增长的全球产品销量，以及保持其响应速度，持续获得客户的好评。最近的增长已预计在未来继续推动 High QA 的发展，因为更多的制造商正在自动化其质量保证过程。”

Jim Moroz

High QA appoints new positions to support growth

High QA, Inc. 是 Inspection Manager™ 质量管理软件的开发者，已任命 Christopher (Chris) Mendicino 为高级软件支持应用程序工程师，并任命 Jim Moroz 为高级软件支持应用程序工程师。在各自的职位上，Mendicino 和 Moroz 负责上机、安装、开展基本和高级培训，协助软件实施，确保所有功能和益处得到实现，并提供全面的后续支持和服务。High QA 的客户涉及各种制造业行业。公司新设这些职位是为了应对日益增长的全球产品销量，以及保持其响应速度，持续获得客户的好评。最近的增长已预计在未来继续推动 High QA 的发展，因为更多的制造商正在自动化其质量保证过程。”

Jim Moroz

High QA appoints new positions to support growth

High QA, Inc. 是 Inspection Manager™ 质量管理软件的开发者，已任命 Christopher (Chris) Mendicino 为高级软件支持应用程序工程师，并任命 Jim Moroz 为高级软件支持应用程序工程师。在各自的职位上，Mendicino 和 Moroz 负责上机、安装、开展基本和高级培训，协助软件实施，确保所有功能和益处得到实现，并提供全面的后续支持和服务。High QA 的客户涉及各种制造业行业。公司新设这些职位是为了应对日益增长的全球产品销量，以及保持其响应速度，持续获得客户的好评。最近的增长已预计在未来继续推动 High QA 的发展，因为更多的制造商正在自动化其质量保证过程。”

Jim Moroz

High QA appoints new positions to support growth

High QA, Inc. 是 Inspection Manager™ 质量管理软件的开发者，已任命 Christopher (Chris) Mendicino 为高级软件支持应用程序工程师，并任命 Jim Moroz 为高级软件支持应用程序工程师。在各自的职位上，Mendicino 和 Moroz 负责上机、安装、开展基本和高级培训，协助软件实施，确保所有功能和益处得到实现，并提供全面的后续支持和服务。High QA 的客户涉及各种制造业行业。公司新设这些职位是为了应对日益增长的全球产品销量，以及保持其响应速度，持续获得客户的好评。最近的增长已预计在未来继续推动 High QA 的发展，因为更多的制造商正在自动化其质量保证过程。”

Jim Moroz

High QA appoints new positions to support growth

High QA, Inc. 是 Inspection Manager™ 质量管理软件的开发者，已任命 Christopher (Chris) Mendicino 为高级软件支持应用程序工程师，并任命 Jim Moroz 为高级软件支持应用程序工程师。在各自的职位上，Mendicino 和 Moroz 负责上机、安装、开展基本和高级培训，协助软件实施，确保所有功能和益处得到实现，并提供全面的后续支持和服务。High QA 的客户涉及各种制造业行业。公司新设这些职位是为了应对日益增长的全球产品销量，以及保持其响应速度，持续获得客户的好评。最近的增长已预计在未来继续推动 High QA 的发展，因为更多的制造商正在自动化其质量保证过程。”

Jim Moroz

High QA appoints new positions to support growth

High QA, Inc. 是 Inspection Manager™ 质量管理软件的开发者，已任命 Christopher (Chris) Mendicino 为高级软件支持应用程序工程师，并任命 Jim Moroz 为高级软件支持应用程序工程师。在各自的职位上，Mendicino 和 Moroz 负责上机、安装、开展基本和高级培训，协助软件实施，确保所有功能和益处得到实现，并提供全面的后续支持和服务。High QA 的客户涉及各种制造业行业。公司新设这些职位是为了应对日益增长的全球产品销量，以及保持其响应速度，持续获得客户的好评。最近的增长已预计在未来继续推动 High QA 的发展，因为更多的制造商正在自动化其质量保证过程。”

Jim Moroz
Italian manufacturer Magni reaches new heights with Liebherr

Magni’s company history is short, but nonetheless amazing: In just five years, the Italian manufacturer has become the premium provider of rotary telehandlers. These machines make load handling easy at heights of up to 46 meters, with impressive flexibility, precision, and safety — not least thanks to the three-stage slewing drives from Liebherr Components. The Italian-German partnership is, therefore, a win-win situation for both companies.

“Our machines are sometimes competing with cranes weighing 40 to 50 tons — in contrast, however, they are much smaller, more versatile, nimble and less expensive. Yet they perform all the required tasks and even combine the three functions of a crane, forklift, and work platform,” said CEO and founder Riccardo Magni, briefly listing the advantages that explain the success of his rotary telehandlers. Within a short time, production figures at Magni Telescopic Handlers rose to more than 700 machines per year — with annual growth rates of 30-40 percent.

Successful operation of these handling machines requires precise control over the load even at greater lifting heights. Magni rotary telehandlers operate at heights of up to 46 meters — which means the manufacturer holds the current world record for rotating models.

“Moving with absolute accuracy and precision is the top priority,” said Enrico Menozzi, head of sales Europe Drive Technology at Liebherr Components in Biberach (Germany).

The two companies first came into contact at the 2016 INTERMAT exhibition in Paris, where they both recognized the improvement potential in the rotary unit. As a result, a Liebherr drive unit has been used in Magni telehandlers since 2017. It consists of a type DAT 200 backlash-free gearbox, a high-pressure, high-speed hydraulic motor, and special brakes. The entire slewing drive increases the machines’ precision and stability, and allows safe working at greater heights.

Compared to single-stage solutions, the three-stage drives from Liebherr enable smoother movement of the boom. The design principle ensures uniform load balancing across the individual stages, resulting in a high-power density. All Liebherr sun gears and planet gears are optimized to minimize circumferential backlash and have minimum play. The inner gears are made of tempered steel, which is also used for the planet carriers. The first jointly produced machines were successfully tested in 2017. Now, Magni equips nearly all models with the slewing drives from Liebherr Components. The 300th drive was recently delivered to Italy.

“These gearboxes are the best components that we could find on the market. Liebherr has the best technology, and we are happy to be able to use it. Together, we are indeed a good combination that brings us great benefits,” said Magni. Menozzi said, “We have a very solid, open working relationship that benefits everyone, especially our customers. Magni was very open to suggestions from the beginning, so we found a new solution together.”

Menozzi benefited from the in-house expertise of the Liebherr Components Division in the development and production of slewing drives for their own mobile
applications. “We have longstanding experience in this area. We also supply drives for turntable ladders and fire engines. The largest of these can reach a height of 64 meters with people on them — high-precision positioning and smooth control being thereby a vital precondition. This know-how is now applied at Magni.”

The partnership between Magni and Liebherr creates valuable synergies. The two family-run companies are united in their pursuit of continuous technical optimization and maximum quality. Customers could recently see the results of this great partnership at the Bauma trade fair, where Magni’s rotary telehandlers were a big attraction. “We entered the market at the right time, which certainly helped our success. Flexible solutions are in high demand,” Magni said. “We are now the No. 2 provider worldwide.

“Many of our customers have now tested the new models with the Liebherr drives – and many want us to swap out their existing units. So, at the moment we are planning a replacement kit with Liebherr.”

MORE INFO www.liebherr.com

New short film goes on a journey to redefine the kilogram

In an act of cooperation, the General Conference of Weights and Measures member states voted to adopt a new kilogram definition for the first time since instituting the international prototype kilogram, or IPK, in 1889. This was the culmination of the years-long effort to create greater constancy in mass measurement examined in “Everything Different, Nothing Changes: Redefinition of the SI Unit Kilogram,” a new short video by Mettler Toledo.

At a basic level, all standards including mass are now tied to fundamental natural constants. In the case of mass, the referenced value is the Planck constant, also known as the fundamental constant of quantum physics.

In the 20-minute piece, Christian Müller-Schöll, Mettler Toledo, Dr. Richard Davis, BIPM, and other metrology experts including Dr. Philippe Richard, METAS, explore the science behind the definition, as well as the nearly poetic way the definition was able to be proven. This combination of smart thinking and technological excellence has produced measurement accuracy that is accessible for all people in all places at all times.

Rare footage takes you inside areas normally reserved for only a few metrology experts to witness everything from the highly technical Kibble balance used to calibrate reference artifacts, to equipment used to create the enriched silicon sphere that was also part of the proof. These strong visuals help to make real the ongoing discussion around the kilogram — a discussion that can seem largely theoretical, especially to those accustomed to dealing with physical weights.

The new kilogram definition eliminates the need to rely on a physical object located in one place, providing a limitless and previously unimaginable access to mass-measurement accuracy. “We are pleased to have been part of the effort to make this new definition a reality,” said Müller-Schöll.

You can watch “Everything Different, Nothing Changes” online at https://youtube/k2XKi9Y7J3s.

MORE INFO www.mt.com/lab

Your Objective:
One face in perfect alignment with another. For infinity.

No problems. No distress. No delays.
That’s the same objective you have for choosing your gear producer. Circle Gear’s objective is to engage with every customer’s objectives.

- One to 1000 gears
- Customer designed or reverse engineered
- Gearbox repair, rebuild or redesign
- OEM or end-users
- ISO 9001:2015 Certified

1501 S. 55th Court, Cicero, IL 60804
(800) 637-9335
(708) 652-1000 / Fax: (708) 652-1100
sales@circlegear.com
www.circlegear.com

Spiral and Straight Bevel Gears (Cut, Ground or Lapped) • Spur Gears • Helical Gears • Long Shafts • Herringbone Gears • Involute and Straight Sided Splines • Internal Gears • Worm and Worm Gears • Racks • Sprockets • ISO Certified

Partnering with QualityReducer to provide Gearbox repair, rebuilding and reverse-engineering.
26 presentations to boast latest gear innovations at 2019 FTM in Detroit

Amid the exciting expansion and new offerings of AGMA’s 2019 Motion + Power Technology Expo is an enduring AGMA fixture: The Fall Technical Meeting (FTM). However, despite tracing its roots back to 1917, the FTM is far from stagnant. This three-day, single-track conference offers 26 presentations showcasing the latest, most innovative, peer-reviewed research in the gear industry. At this annual event, world-renowned industry experts, academics, and engineers gather to present and attend this meeting to learn about emerging technology and processes in their industry. FTM is October 14-16 at the Cobo Center in Detroit, Michigan, also the location of the inaugural Motion + Power Technology Expo.

The meeting opens with the “Application, Design, and Rating” session on Monday afternoon. The six presentations of this topic dive deep into modeling and showcase some interesting real-world applications. Highlights include a presentation that proposes an analytical model to determine the misalignment and crowned teeth influence on spline load capacity and a presentation on the design method of replacing a metal gear with a plastic gear.

The second day of the meeting has both a morning and afternoon session. In the morning session, “Efficiency, Lubrication, Noise and Vibration,” attendees can look forward to three presentations solidly in the NVH category—one presentation that evaluates eight different algorithms to compute gear sliding losses and one presentation highlighting a new water-based lubricant.

Tuesday’s afternoon session, “Materials and Heat Treatment,” begins with an evaluation of steel cleanliness by extreme value statistics, then follows with a presentation on tooth-root testing of steels with high cleanliness. After a presentation on 4D high pressure gas quenching, a new, alternative gear steel is presented, then the session closes by presenting information on gears with alternative microstructures.

The final day of the FTM, Wednesday, October 16, also has two sessions. In the morning session, “Manufacturing, Inspection and Quality Control,” a study on the influence of manufacturing variations on spline root and contact stress is presented between two presentations on new manufacturing processes for chamfering gears and micro skiving gears, respectively. The session also includes a presentation on prototype testing asymmetric gears and a comparison of current surface roughness measurement methods.

The fifth and final session of the meeting is “Gear Wear and Failure.” Attendees will witness thorough discussions on load capacity, scuffing risk, and optimum case depth. Highlights include a newly developed method for determining the tooth flank fracture load capacity of bevel and hypoid gears and a presentation showing how to calculate the power capacity of asymmetric gears.

In addition to learning about the latest gear research, the FTM is also a great place for networking. Formal, technical questions can be posed to the presenters during session Q&As, while more relaxed networking can take place at breaks between presenters or scheduled networking breakfasts, lunches, and dinners. In addition, on Monday, October 14, meeting attendees have the fantastic opportunity to go to the FTM Fun and Games Reception at Punch Bowl Social where they can bowl, play games, sing karaoke, and enjoy the local fare of Detroit. As always, we encourage attendees to check out the final day of the Motion Power + Technology Tradeshow where they can see some of the research being used in real-time at exhibit booths. We look forward to seeing you this October!

For more information visit motionpowerexpo.com/fall-technical-meeting or contact AGMA at 703-684-0211 or at tech@agma.org.
AGMA now offers Supply Chain Management courses!

Through funded research from the AGMA Foundation, AGMA and Ranken Technical College have teamed up to provide the gear industry with Supply Chain Management courses that are conveniently online.

Topics covered in this six-course program include:
- Integrated Supply Chain Management.
- Inventory Management.
- Manufacturing and Service Operations.
- Order Fulfillment and Customer Service.
- Transportation and Warehousing.

The program curriculum also will prepare students for the Council of Supply Chain Management (CSCM) SCPro Certification. To
find out more, visit: www.agma.org/education/online/supply-chain-management-certification-program.

Upcoming AGMA courses

Basic Training for Gear Manufacturing
SEPTEMBER 9-13, 2019 | CHICAGO, ILLINOIS

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

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

Fundamentals of Gear Design and Analysis
SEPTEMBER 17-19, 2019 | CHICAGO, ILLINOIS

Gain a solid and fundamental understanding of gear geometry, types and arrangements, and design principles. Starting with the basic definitions of gears, conjugate motion, and the Laws of Gearing, learn the tools needed to understand the inter-relations and coordinated motion operating within gear pairs and multi-gear trains. Basic gear system design process and gear measurement and inspection techniques also will be explained. In addition, the fundamentals of understanding the step-wise process of working through the iterative design process required to generate a gear pair will be reviewed. Learn the steps and issues involved in design refinement and some manufacturing considerations. An explanation of basic gear measurement techniques, how measurement equipment and test machines implement these techniques, and how to interpret the results from these basic measurements also will be covered.

Gear Failure Analysis
NOVEMBER 6-8, 2019 | ST. LOUIS, MISSOURI

Explore gear failure analysis in this hands-on seminar where students not only see slides of failed gears but can hold and examine those same field samples close up, and use of a microscope to examine field samples.

Class hours: 8 a.m.-5 p.m.
This course is taught at Ranken Technical College. A shuttle bus is available each day to transport students to and from the hotel.

Online Education

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

AGMA’s online education courses include:
- Gear Failure Analysis.
- Gearbox CSI: Gears Only.
- Detailed Gear Design—Beyond Simple Service Factors.
- Fundamentals of Gearing.
- Hobbing.
- Parallel Gear Inspection.
## CALENDAR OF EVENTS

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

### AUGUST
- **August 6** — Helical Gear Rating Committee Meeting — WebEx
- **August 14** — Helical Enclosed Drives High Speed Units Committee Meeting — WebEx
- **August 14-15** — TDEC — *Chicago, Illinois*
- **August 20-21** — Aerospace Gearing Committee Meeting — AGMA Headquarters, Alexandria, Virginia
- **August 22** — Lubrication Committee Meeting — WebEx
- **August 22** — Helical Enclosed Drives Marine Units Committee Meeting — WebEx

### SEPTEMBER
- **September 3** — Metallurgy and Materials Committee Meeting — WebEx
- **September 5** — Gear Accuracy Committee Meeting — WebEx
- **September 11** — Bevel Gearing Committee Meeting — WebEx
- **September 24** — Plastics Committee Meeting — WebEx

### OCTOBER
- **October 14-16** — Fall Technical Meeting — *Detroit, Michigan*
- **October 15-17** — Motion + Power Technology Expo — *Detroit, Michigan*
- **October 22** — Helical Gear Rating Committee Meeting — WebEx
- **October 24** — Metallurgy and Materials Committee Meeting — WebEx

## AGMA LEADERSHIP

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

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

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

---

**General requests**: webmaster@agma.org  |  **Membership questions**: membership@agma.org  |  **AGMA Foundation**: foundation@agma.org

**Technical/Standards information**: tech@agma.org  |  **MPT Expo information**: mptexpo@agma.org
WHAT’S NEW AT MOTION + POWER TECHNOLOGY EXPO?

Shop and compare the full range of power transmission solutions utilizing mechanical power transmission, pneumatics, hydraulics, electric motors, and drives.

At MPT Expo, you’ll see the entire power transmission supply chain — from forgings to machine tools to robotics. More than 300 exhibitors will show you the latest technologies and solutions.

Experience the brand-new MPT Conference, presented by NFPA and AGMA, with sessions presented by 16 speakers focusing on business topics and emerging technologies that all manufacturers will want to hear.

Participate in the inaugural Women’s Breakfast featuring Society of Women Engineers’ Fellow Stacey DelVecchio.

50 first-time exhibitors showcasing unique solutions.

Fluid Power Pavilion — your destination to learn if hydraulics and pneumatics could improve your project.

Emerging Technology Pavilion — provides a look at new, cutting-edge technology that is coming into the manufacturing space.

Young Professionals Reception — meet and mingle with the next generation of leaders.

The Heat Is On networking event — get the flavor of Detroit with regional food and drink.

WHO SHOULD ATTEND?

CEOs Owners Presidents Engineers Marketing Consultants
This meeting brings together top researchers from across the globe who will provide the latest information on their peer-reviewed gear industry research. Network with industry experts, academics, and engineers; ask your burning questions; and see what’s next for the future of this industry.

**FALL TECHNICAL MEETING NETWORKING AND EVENTS SCHEDULE**

**MONDAY, OCTOBER 14** | 1:00 PM – 8:00 PM  
**TUESDAY, OCTOBER 15** | 7:00 AM – 5:00 PM  
**WEDNESDAY, OCTOBER 16** | 7:00 AM – 5:00 PM

Each session will showcase five to six presenters sharing their highly technical knowledge of specific topics within the following research areas:

- **SESSION 1**: Application, Design, and Rating
- **SESSION 2**: Efficiency, Lubrication, Noise, and Vibration
- **SESSION 3**: Materials and Heat Treatment
- **SESSION 4**: Manufacturing, Inspection, and Quality Control
- **SESSION 5**: Optimization, Gear Wear, and Failure

**PRICING — INCLUDES ADMISSION TO THE EXHIBIT HALLS:**

- **Member early bird**: $995  
- **Non-member early bird**: $1,295  
- **Member regular**: $1,095  
- **Non-member regular**: $1,395  
- **Single session member**: $295  
- **Single session non-member**: $395  
- **FTM Fun and Games Reception**: $50
NEW! MPT Conference

Each session includes a 45-minute presentation with an additional 15-minute Q&A portion.

**Wednesday, October 16**

**9:00 AM – 10:00 AM**

*Supply Chain: Jeff Newman, VP, Supply Chain Visibility Solution Sales, CalAmp*

**Improve In-Transit Visibility to Reduce Supply Chain Risk**

Advances in IoT technology provide greater visibility insights through real-time data and monitoring to eliminate tracking blind spots across providers and modes. These smart sensors and devices continually log data in transit and transmit the information to a cloud portal that is accessible anywhere.

You will learn how a supply chain with embedded IoT technology provides this key data for making critical decisions on improving your operations and reducing risk.

**2:00 PM – 3:00 PM**

*Kirk Rogers, PhD, Senior ADDvisorSM, The Barnes Group Advisors*

**The Evolution of the Automotive Powertrain**

At present, most tasks in durable goods manufacturing are either fully manual or fully automated — there is no safe in-between. But automating tasks that are better done by humans and, conversely, adapting tasks that are better done by machines for human workers is suboptimal — it either over-complicates manufacturing in the case of full automation, or requires humans to perform tasks for which they are ill-suited in the case of a fully manual process.

Robots to understand where they are in a workcell, identify workpieces and the computing platforms, we are now able to develop algorithms that allow industrial robots to collaborate effectively. With modern sensors and big, fast, and strong industrial robots collaborative. With modern sensors and computing platforms, we are now able to develop algorithms that allow industrial robots to collaborate effectively.

**3:30 PM – 4:30 PM**

*Tom Rouse, Founder, Rouse Contract Consultants, LLC*

**Effective Contract Negotiations: The Path to Commercial Success with Large OE Customers**

In this session, you will learn to:
- Manage OE agreements to ensure profits are maximized and risks reduced
- Improve your quotation process to help with future customer negotiations
- Identify all the value issues and risk issues of a customer agreement
- Understand the roles of each person in effective contract negotiations
- Identify the priority points for negotiation
- Understand the timing considerations in negotiating an OE sales agreement

With this knowledge, you will be able to more effectively negotiate sales agreements with your large OE customers, thereby maintaining the business value, and reducing risks over the life of the contract.

**Thursday, October 17**

**9:00 AM – 10:00 AM**

*Casey Selecman, Director — Advisory Services, IHS Markit*

**The Evolution of the Automotive Powertrain**

At present, most tasks in durable goods manufacturing are either fully manual or fully automated — there is no safe in-between. But automating tasks that are better done by humans and, conversely, adapting tasks that are better done by machines for human workers is suboptimal — it either over-complicates manufacturing in the case of full automation, or requires humans to perform tasks for which they are ill-suited in the case of a fully manual process.

In this presentation, you will learn about the pressing need to make our existing big, fast, and strong industrial robots collaborative. With modern sensors and computing platforms, we are now able to develop algorithms that allow industrial robots to collaborate effectively.
PRICING:
Member/Non-member early bird: $295
Member/Non-member regular: $395

Price includes admission to all 16 presentations, plus admission to the expo hall.

By now, everyone has heard the noble truth about the future of powertrain development around the globe: "This is the last generation of ICES ever to be built!" While the shift to electric vehicles may be inevitable, the journey to make them a reality is going to be very complex and time-consuming. Is there enough capacity to build the battery packs required? Will oil-producing countries give up producing a critical natural resource to protect the health of the planet? Will the technology advance quickly enough to enable faster charging and greater range necessary to get customers to choose electrons over oil? This presentation will provide a critical assessment of the changing powertrain offerings and the potential impact on the industry.

9:00 AM – 10:00 AM

IIoT: Russ Waddell, Director, MTConnect

Standards for IoT Interoperability
Manufacturing data and information systems are rapidly evolving to enable myriad new technologies around software and networking. Underlying this evolution is a set of standards and protocols developed by industry, academia, research organizations, and governments around the globe. Motion and power, like many other industry verticals, have unique needs and business requirements. Yet, there is much to be learned from previous standards development efforts and neighboring segments in manufacturing.

10:30 AM – 11:30 AM

Workforce: Tony Velotta, Organizational Development Leader, Scot Forge

Workforce Development Using a Farm Team Approach
There is a significant deficit in the number of workers needed and the number available to most companies. Scot Forge Company has a program to develop the future workforce to be ready when needed similar to major league sports teams using a farm team concept. The farm team is a ready-to-go supply of talent that is called to the big league when needed. Scot Forge starts with high school students and develops their skills and, most importantly, their culture, to be hired full-time when ready and needed. The program consists of two key components: organizational development and employee ownership that involves high school student learners, college internships, apprenticeships, associate and bachelor degrees, and in-house training such as leadership, supply chain management, and sales training programs.

10:30 AM – 11:30 AM

Electric Drive Technology: Jeff Hemphill, CTO, Schoeffler

Losing Teeth? The Future of Gear Trains in the Age of Electrification
The rate of electrification seems to be accelerating every day. Major OEMs make regular announcements about battery electric vehicles and Tesla continues to disrupt its segments. But where does that leave a gear supplier or engineer? In this session, we’ll take a look at some of the new challenges and new applications and see where the gears and bearings of the future will be deployed.

2:00 PM – 3:00 PM

Cybersecurity: James McQuiggan, CISSP, Chapter President, (ISC)² Central Florida Chapter

Cybersecurity Hygiene in Motion
When it comes to hygiene, we grew up understanding what is good hygiene, washing our hands before dinner, brushing our teeth before bed, and taking a shower at least every other day. In cybersecurity, similar hygiene can be applied to our daily lives that can help not only at home, but also in the places we work. Within the company and as it relates to cybersecurity, leaders are unsure of that hygiene in the standards they need to follow, what technology they need to purchase, and how to protect against an attack. In motion or standing still, there are simple things that we can do to protect ourselves online, at home, and at the office.
EDUCATION COURSES

Free pass to both exhibit halls when you register for any education course.

Technical Overview of Automotive Differentials
Instructor: William Mark McVeal, KBE+, Inc.
TUESDAY, OCTOBER 15
8:00 AM – 12:00 PM
This seminar will provide insight into automotive differential technologies – specifically, the intended function, issues with the common differential types (i.e., open differential), the concept of traction aiding differentials and the difference between passive mechanical and active electronic, and finally an overview of the design requirements and common manufacturing nuances specific to differential gears.

Registration Fee:
Early Bird, through September 13, 2019:
Member: $295
Non-Member: $395
After September 13, 2019:
Member: $350
Non-Member: $450

Supply Chain Management
Instructors: Dr. Justin Jones and Keyvan Gerami, Ranken Technical College
TUESDAY, OCTOBER 15
8:00 AM – 12:00 PM
This course provides an overview on knowledge of supply chain management concepts, components, and principles. An introduction to the competitive advantages needed by skilled individuals to design, execute, and manage their supply chain.

Registration Fee:
Early Bird, through September 13, 2019:
Member: $295
Non-Member: $395
After September 13, 2019:
Member: $350
Non-Member: $450

Hydraulic Fluid Properties, Efficiency, and Contamination Control
Presented by: Paul Michael, Research Chemist, MSOE
TUESDAY, OCTOBER 15
8:00 AM – 12:00 PM
In this seminar, participants will learn about the composition of oils, the properties of lubricants, and how hydraulic fluids can affect machine performance. Conventional, multi-grade, synthetic, and biodegradable fluids will be discussed. Research studies examining fluid efficiency effects in hydraulic motors, as well as piston and gear pumps will be presented. The principles of oil analysis and filter selection will be outlined. The seminar will conclude with case studies that demonstrate how filter debris analysis can be used to troubleshoot hydraulic system contamination control problems.

Overview of Fluid Power Components and Systems
Presented by: Thomas Wanke, CFPE Director, Fluid Power Industrial Consortium and Industry Relations, MSOE
TUESDAY, OCTOBER 15
1:00 PM – 5:00 PM
This introductory-level course will cover the benefits and challenges of using fluid power systems for power transmission and motion control. Physical laws that govern how and why fluid power systems function will be discussed. Individual components that comprise a fluid power system, including their design, construction, and operational characteristics, will be presented. ISO symbology used for representing individual components will be covered. The course will collimate with a brief overview of circuit architectures.

Registration Fee:
Early Bird, through September 13, 2019:
Member: $295
Non-Member: $395
After September 13, 2019:
Member: $350
Non-Member: $450

Technical Overview of Automotive Powertrain Lubricants
Instructor: William Mark McVeal, KBE+, Inc.
TUESDAY, OCTOBER 15
1:00 PM – 5:00 PM
This course will provide a brief review of all common transmission technologies as a precursor to development of the functional requirements of the lubricants for each of the common transmission technologies, ending with a detailed discussion of lubricant theory, composition, and application.

Registration Fee:
Early Bird, through September 13, 2019:
Member: $295
Non-Member: $395
After September 13, 2019:
Member: $350
Non-Member: $450

Fundamental Understanding of Electro Fluid Power Technology
Presented by: Dr. Medhat Khalil, CHFPS, CFAPI, Director of Professional Education and Research Development
WEDNESDAY, OCTOBER 16
8:00 AM – 12:00 PM
This seminar briefly introduces electro fluid power technology and its outstanding features as compared to the other power transmission and motion control systems. Fundamental knowledge about the most common types of electrohydraulic and electropneumatic valves will be covered. Various criteria to select a specific valve for an application, including valve type, spool design, operating conditions, and static and dynamic characteristics, will be discussed. This seminar also covers various system-level control loops architectures and tuning methods for system performance.

Registration Fee:
Early Bird, through September 13, 2019:
Member: $295
Non-Member: $395
After September 13, 2019:
Member: $350
Non-Member: $450

Gearbox Field Inspection — Load Distribution, Lubrication, and Condition Monitoring
Instructors: John B. Amendola, John B. Amendola III, and Derek Yetzko, Artec Machine Systems
WEDNESDAY, OCTOBER 16
8:00 AM – 12:00 PM
Gears can fail due to various damage patterns. In this seminar, the combined influence of shaft misalignments and gear load crown on load distribution and tooth bending stresses is applied to real-world circumstances. Both the operator and the designer must consider gear tribology. Consequences of inadequate lubrication and how to establish ongoing maintenance procedures will be covered.
Gearbox diagnostics and service are critical to the field inspection process and will also be explored in depth.

Registration Fee:
Early Bird, through September 13, 2019:
Member: $295
Non-Member: $395
After September 13, 2019:
Member: $350
Non-Member: $450

Reverse Gear System Engineering —Why, When, and How
Instructor: Raymond Drago, P.E., Drive Systems Technology
WEDNESDAY, OCTOBER 16
8:00 AM – 5:00 PM
Reverse engineering a gear system is not too unusual of a task. In many cases — but not all — the process goes fairly well; thus it is easy to become complacent. It is important, however, to fully understand the process and the best practice procedure for reverse engineering a gear system. Failure to fully follow best practice can result, at best, in an unhappy gear user, but in the worst case it can lead to very expensive, time-consuming, and reputation-damaging litigation. We will discuss the basic types of reverse engineering. The need for understanding the operation of the system in which the gears will be used, the conditions that led to the need for the project, and especially the specific nature of the failure that occurred (if that is the reason for the project) are key and often ignored elements of the process.

Registration Fee:
Early Bird, through September 13, 2019:
Member: $445
Non-Member: $575
After September 13, 2019:
Member: $525
Non-Member: $655

Basics of Gearing
Instructor: William Mark McVea, KBE+, Inc.
WEDNESDAY, OCTOBER 16,
THURSDAY, OCTOBER 17
8:00 AM – 5:00 PM
Dramatically improve your knowledge and productivity through Basics of Gearing. This course will be presented in a two-day format and will give you a comprehensive overview of standard gearing nomenclature, gear involute geometry, inspection procedures, and much more.

Registration Fee:
Early Bird, through September 13, 2019:
Member: $650
Non-Member: $780
After September 13, 2019:
Member: $750
Non-Member: $880

Taming Tooth Deflections: The Case for Profile Modifications
Instructor: Raymond Drago, P.E., Drive Systems Technology
THURSDAY, OCTOBER 17
8:00 AM – 12:00 PM
Pack your “bag of tricks” with knowledge of how teeth deflect, what involute interference really is, the potential consequences of inadequate profile modifications, and the difference between tip relief, flank relief, and fully modified profiles. Students learn how to calculate tooth deflections under load and, most importantly, how to modify a gear set properly to eliminate involute interference. Finally, we will examine the optimum drawing definitions for profile modifications and how to interpret involute inspection charts to determine if the drawing’s required profile modifications have actually been produced on the gear set.

Registration Fee:
Early Bird, through September 13, 2019:
Member: $295
Non-Member: $395
After September 13, 2019:
Member: $350
Non-Member: $450

Materials Selection and Heat Treatment of Gears
Presented by: AGMA and ASM International
THURSDAY, OCTOBER 17
8:00 AM – 5:00 PM
Because of their unique contribution to the operation of so many machines and mechanical devices, gears have received special attention from the technical community for more than two millennia. New developments in gear technology, particularly from the materials and heat treatment perspectives, have improved gear performance. This course, developed jointly by AGMA and ASM International, will provide an overview of materials selection and heat treatment of gears.

Registration Fee:
Early Bird, through September 13, 2019:
Member: $445
Non-Member: $575
After September 13, 2019:
Member: $525
Non-Member: $655

Loaded Tooth Contact
Instructor: Terry Klaves
THURSDAY, OCTOBER 17
1:00 PM – 5:00 PM
This seminar will calculate and demonstrate the effect that shaft bending, torsional windup, and tooth deflections have on loaded tooth contact on various configurations of parallel shaft spur and helical gearing. With the loaded tooth and shaft deflections identified in real-life examples, tooth helix and profile modifications will be developed that, when properly manufactured and applied, will significantly improve loaded tooth mesh contact to support realistic load distribution factors used in rating of parallel shaft spur and helical gears. The process involves the application of commercially available software that models the loaded gear mesh in FEA. This evaluation and corrective action will promote optimization of power density with predictable fatigue life.

Registration Fee:
Early Bird, through September 13, 2019:
Member: $295
Non-Member: $395
After September 13, 2019:
Member: $350
Non-Member: $450

EXHIBIT HALL HOURS
TUESDAY, OCTOBER 15 | 9:00 AM – 6:00 PM
WEDNESDAY, OCTOBER 16 | 9:00 AM – 5:00 PM
THURSDAY, OCTOBER 17 | 9:00 AM – 4:00 PM
EXCITING EVENTS
TO NETWORK AND BUILD YOUR COMMUNITY

Hosted by AGMA, NFPA, and ASM, open to all registrants of both events.

FTM FUN AND GAMES RECEPTION
MONDAY, OCTOBER 14 | 6:00 PM – 8:30 PM
MPT Expo attendees are invited to join AGMA Fall Technical Meeting attendees at our FTM Fun and Games Reception at Punch Bowl Social Detroit. Enjoy food and drinks with your colleagues while participating in fun activities such as bowling, darts, karaoke, and arcade games. A great way to kick off a busy week at MPT Expo!
✓ FREE for FTM attendees
✓ $50 for all other attendees

OPENING NIGHT WELCOME RECEPTION
TUESDAY, OCTOBER 15 | 5:00 PM – 6:00 PM
Don’t miss this meet-and-greet event right on the show floor!
✓ FREE for all attendees
✓ Two drink tickets included with registration.

YOUNG PROFESSIONALS RECEPTION AT MPT EXPO
TUESDAY, OCTOBER 15 | 6:00 PM – 8:00 PM
The evening will be a great opportunity for all those business professionals 35 and under to network and engage in industry discussion while enjoying food drinks and entertainment.
✓ $15/person

THE HEAT IS ON
WEDNESDAY, OCTOBER 16 | 6:30 PM – 9:30 PM
Join your fellow Heat Treat and MPT attendees during our premier networking event, “The Heat Is On.” This special evening will capture the heart of Detroit and all attendees with live music, a tempting array of Detroit-inspired food, craft beer, and a few “hot” surprises!
✓ Member: $85
✓ Non-Member: $95

WOMEN IN MANUFACTURING BREAKFAST
THURSDAY, OCTOBER 17 | 7:30 AM – 8:30 AM
This breakfast will allow women in all sectors of manufacturing and power transmission to share thoughts and ideas about industry innovation. Hear our guest speaker share her experience and leave with ideas and a fun giveaway!

Featured Speaker:
Stacey M. DelVecchio, President, StaceyD Consulting, F. SWE, Secretary of Women in Engineering Committee for WFEO
✓ $15/person

REGISTER TODAY AT MotionPowerExpo.com
AIM HIGH.

KAPP NILES ZE Series

Gear profile grinding

High precision for external and internal gear grinding. Durable ZE Series are characterized by accuracy and good ergonomics.

Small batches or serial – fits perfectly to your requirements!

KAPP Technologies
2870 Wilderness Place Boulder, CO 80301
kapp-niles.com info@kapp-niles.com (303) 447-1130
Selecting media for optimum vibe bowl gear finishing

Choosing the best media depends on structure and shape of the tooth flank, and whether media components should be abrasive, non-abrasive, or a blend.

The second in our multi-part series on vibratory processing of gears is focused on the selection of media that will be used to improve gear surface quality.

MEDIA CONTACT PATTERN VS. THE FORM OF THE SURFACE TO BE CONTACTED

When gear finishing callouts require a final tooth flank Ra that is lower than the as-shaved, as-lapped, or as-ground surface, a typical response is to use vibratory abrasive ceramic media for generic tooth finishing to an Ra = 8–20 μinches, or high-density, non-abrasive media for an isotropic superfinish of Ra ≤ 4 μinches.

Size, shape, and composition of media used depend on the morphological form of the gear teeth and the final Ra value required. Abrasive ceramic media typically contains aluminum oxide abrasive grit and mechanically abrades the surface to improve the Ra value. In isotropic superfinishing, a chemical accelerator is employed to create a soft conversion coating that is wiped from the tooth flank surface with the high-density non-abrasive media.

Vibratory processing is optimized when the shape of the media closely matches the shape of the tooth flank. The most efficient contact pattern is plane-to-plane. When the flat face of the tooth flank is matched with a media having a flat-face(s), then the maximum surface area possible is contacted per unit of processing time. Plane-shaped media examples are straight and angle cut triangles, tetra-pyramids, and the base of a cone.

Circular-shaped media, such as cylinders, offer a less efficient tangent-line contact pattern. Such contact isn’t planar, but linear. Much less surface area is contacted per unit of processing time and the cycle is usually extended. Media offering linear contact patterns are cylinders, or the side of a cone.

Finally, spherical media offers the least efficient contact pattern possible, contacting a tooth flank only at a single point. Spherical media should be considered a media of last resort if no other shape can be employed. Spherical media typically results in a longer processing time than the other two contact patterns.

MEDIA COMPOSITION CONSIDERATIONS

The two main components in the make-up of an abrasive ceramic media are aluminum oxide grit and clay. Blended together with several other ingredients, the media is extruded through a die, cut to length, then kiln-fired. The kiln firing operation converts the clay to ceramic. Assorted clay types that may be used are river, bentonite, kaolin, porcelain and china clay. After firing we can consider the resultant ceramic as the binder that holds the media together.

When considering media composition, we are trying to determine which media to use based on the ratio of the abrasive grit to the ratio of the clay. As the percentage of abrasive increases in the composition, the proportion of ceramic must consequently decrease. Since the ceramic is the binder that holds the media together, a media with less binder present has a higher attrition rate. Attrition is the rate at which media decreases in volume as a function of processing time. A high abrasive media with a high attrition rate decomposes rapidly, contributing more loose abrasive into the vibratory mass. This increases abrasive action, decreases processing time, and produces a matte final finish. An attrition rate of 2 percent per hour is typical.

Media of different compositions attrit at different rates. High abrasive content media will finish parts rapidly, generating a final Ra value 15-18 μinches. Lower abrasive content media will finish at a slower speed, producing an Ra value in the 9-12 μinch range. The higher the media’s attrition rate, the greater the volume of sludge it will produce per unit time.

Isotropic superfinishing employs high-density, non-abrasive media to wipe, not abrade, surface asperities when used with a chemistry that forms a soft conversion coating. A non-abrasive media leaves a mirror-reflective surface on steel surfaces hardened to Rc ≥ 40. The attrition of this media is nearly nil, typically 0.008 percent per hour. Final Ra values are ≤ 4 μinches are usually achieved, and a final step burnishing step removes the conversion coating to leave a clean final finish.

WHEN TO USE A BLEND OF MEDIA

Low DP tooth patterns are easier to refine as the media can more uniformly contact the tooth flank, addendum to dedendum. Tighter pitch pattern gears may be better finished using a media blend.

Tooth addendums project into the media mass and are more easily recessed than dedendums. Therefore, metal removal rates vary from addendum to dedendum. To equilibrate metal removal from top land to root, consider blending two or more media types. Smallish, high-density media with a density of 125 lbs/ft³ fails to the root where its weight is advantageous in applying more inertial force in this recessed location.
Large, bulky media affects the part surface more forcefully and does more work per unit run time. Smaller media affects the part surface less forcefully, but encapsulates the part uniformly, offering cushioning and a higher quality final finish.

Inversely, a large, bulky, lightweight media of polyester plastic composition will bring to bear much less force to the location it contacts. With a density of just 65 lbs/ft³, coupled with a bulky-shape, this media only contacts the gear’s topland and addendum locations. Concomitantly, its light density applies a much lower inertial force in these easily contacted areas, thereby reducing the metal removal rate there and permitting it to match the high-density media metal removal rate in the dedendum and root.

FLUID RETENTION IN THE VIBRATORY BOWL
Large, bulky media affects the part surface more forcefully and does more work per unit run time. A large, bulky media does not fill a volume efficiently, resulting in large interstitial void spaces that drain fluid efficiently during vibratory finishing.

Smaller media affects the part surface less forcefully, but encapsulates the part uniformly, offering cushioning and a higher quality final finish. Smaller media packs tighter to fill a void space efficiently. There are more void spaces, but they are very small in size and retain fluid in the bowl due to surface tension. This slows mass roll speed and increases the propensity to form fluid geysers. A fluid extraction pump is usually a necessity when small media is employed.

ABOUT THE AUTHOR

William (Bill) P. Nebiolo received a B.A. from The University of Connecticut and an M.S. in environmental sciences from Long Island University. He has been with REM Surface Engineering since 1989 and currently serves as a sales engineer and as REM’s product manager. Since 1978, Nebiolo has been an active member in the National Association for Surface Finishing (NASF) where he has represented the Connecticut chapter as an NASF national delegate and is the 2010, 2014, and 2015 recipient of the NASF National Award of Merit. From 1996 to 2000, he served as one of SME’s Mass Finishing technical training program instructors. He has published and presented dozens of technical papers and is the author of the SME Mass Finishing Training Book. Nebiolo can be reached at bnebiolo@remchem.com.
What do you do? I sell gears!

What reaction do you get at a cocktail party when you try to explain your profession?

This year, my 11-year-old daughter asked me to be one of the parents who presented their profession on career day. She is very proud of her dad and wanted to show all of her classmates the cool job that her dad had. After all, being a gear engineer is just as cool as being a firefighter, or a police officer, or a teacher, or a social worker, or an orthodontist. The biggest difference between being a gear engineer and all of these other professions is that the others are all public-facing professions that people have a good understanding of, whereas they have little or no understanding of what a gear engineer is or does.

I get the same response from both adults and children when I explain that I sell gears and gear designs as a career. They all say, “Oh, like for cars!” When I start to explain that I don’t sell gears for automotive applications but for ordinary industrial applications, their eyes glaze over, and they just nod their head.

When I presented to the sixth-graders this year, they answered just like their parents. The only concept of gearing that they knew was automotive in nature. It was my responsibility to educate them and expand their understanding. My first attempt at bringing a real-world gearing example to their attention was to show them the inner workings of the mechanical pencil sharpener. It contains two conical gears that intersect in such a way that they grind the pencil into a sharp point. Unfortunately, they no longer have mechanical pencil sharpeners in the classroom, as the students all use mechanical pencils these days. My next example was the gearing that operates the local drawbridge leading to the beach. They all knew the bridge, but as the gears are hidden from view, they couldn’t visualize that example either. Next on my list was the conveyor belt used on the self-checkout at the local supermarket. I asked the students how they thought the belt was able to move. This finally clicked in their heads. They understood that a motor created the motion and a gear train moved that motion to the conveyor.

There are so many examples of gearing in everyday life, but they are mostly hidden and therefore go unnoticed. It could be the elevator that takes you up to the eighth floor of the hotel or the escalator that takes you up to the second floor of the mall. It could be the cash dispenser at the ATM or the postage machine in the post office lobby. It could be the electric can opener in your kitchen or the paper shredder in your den. Each of these items has gears inside of them, and their job would be impossible to do without gearing.

For each gear application, a gear engineer has used their knowledge of physics, strength of materials, thermodynamics, stress, strain, and mathematics to design the optimum gear for the usage conditions assumed for the project. When the gear is used as designed, the general public never realizes that it is working. Unfortunately, gears typically do all of their good work behind the scenes. It is only when they fail that they become exposed. This is when most people become aware of the gears around them in everyday life.

If I do find a sympathetic ear to listen to me describe my career as a gear engineer, the conversation will eventually turn to the availability of 3D CAD models and how they can simplify and prove out a design before producing physical gears. With the use of 3D printing, generating a physical prototype is becoming easier. However, just because you can draw something in CAD and have it 3D printed, doesn’t mean that it can be produced using traditional gear machinery.

When you were a child, I am certain that you drew pictures that represented ideas that you had but were not possible in real life. Like the picture that you drew of your family. Mom and Dad, the cat, the dog, and your siblings, all standing in front of your house. In the picture Mom and Dad were almost the same height as the house. Either you had very tall parents or you lived in a very short house. In reality, neither was true. You just sketched out your thoughts, and the concept of scale was absent from your young mind.

Similar situations occur within CAD designs. It is certainly possible to draw a gear with a 20mm hub that has an 18mm bore, but is it practical to have a 1mm wall thickness on the hub? How could you machine this and maintain the concentricity of the hub? How about a gear with a Module 6 pitch and a face width of 4mm? It might look OK in CAD, but it wouldn’t be practical in a real application.

I have always enjoyed being a gear engineer because each project brings unique challenges, but sometimes I wish that it was easier to explain what I do and where gears affect our everyday lives.
Connect your company to the gear industry with a storefront in the Gear Solutions Community.

Storefronts paint a portrait of your company with a 500-word description and include your logo, website link, phone number, email addresses, and videos. Your social media pages such as Twitter and Facebook are integrated with live updates, which may also be re-posted through our social media feeds.

With a community storefront, your company also receives a premium listing in the annual Buyer’s Guide published each November. Premium listings feature graphic treatments to draw more attention to your company.

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

Chad Morrison – associate publisher
800.366.2185 x 202
Back to basics with tempering (Part II)

Fundamental methodology for calculating tempering times and temperatures for steels can simplify the empirical determination of appropriate temperatures to use to process a new part.

After a part has been austenitized and quenched, it must be tempered. As was discussed previously [1], the purpose of tempering is to relieve the transformational residual stresses from quenching, and to transform the brittle martensite to tougher tempered martensite. It can also convert any remaining austenite to tempered martensite or bainite.

One of the issues facing the heat treater is determining the time and temperature to achieve the desired hardness or mechanical properties. Most data is similar to Figure 1, which shows typical hardness after quenching a 25mm round to full as-quenched hardness [2].

There are several methods of determining the appropriate time and temperature for tempering. One method of determining time and temperature is described by Canale et al [3]. As a first step, the desired temperature is calculated using the equation developed by Just [4].

\[
T_t = 917 \sqrt{\ln \left( \frac{H_q - 8}{H_t - 8} \right)} - 273°C
\]

Where \(T_t\) is the absolute temperature of tempering (°K) – valid in the range of 390° - 660°C; \(H_q\) is the as-quenched hardness (HRC); \(H_t\) is the required hardness after tempering (HRC); and \(S\) is the ratio of the as-quenched hardness versus the maximum hardness (\(S = \frac{H_q}{H_{max}}\)).

The total tempering time including heat-up and soaking time is calculated from [5] [6]:

\[
t = a \frac{m}{A} + b
\]

where \(t\) is the time in minutes, \(m\) is the mass of the load (kg), \(A\) is the total surface area (m²), and \(a\) and \(b\) are constants that are developed empirically for each furnace used. This method requires significant empirical work to be done to evaluate each possible furnace and alloy and load combination.

Tempering is dependent on time, temperature carbon content, and alloying elements. Alloying elements retard softening during tempering, and change the kinetics of tempering [7]. Figure 2 shows the hardness of iron-carbon alloys tempered at various temperatures.

One relationship that has been used successfully in determining the time for tempering is the Holloman-Jaffe equation [8], also known as the Larson-Miller equation [9]:

\[
T_1(C + \log t_1) = T_2(C + \log t_2)
\]

\(T_1\) and \(t_1\) are the known temperatures and times for \(T_2\) and \(t_2\) are the desired temperatures and times. \(C\) is a constant, which varies by steel grade, and ranges from 15-22. It is generally accepted to have a value of 20, but some authors recommend a value 18 [1]. Table 1 shows Larson-Miller values of \(C\) for various alloys.

One of the problems with the use of the Larson-Miller equation is that it assumes an isothermal process. However, the process of tempering involves heating the parts to temperature, holding at the desired temperature for the desired amount of time, and cooling the parts to room temperature. During the heating of parts, there will be...
some transformation of the martensite to temperature martensite. This is also true of the cooling process. To overcome these issues, the effect of heating and cooling was examined by Gulvin et al., using the Larson-Miller equation to determine appropriate times for stress-relieving. An additional equivalent time $T_{eq}$ at the tempering temperature, based on linear heating and cooling, was calculated \[ T_{eq} = \frac{T}{2.3k(20 - \log k)} \]

where $T$ is the tempering temperature in °K, and $k$ is the heating or cooling rate in °K/hr. The total time during tempering is then:

$$t_2 = t_{eq-heating} + t_{soak} + t_{eq-cooling}$$

From the above equations, the tempering time can be estimated if one time-temperature relationship is known.

CONCLUSIONS
In this short article, the basic methodology for calculating different tempering times and temperatures for steels was provided. While somewhat math intensive, it can simplify the empirical determination of appropriate temperatures to use when processing a new part.

Should you have any questions regarding these calculations, or to suggest a future heat-treating article, please contact the author at the email address at the end of the article.

REFERENCES


DESIGN FEATURES OF WORM GEARING COMPOSED OF PLASTIC AND/OR POWDER-METAL COMPONENTS
The technology used in production of plastic gears, as well as powder-metal technology, imposes certain constraints on the design parameters of a worm and of a mating gear.

By STEPHEN P. RADZEVICH

This article deals with worm gearings in cases when the worm-gear pair is composed either of plastic or of powder-metal made components. The technology used in production of plastic gears, as well as powder-metal technology, imposes certain constraints on the design parameters of a worm and of a mating gear. Gears of this kind are better suited for manufacturing, and, thus, they can be cheaper in production, while gears of other kinds are inconvenient in production, which makes them costlier. Certain advantages of gearing theory accomplishments can be taken in order to combine the benefits of plastic-gear technology, and of powder-metal technology, with benefits of particular designs of worm-gear pairs.

INTRODUCTION

In recent decades, plastic gears, as well as powder-metal gears (PM gears) got an extensive application in a variety of industries. In many cases, gears of regular design can be successfully replaced either by plastic gears, or by PM gears that are usually less expensive and of a higher quality. Unfortunately, not every kind of gears can be made of plastic or use conventional methods adopted in powder-metal industry. For example, spur gears are easier in production compared to worm gears, helical gears, double-helical and/or herring-bone gears, gears with circular arc geometry in the length-wise direction of the gear tooth, and so forth.

In “worm-to-spur gear” mesh, it is a common and well-established practice to set the worm in relation to a mating spur gear at an angle that corresponds to the worm pitch helix angle, $\psi_w$. The shaft angle, $\Sigma$, in this case equals $\Sigma = 90° - \psi_w$. Such a case is illustrated in Figure 1. It is evident that the shaft angle in this particular application is not a right angle ($\Sigma \neq 90°$).

However, in particular applications, it is preferred to have worm gearings (a) with a shaft angle equal to a right angle, and (b) with a spur (not helical) gear in mesh with a mating worm. Under such a scenario, the spur gear is manufactured using a technology adopted easier in production of plastic gears or PM gears. Manufactured this way, the gears get cheaper. The replacement of a helical gear with an equivalent spur gear is beneficial as the axial thrust pointed along the spur gear axis of rotation in this case is eliminated, and the shaft can be mounted on bearings of a cheaper design.

It should be mentioned here that right-angle gear pairs with an involute worm engaged in mesh with a spur involute gear are known. An example of such a gear pair is depicted in Figure 2. Here, a “worm-to-spur gear” pair with a right shaft angle is shown ($\Sigma = 90°$). It is right point to stress here that originally shown in the Figure 2 worm was designed to be engaged in mesh with a helical gear. Later on, width of the space between the worm threads was enlarged, and in this way, an additional room was created in order to get the worm engaged in mesh with a spur gear. This is made clear from a comparison of the thickness of the worm top land, $t_{o,w}$, and of the space width, $w_{f,w}$, in the bottom land ($t_{o,w} \ll w_{f,w}$).

Figure 1: An orthogonal “worm-to-helical gear” gear pair.

Figure 2: Nowadays, design of an orthogonal “worm-to-spur” gear pair: thickness of the worm top land, $t_{o,w}$, is much smaller compared to the space width, $w_{f,w}$, in the bottom land ($t_{o,w} \ll w_{f,w}$).
cussion that the two requirements, that is, (a) to keep the shaft angle equal to a right angle, and (b) to use a spur gear instead of helical gear, are contradictory to one another.

The developments in the theory of gearing [1] make designing worm gear pairs with a right shaft angle (\( \Sigma = 90° \)) possible, and with a spur gear engaged in mesh with the worm.

**ELEMENTS OF THE THEORY OF ENVELOPING SURFACES**

When a worm and a mating spur gear rotate in mesh, a virtual straight-sided rack is engaged in mesh with each of the components. This rack is commonly referred to as the "basic rack," \( \mathcal{R} \). Tooth flanks of the spur gear may be viewed as envelopes to the consecutive position of a tooth flank of the basic rack, \( \mathcal{R} \), in its motion in relation to a reference system associated with the spur gear. Generated this way, the worm is referred to as the "involute worm" (that differs from "Archimedean worm," as well as from "convolute worm"). The same is also valid with respect to the mating worm: The worm threads may be construed as envelopes to the consecutive position of a tooth flank of that same basic rack, \( \mathcal{R} \), in its motion in relation to a reference system associated with the worm. With that said, one can conclude that the geometry of the tooth flank of the spur gear, as well as the threads of the worm, are generated as envelopes to a plane surface that performs a screw motion along and about a straight line, which, in nature, is the axis of rotation of the spur gear (of the worm).

Following [1], the generation of an enveloping surface to consecutive positions of a plane that performs a screw motion is briefly outlined:

In a more general case, that is, in a case of an involute helical gear, the generating basic rack, \( \mathcal{R} \), of a helical gear is tilted at a certain angle, \( \psi_{b.g} \), in relation to the axis of rotation of the gear as shown in Figure 3. When the gears rotate, the basic rack, \( \mathcal{R} \), travels in the direction specified by the vector, \( \mathbf{V}_r \). The magnitude, \( V_r \), of the vector, \( \mathbf{V}_r \), of the linear velocity is synchronized with a rotation, \( \omega_g \), of the gear in a timely manner.

The gear tooth flank, \( G \), is an envelope to consecutive positions of the lateral plane when the rack, \( \mathcal{R} \), performs the screw motion along and about the axis, \( O_g \).

To derive the geometry of a gear tooth flank, \( G \), and of mating worm threads, \( W \), consider a plane, \( \mathcal{R} \), that performs a screw motion, shown in Figure 4. The plane, \( \mathcal{R} \), forms a certain angle \( \psi_{b.w} \) with \( X_0 \)-axis of the "Cartesian" coordinate system, \( X_0Y_0Z_0 \) (shown later in this article, angle \( \psi_{b.w} \) in nature is the base helix angle of a helical gear). The axis, \( X_0 \), is the axis of the screw motion.

The screw motion of the plane, \( \mathcal{R} \), is composed of two elementary motions:

1. The rotation with an angular velocity, \( \omega_g \), about the \( X_0 \)-axis.
2. The translation, \( \mathbf{V}_r \), along the \( X_0 \)-axis is another motion.

The magnitudes, \( \omega_g \) and \( V_r \), of the rotation vector, \( \mathbf{m}_g \), and the linear velocity vector, \( \mathbf{V}_r \), respectively, are synchronized with one another in Equation 1:

\[
V_r = 0.5 \omega_g d_g
\]

Here, the pitch diameter of the gear is denoted by \( d_g \).

The linear velocity vector, \( \mathbf{V}_r \), can be expressed as the sum of two vectors in Equation 2:

\[
\mathbf{V}_r = \mathbf{V}_1 + \mathbf{V}_2
\]

The component \( \mathbf{V}_1 \) of the translation vector, \( \mathbf{V}_r \), is within the plane, \( \mathcal{R} \). This component does not affect the geometry of the enveloping surface, \( G \), and, thus, the component \( \mathbf{V}_1 \) can be omitted from further analysis. The component \( \mathbf{V}_2 \) is perpendicular to the plane, \( \mathcal{R} \). The geometry of the gear tooth flank strongly depends on the magnitude

Orthogonal worm gear pairs may be designed so as to engage a spur gear in mesh with a mating involute worm under a right shaft angle in the worm gear pair.
rack, $\phi$, and of the angle, $\xi_r$, that the basic rack, $\phi$, forms with the perpendicular to the gear axis of rotation (see Figure 4).

The expression in Equation 3 can be transformed and represented in the form of Equation 4:

$$\tan \phi_{b,g} = \frac{\sin \phi_{b,g} \sin \xi_r}{\sqrt{1 - \sin^2 \phi_{b,g} \sin^2 \xi_r}} \quad \text{Equation 4}$$

known from many advanced sources [3], and others.

It is important to stress that the angle (which is commonly referred to as the “worm setting angle, $\xi_r$”), and the worm pitch helix angle, $\psi_{b,g}$, are not identical to one another as they are of a different nature.

Equation 3 is the core for understanding “spur gear-to-worm” right-angle gearing.

The involute gear tooth flank, $\phi$, generated this way perfectly correlates with involute gears’ tooth flank geometries generated using other method. A well-known schematic (available from the public domain) is used here intentionally (Figure 5). This schematic is adopted by many gear experts, which makes it easier to demonstrate the configuration of the rolling plane in relation to the involute gear tooth flank. The schematic is overlapped by the plane that performs a screw motion. It is instructive to stress that the plane, $\phi$, shown in Figure 4 is that same newly introduced plane in Figure 5.

The earlier discussion on generation of a screw involute surface can be summarized with the following statement:

If we screw, with pitch, $p$, a plane about an axis fixed in space, which axis makes an angle, $\alpha$, with the said plane, we describe in space a continuum of planes that successively intersect one another in a continuum of straight lines. These lines sweep out the involute helicoid, $(a, \alpha)$, where $a = ptan \alpha$.

It might be correspondingly said that the screw of the plane “sweeps” in the same involute helicoid. The involute helicoid is, in any event, the so-called “envelope” of the continuum of planes.

This is a well-known theorem not found in most books about gearing. It may however be found in some books about kinematics [9]. See also page 335 in the book by Dr. Phillips [10].

Another solution to the problem of determining the envelope of a plane that performs a screw motion is given by Cormac [8].

**‘SPUR GEAR-TO-WORM’ ORTHOGONAL GEARING**

At hand, the problem designing the worm can be formulated as follows: To design an involute worm that can be engaged in a proper right-angle mesh with a spur involute gear.

For an involute worm of a specified module, $m$, the number of starts, $Z_w$, normal profile angle, $\phi_n$, and the worm-setting angle, $\xi_w$,...
in Equation 5 (see Figure 6):

\[ d_{b,w} = \frac{m \cdot Z_w \cdot \cos \phi_n}{\sqrt{1 - \cos^2 \phi_n \cdot \cos^2 \zeta_w}} \quad \text{Equation 5} \]

is used for the calculation of the base diameter of the worm, \( d_{b,w} \).

Once the shaft angle in a “spur gear-to-worm” pair is a right angle, then the “worm setting angle, \( \xi_r \)” has to be equal to zero, and, thus, an equation \( \xi_r = 0^\circ \) has to be valid. Under such a scenario, the equality \( \psi_{b,w} = \phi_n \) (see Equation 3) is observed.

In this particular case (that is, when \( \xi_r = 0^\circ \)) Equation 5 reduces to:

\[ d_{b,w}\big|_{\xi_r=0^\circ} = m \cdot Z_w \cdot \cot \phi_n \quad \text{Equation 6} \]

Having the base helix angle, \( \psi_{b,w} \), of the worm calculated, the rest of the design parameters of the worm are calculated as follows [1], [4]:

1. Axial pitch of the worm, \( p_x \):

\[ p_x = \pi \cdot m \quad \text{Equation 7} \]

Here, the module of the worm is designated as “m.”

2. Base diameter of the worm, \( d_{b,w} \):

\[ d_{b,w} = \frac{p_x}{\pi \cdot \tan \phi_n} \quad \text{Equation 8} \]

With the axial pitch, \( p_x \), the base diameter, \( d_{b,w} \), and the design parameters of the basic rack, \( m, \phi_n, \) known, the rest of the design parameters of the worm can be calculated using known formulae [1], [4].

Having calculated the design parameters of a helical rack, the corresponding design parameters of a helical gear with a given tooth number, \( N_x \), can be calculated as well. Standard equations [1], [4], are used for the calculation of the design parameters of a helical gear.

Compare the design parameters of the worm of the proposed design (see Figure 6) with that shown in Figure 2. The performed comparison reveals that, for a spur gear with a standard tooth profile, tooth thickness and space width in the worm of the proposed design are equal to one another (\( w_w = t_w \) measured on the pitch cylinders), while in the current worm design they are not (\( w_{f,w} > t_{o,w} \) measured on the bottom-land and outer cylinders correspondingly). The thicker threads in the worm depicted in Figure 6 are stronger, and — what is also of critical importance for highly-rotating worms — provide significantly better heat removal from the friction zone between the worm threads and the gear tooth flanks.

The discussed approach for the calculation of the design parameters of an involute worm for a right-angle mesh with an involute spur gear also was used in designing hobs for cutting spur and helical cluster gears [5], [6], [7], and others.

**CONCLUSION**

Orthogonal worm gear pairs may be designed so as to engage a spur gear in mesh with a mating involute worm under a right shaft angle in the worm gear pair. The same is also valid with respect to two-starts worm gear pairs. Axial thrust in the spur gear is eliminated under such a scenario. The involute worm gear may be mounted on cheaper bearings. No increase in design and production of a worm of such a design can be anticipated.

The designed involute worm can be approximated either by a corresponding Archimedean worm or by a corresponding convolute worm (that is, by a worm, straight generating lines of which are not tangent to the base cylinder, as no base cylinder can be constructed to a convolute worm).

Multiple-start worms can be designed using the disclosed approach.

The discussed approach is validated for designing hobs for hobbing spur and helical cluster gears.

**REFERENCES**


**ABOUT THE AUTHOR**

Stephen P. Radzevich, M.S., Ph.D., Dr. (Eng.) Sci., can be reached at 586-292-7209 or radzevich@usa.com.
GET CONNECTED

GearSolutions.com is your trusted online source for information and technical knowledge about the gear manufacturing industry, getting more than 42,000 page views each month.

GEAR Solutions

Get your FREE subscription, plus our online content, at www.gearsolutions.com
TAKING DEBURRING TO THE NEXT LEVEL

The TM 200-R3 CNC produces finished work pieces in under a minute.  
(Courtesy: Helios Gear Products)
Recent developments from Helios Gear Products increase the productivity of the company’s Tecnomacchine CNC gear deburring technology.

By Gear Solutions staff

Once a gear is created, deburring becomes a necessary step to ensure a gear’s accuracy. Traditionally, deburring has been done by hand, but that method can often take hours to complete.

But with CNC technology, deburring can be done faster and with much tighter tolerances than could ever be accomplished manually.

CNC machines are becoming a common fixture in both small job shops as well as large gear departments for major companies. Their speed and accuracy often can make the initial cost a worthy investment.

CNC UPGRADE

Helios Gear Products (formerly Koepfer America) has made great strides in the field of gear deburring by upgrading its Tecnomacchine model TM 200-R3.

Helios Gear Products, LLC specializes in the parallel axis gear industry and offers hobbing machines with optional automatic loading systems, worm and thread milling machines, gear-inspection equipment, deburring and chamfering machines, consumable tools (including hobs, gear grinding, and honing wheels), hob and shaper cutter sharpening machines, and expert services for hob sharpening and part inspection.

The TM 200-R3 CNC produces finished work pieces in under a minute. This productivity comes from the machine’s CNC workstations and flexible automatic loading and unloading system, and it offers gear manufacturers a long-term competitive deburring solution. The TM 200-R3 CNC provides an optimum balance between productivity and flexibility, which is perfect for job shops as well as gear manufacturing departments with a complex variety of parts.

COMPLETE DEBURRING, BRUSHING STATIONS

This recent design iteration of the TM 200-R3 offers complete CNC deburring and brushing stations with the ability to save all parameters within each part program. Each of the machine’s four stations use CNC for vertical, tangential, radial, and inclination positions.

Like previous TM 200 models, this automated solution alleviates human error and increases gear deburring productivity by removing the need for repeated setups. This machine is ideal for job shops and other gear manufacturing facilities for the machine’s ability to process diverse part types and sizes. The machine’s base configuration allows part diameters up to 200 mm (7.9 inches), but alternative configurations allow for parts up to 300 mm (11.8 inches) and larger diameters.

USER-FRIENDLY PROGRAMMING

For the TM 200-R3’s processes, a TexComputer control panel is integrated directly into the machine enclosure and offers user-friendly dialog programming. Users can store programs on a memory stick or USB drive to be saved for later use. This helps reduce set-up time. The TM 200-R3 also is equipped with an RJ45 port for cost-effective remote assistance with Helios Gear Products or Tecnomacchine service personnel.

The TM 200-R3 CNC deburring machine has five workstations:

- Loading/unloading station.
- Deburring top station.
- Deburring bottom station.
- Brushing top station.
- Brushing bottom station.

Workers involved with setup can easily adjust all tools for position, orientation, pressure, and speed up to 30,000 rpm. Each of these CNC settings is programmable and can be saved within the part program.

These stations can be equipped with milling tools, cutoff wheels, and brushes depending on the operation, and all stations work simultaneously for highly productive deburring; moreover, each station can be individually turned off, allowing the option of having only one station running.

Workers involved with setup can easily adjust all tools for position, orientation, pressure, and speed up to 30,000 rpm. Each of these CNC settings is programmable and can be saved within the part program. The stations are programmed via the control panel and are equipped with electric high-frequency tools or a silicon-coated nylon brush for the brushing stations.
The TM 200-R3 CNC provides an optimum balance between productivity and flexibility, which is perfect for job shops as well as gear manufacturing departments with a complex variety of part. (Courtesy: Helios Gear Products)

The TM 200-R3 also includes CNC radial tool wear compensation and uses flexible workholding solutions to accommodate a variety of part sizes and types.

10 CARRIAGE TOWERS
The loading table of the 2019 TM 200-R3 CNC has up to 10 total carriage towers that rotate past the loading/unloading station. The operator can load all but one of the carriage towers with raw parts to be deburred, and a pneumatic loader arm picks and places parts into the work area. The machine’s rotary table then transfers workpieces between stations allowing each part to be deburred and brushed before returning to the loading/unloading station. The placement and removal of the parts to and from the carriage towers occurs while the machine is brushing or deburring other parts. This process has the added benefit of saving even more operation time, which in turn, increases productivity.

The TM 200-R3 CNC machine’s SPC (statistical process control) station offers another advantage. This allows the operator to conduct quality control on a part without stopping the machine’s part-to-part cycling. The SPC station also allows operators to manually load/unload single workpieces safely and efficiently.

MORE INFO
heliosgearproducts.com

The TM 200-R3 CNC provides an optimum balance between productivity and flexibility, which is perfect for job shops as well as gear manufacturing departments with a complex variety of part. (Courtesy: Helios Gear Products)
Introducing our new

**SW PLUS + Series**

12% – 22% MORE STORAGE

STOR-LOC MODULAR
DRAWER SYSTEM
880 N. Washington Ave. Kankakee, IL 60901
Toll Free: 1.800.786.7562 • Fax: 1.800.315.8769
email: sales@storloc.com

www.storloc.com
‘ANY MAKE, ANY MODEL, ANYTIME, ANYWHERE’

Atlanta Gear Works is committed to doing whatever it takes. Any make. Any model. Anywhere. Anytime.
(Courtesy: Atlanta Gear Works)
Atlanta Gear Works designs, engineers, builds, rebuilds, and repairs heavy industrial gearboxes for some of America’s leading manufacturers with one main goal — to minimize or prevent downtime.

By KENNETH CARTER, Gear Solutions editor

Atlanta Gear Works set out in the beginning to do one thing and do it well: gearbox repair.

But when the quality of the available components needed for their repairs wasn’t up to the company’s standards, Atlanta Gear Works decided to expand.

“Originally, we just wanted to do gearbox repairs,” said Jack Conway, president of Atlanta Gear Works. “We didn't intend to actually manufacture anything. But we kept finding it harder and harder to find qualified gear suppliers that would deliver exactly what we wanted when we needed it. So, we wound up doing some machining, and then we added gearing and gear grinding. Today, we continue to add services to better serve our customers.”

That desire for the best quality continues to drive Atlanta Gear Works.

CUSTOM PIECES

“We repair process-critical gearboxes for large industrial companies,” Conway said. “We service customers that have a requirement for very high quality, and these are the customers that we can serve best. We also manufacture gearing. Even there, in gearing, we look for customers that demand very high quality in gears.”

Those gears are typically low-volume, custom-designed pieces, according to Conway.

“We can make a gear from a sample or a customer-supplied print or design it from scratch to solve a particular problem,” he said. “We have a very skilled engineering department that enables us to reverse engineer every part we touch, basically.”

In addition to gear manufacturing and gearbox repair, Atlanta Gear Works also does field services and field machining, which means in-place gearbox rebuilds, replacement, inspections, and in-place machining, according to Craig Massa, vice president of sales for Atlanta Gear Works.

“We solve our customers’ problems,” he said. “It doesn’t matter what that problem is. In gearboxes, it’s about delivering a high-quality product that’s been engineered and assembled correctly every time. We document all of our processes; we measure everything that we do. We do that so we can deliver a product to a customer that’s reliable, and they know it’s going to work when they put it in.”

Atlanta Gear Works achieves this by investing in its people, plant, and processes, according to Conway, investing in state-of-the-art equipment and ongoing training for everyone.

“We do whatever it takes to keep our customers up and running,” he said. “We’re continually investing to add services so that we can bring the manufacturing in-house, where we have control over it and can maintain the quality level.”

TACKLING CHALLENGES

It’s a process that Atlanta Gear Works takes seriously, especially when a customer approaches the company with a challenge.

“We usually get the problem-child gearbox — the one that they’ve had continuous failures on,” Massa said. “Our process is there’s no charge for us to go through a gearbox. If a customer sends it to us, we completely disassemble, inspect it, and develop a thorough inspection report and a failure analysis where we can pinpoint the problem. Then we do a detailed engineering review of the system or the process. We present the scope of what we find, any upgrades or modifications that we would recommend to improve the reliability of the gearbox — or the gear if it’s just the gear that we’re manufacturing. Then, from there, we execute what we quoted.”

That process involves making recommendations to the customer about what caused the failure, along with any recommended upgrades to make the gearbox more reliable, according to Massa. But it doesn’t stop there. Atlanta Gear Works will find out the complete history of the gearbox, which includes past failure modes. After that, the company develops a detailed engineering drawing of all the components. The staff engineers will then vet it before the needed parts are produced.

“One of the things that sets us apart from other gear companies is we can work on any gearbox — any make, any model, anytime, anywhere,” Conway said. “We’ll do it here, or we’ll do it at your plant. We’ll do what it takes to get our customer back up and running.”

THOROUGH INSPECTIONS

With gearboxes in need of repair coming from a variety of sources, Massa said Atlanta Gear Works makes sure the equipment gets a thorough inspection.

“One thing that we tell our technicians is that we don’t know who’s rebuilt the gearbox before,” he said. “It may have been an OEM, or it could’ve been another repair shop. But we certainly don’t want to repeat anyone’s mistakes. That’s why we go over it with a fine-
tooth comb and do the detailed engineering review. Anything that
doesn’t look right probably isn’t right.”

Not only can Atlanta Gear Works get any job done, but it also has
the ability to react quickly to a customer’s needs, especially if it’s
an emergency situation, according to Carol Niemi, PR/marketing
consultant for Atlanta Gear Works.

“When they send a field services team out to a customer’s site,
every one of them brings a packed backpack and is prepared to stay
there till the job is done — even for days on end,” she said. “They can
turn a job around a lot faster because they have that kind of team
in the field.”

FLEXIBILITY IS KEY
That unknown quantity when dealing with a customer’s problem is
what makes Atlanta Gear Works’ flexibility so important, according
to Conway.

“We don’t know what we’re going to find when somebody’s in the
middle of a breakdown,” he said. “When our crews go out to a cus-
tomer’s plant, we’ll do the initial evaluation to help diagnose the
situation, consult with the plant, and give them our assessment of
what we think should happen. Once we agree on a plan, we might
bring in additional crews to work around the clock there as well as
around the clock here at our facility to manufacture the parts they
need to get back up and running.”

That includes having field-service trucks that are fully staffed
and stocked with equipment that can react at a moment’s notice,
according to Conway.

“Most times, service calls are planned, but it’s not unusual to get
a call on a Friday night about 6 o’clock that a plant’s down or needs
something quickly,” Massa said.

But Massa said even planned service calls can sometimes morph
into much more.

“We had one not too long ago with a big steel company where our
guys walked in with planned scope of work to replace some high
speed pinion bearings,” he said. “The job was supposed to be just
one day, but after our crew started the job, we found several more
problems that needed to be addressed. The job ended up lasting
seven days, around the clock, including manufacturing new gears
and repairing several shafts. The parts came back here to be reverse
engineered and remade, and we sent our field machining crew to
re-machine the housing in place.”

But even with the expanded work time, Massa said the mill didn’t
lose any downtime, and Atlanta Gear Works prevented an even big
ger problem from striking in the future.
ADVANCING WITH THE INDUSTRY

As the gear industry has advanced, Atlanta Gear Works has strived to advance along with it, according to Conway.

“We’ve added gear grinding to our product offering,” he said. “We just put in some CNC gear-cutting equipment. All of the investment has just allowed us to produce a better-quality part in a shorter amount of time. That’s what our customers want.”

And Conway said he expects his company’s expertise to continue to be a needed commodity in the gear world.

“We’ll always have a place as a repair and rebuild facility,” he said. “The manufacturing equipment we’re using today is much different than what it will be in the future. The innovation in new machinery is fascinating, but if you can’t engineer the gear, you’re still not going to be able to produce one that will meet the customers’ needs.”

Obviously, Conway sees engineering as one of the keys to Atlanta Gear Works’ continued success.

“Our engineering team is led by Chris Dale,” he said. “They do an amazing job because he insists that everyone on his team knows how to perform repairs and manufacture parts. They also continue to go to classes, and we invest in training software, whether it’s an auto CAD program, a CAM program in the shop, or a design program for gearing. We have to stay on top of what’s happening in the industry in order to be relevant and to continue to serve our customers.”

MORE INFO
atlantagear.com
Hardinge introduces new Bridgeport V1320 milling solutions

Hardinge Inc., the leading international provider of advanced metal-cutting tool solutions and accessories, introduces the Bridgeport® V1320 vertical machining center. As an addition to its Bridgeport V-series vertical milling center line, the new V1320 is the best overall working cube in its class, offering a high-quality, rugged, and powerful machine center developed for tough machining applications that is well suited for high-speed and hard metal cutting conditions.

The V1320 is a state-of-the-art advanced performance CNC machining center at the top of the Hardinge milling product line, said Michael Marshall, Hardinge’s global milling product manager. “Our machine centers provide not only highly accurate and precision detailed parts in the aerospace and medical industries but also the robustness to handle the demanding day to day operations in the automotive industry.”

The new machine is a fully digital, high-quality machine tool, designed to achieve maximum capacity and performance in the job shop, OEM, aerospace, automotive, energy, and other demanding markets.

V1320 features include:

- Dual Y-axis ballscrews for improved surface quality and roundness accuracy, acceleration, reduced vibration, and increased tool life.

- Easy and intuitive to use with new touch screen control: Equipped with a 15” Mitsubishi M80 Color LCD touch screen, users can intuitively control the machine. Pinch to zoom in and out, scroll through screens, move pop-up windows on the screen, or drag with a single finger. The M80 also will come standard with two 32 Gb SD card slots for memory expansion, USB program running, high accuracy modes, and super smooth surface software.

- Provides superior machine accuracy and repeatability with dual ballscrews: The V1320 comes complete with oversized high-class 45mm double nut Ballscrews, fixed and pre-tensioned and large 45mm linear high-quality linear guideways supported by six trucks on the X and Z axis., with dual 40 mm ballscrews on Y axis.

- Confident cutting with a powerful spindle motors: The new V1320 has a Big Plus, 40 taper, 12,000-rpm Direct Drive spindle powered by a dual-wound Mitsubishi spindle motor. Quad set of 70mm angular contact bearings and a 60mm rear taper roller bearing provide superior thermal stability, significant radial and axial stiffness and high accuracy as well as 900 kgf tool retention for aggressive cutting applications.

MORE INFO www.hardinge.com

Hainbuch Maxxos T211 with hexagonal pyramid shape can cut costs

The Hainbuch Mandrel Maxxos is a powerfully strong mandrel with hexagonal pyramid shape instead of a round taper, designed with stringent manufacturing requirements and process reliability in mind. Hainbuch has acted in response to demand from specific areas that has been growing year by year. Users are requesting mandrels that deliver higher performance as well as process reliability. The result is called Maxxos. It exceeds even the specified customer requirements and, more than this, offers all the advantages of a hexagonal clamping mechanism. The segmented clamping bushing with hexagon inside shape fits perfectly onto the clamping pyramid and enables maximum cutting performance. The lubrication, combined with its tightness ensures a very constant production flow and as a result, achieves maximum reliability. Customers who value process reliability and maximum torque transmission will be impressed with the Maxxos T211.

Thanks to the hexagonal pyramid clamp, maximum torque transmission can...
be achieved, up to 155 percent more transmissible torque and up to 57 percent higher bending stiffness compared to the classic Mando T211 mandrel. This makes it possible to achieve higher process parameters and consequently improve the yield of finished parts. Greater process reliability is facilitated by the spacious layout between the clamping bushing and the clamping pyramid. Even during the clamping process, this design prevents virtually any dirt getting onto the surfaces. This significantly cuts down the frequency of maintenance times for cleaning and lubrication. Overall, the mandrel has a clamping diameter range of 18 to 100 mm. The clamping areas of each size are designed to overlap. This has the advantage that users can choose from up to three mandrel sizes depending on the clamping diameter. The larger the mandrel is, the greater its stability and rigidity. Smaller mandrels may be able to handle more of the customer’s smaller workpieces. Users are free to choose the size they want, based on their own judgment and preferences. The aligned, segmented clamping bushings have a minimum concentricity of 0.01 mm and can even be supplied in a high precision version.

Key advantages:
- I.D. clamping mandrel for clamping diameters of 18 to 100 mm.
- Ideal for stringent manufacturing demands and process reliability.
- Unique rigidity due to spacious layout of the clamping segments.
- High transmissible torque and holding forces.
- Contamination resistant due to hexagonal pyramid shape.
- Concentricity < 0.01 mm also available in high precision version.

New machining kits, bushing plugs for Jergens mounting system

Jergens Inc. announces fixture plate machining kits and new receiver bushing plugs for its popular line of Ball Lock® mounting systems. The machining kits consist of one fixture plate, four extra-long Ball Lock shanks and four spacers that provide clearance between the fixture plate and sub-plate below. This open space allows cutting tools to ‘break through’ the fixture plate without damaging the subplate, making it possible to machine fixture plates while mounted to the same subplates they will be used with during production.

Another convenient development is the company’s new simple-to-install plugs that prevent chips and coolant from accumulating inside receiver bushings that are not in use (during certain operations). This saves time by eliminating the need to clean out receiver bushings in between setups. The receiver plugs are blue anodized aluminum, a durable construction for better resistance to hot chips when compared to plastic plugs. The flush mount design does not protrude above subplate surface making it easy to clean of and ensuring no interference in machining. These plugs are available in standard sizes to accommodate different hole openings, and come with an O-ring and tapped hole for easy installation.

Ecoclean offers solvent-based cleaning at high pressure

Increasing demands on cleanliness, in terms of freedom from both particulate and film-type contaminants, call for the use of adapted cleaning solutions. These now include a new spray cleaning system for solvent-based cleaning machines by Ecoclean. With this process option, spray processes and injection flood washing can be performed at adjustable pressures between 10 and 16 bar via two spraying bars. The additional cleaning capability delivers markedly improved cleaning results on geometrically complex parts and bulk-cleaned items.

Spray cleaning systems are already a feature on many solvent-based cleaning machines. However, their spraying pressure is commonly in the range of 2-3 bar. With
densely packed bulk items and geometrically complex workpieces exhibiting undercuts, threaded holes and blind holes – and, at times, parts obtained by additive manufacturing – that pressure will not suffice to achieve increased standards of cleanliness, i.e., an effective removal of film-type and/or particulate contaminants. This is because downstream processes such as coating, adhesive bonding, and heat-treatment require significantly cleaner surfaces today. Ecoclean GmbH has responded to this trend by developing a high-pressure spraying system for solvent-based cleaning machines. This system allows spraying processes and injection flood washing with hydrocarbons or modified alcohols to be conducted at 10-16 bar pressure.

For the high-pressure spray cleaning option, the cleaning machine – e.g., an EcoCore model – is equipped with a high-pressure pump and additional spraying bars in addition to any 2–3 bar spraying device that may already be fitted. One spraying bar is mounted on the interior wall of the work chamber. The second is placed centrally in the work chamber to provide both interior or exterior spraying, either simultaneously or in an alternating pattern. The spray pressure is adjusted via the high-pressure pump, which is controlled by variable-frequency drive. The number of nozzles and the product movement can be conveniently adapted to optimize the spraying process for a given part size and geometry. Moreover, this sophisticated and easy-to-handle technology supports the use of various nozzles matched to the specific application in terms of size and jet shape. The pressure, spray duration, spraying mode (simultaneous or alternating) and product movement can be defined in a part-specific cleaning program and stored in the machine controller.

For the interior and exterior spraying step, the parts — whether oriented or bulk — are positioned and secured in special carriers. With oriented parts the cleaning medium can thus be selectively directed at critical zones. Defined movements of the wash load carrier ensure that the spray jet will reach all areas. Throughout the process, contaminants become dislodged from the part surface by the spray jet’s mechanical energy. At the same time, the high fluid exchange rate causes dislodged foreign matter to be flushed away from these areas so that a markedly improved cleaning result is obtained.

The new high-pressure spray cleaning option for solvent-based cleaning machines such as the EcoCore allows spraying processes and injection flood washing to be performed at adjustable pressures of up to 16 bars. Markedly improved cleaning results are thus achieved with geometrically complex parts and bulk-cleaned items. (Courtesy: Ecoclean GmbH)
High-productivity 3D laser scanner comes to Hexagon’s Absolute Arm

Hexagon’s Manufacturing Intelligence division has launched the RS6 Laser Scanner, a cutting-edge 3D laser scanner for the new generation of Absolute Arm portable measuring arm systems that was launched in 2018. This new scanner offers extremely high-density point-cloud data collection at high speeds and high accuracy. The RS6 delivers unmatched productivity improvements over competing scanning solutions through the introduction of SHINE – an advanced set of algorithms that allows RS6 to measure at the highest quality and accuracy setting with no reduction in laser scan line width or scanning frame rate.

The RS6 Laser Scanner boasts a scan line that is 150 millimeters wide at mid-range, representing a greater than 30 percent increase in surface area covered by each scan movement compared to the previous generation Absolute Arm laser scanner. The scanner also measures faster than its predecessor, with a threefold increase in frame rate to 300 Hertz, meaning scanning can be performed three times faster with no loss of point-cloud detail.

“Often, the problem with high-performance laser scanners is that their advertised acquisition speeds seem incredible, yet when you measure with them in the real world, provisos and conditions mean that the performance isn’t actually that special,” said Anthony Vianna, product manager for Absolute Arm systems. “With the RS6, we’re providing a scanner that doesn’t leave the user disappointed in this way. Our new SHINE technology means that users can scan at full speed with the full laser width all of the time, on all parts.”

The SHINE technology means that the RS6 is both better and easier to use than other scanners. There’s no need to learn many complex combinations of settings depending on accuracy and surface-type requirements; with SHINE, the RS6 is permanently ready to scan any material at full accuracy with no reduction in frame rate, scan line width or data quality.

Just like the RSS5 Laser Scanner, the RS6 can be completely removed from the arm in just seconds to allow for easier handling when not in use. Thanks to its innovative repeatable mounting system, it can then be remounted just as quickly and with no need for recalibration when scanning functionality is again required. The RS6 also boasts a unique laser targeting grid designed to simplify measurement alignment. “This is an exciting launch because we’re taking the scanning performance of the Absolute Arm 7-Axis to another level without compromising usability,” said Stephan Amann, business director for the Absolute Arm range. “What we wanted is to provide a scanner that allows any user to walk up and measure, without worrying about settings. We want the data quality to be excellent, regardless of how experienced the user is.”

The RS6 Laser Scanner is available to order, with the first units shipping in August 2019.
Our ISO 17025 A2LA Laboratory is available to certify or recertify your Master Gears and Spline Gauges or Contract Inspection of your gears. Our rapid turnaround service minimizes the “out of service” time.

WE’RE CERTIFIABLE

Koro Sharpening Service
Quick Turnaround 2 Day Service
Spur Shaper Cutter Sharpening
HSS & Carbide Hob with center hole and straight flutes
Thin Film Coatings
Length up to 7 inches

WE OFFER:

- Diameter up to 5 Inches
- Precise rake and spacing guaranteed to AGMA standards
- RUSH SERVICE AVAILABLE
Koro Sharpening Service
9530 85th Ave North
Maple Grove, MN 55369
763-425-5247
info@koroind.com

PENTA GEAR METROLOGY
a brand of KAPP NILES
6161 Webster Street, Dayton, Ohio 45414
937-660-8182 sales@pentagear.com
www.gearinspection.com

Custom Manufactured GEAR RACKS & GEARS

THINK OUTSIDE THE BOX

REACH MORE CUSTOMERS
Advertise with us in print and online, and you can reach over 45,000 potential readers – many who are key decision makers at their companies.

To learn more, contact assistant publisher Chad Morrison at chad@gearsolutions.com or call 800.366.2185 ext. 202
CONTENTS PAGE NO.

AGMA (American Gear Manufacturers Association) ........................................ IBC
ALD Thermal Treatment Inc ................................................................. 52
American Precision Gear Co ................................................................. 10
Circle Gear & Machine Co Inc ............................................................. 16
Forest City Gear .............................................................................. IFC
Gleason ............................................................................................ 2
GMTA (German Machine Tools of America) ........................................... 39
High Gear Tools .................................................................................. 54
Innovative Rack & Gear ................................................................. 54
KAPP Technologies ........................................................................... 29
KISSsoft USA LLC ........................................................................... 11
Koro Sharpening Service ..................................................................... 54
McInnes Rolled Rings ......................................................................... 13
Mitsubishi Heavy Industries America Inc ........................................... BC
New England Gear ............................................................................... 7
Nordex ............................................................................................... 51
Penta Gear Metrology ......................................................................... 15, 54
Piselli Enterprises Inc .......................................................................... 49
Proto Manufacturing ........................................................................... 12
Russell Holbrook & Henderson Inc ................................................... 10
STD Precision Gear & Instrument Inc ................................................. 11
Stor-Loc ............................................................................................. 45, 54
The Broach Masters Inc .................................................................... 4
Toolink Engineering Inc ...................................................................... 1
United Tool Supply ............................................................................. 55

Gear Solutions magazine has been the most trusted source for information and technical knowledge in the gear manufacturing industry for more than 15 years.

Each issue, Gear Solutions offers its readers the latest, most valuable content available from companies, large and small, as well as critical thoughts on what this information means for the future of the gear manufacturing industry.

Best of all, it's free to you. All you need to do is subscribe.

SUBSCRIBE FOR FREE
www.gearsolutions.com
“This is a company with unique technology, and we are extremely customer focused.”

What’s a typical day like for you at Weiler?
I wished there was a typical day — no such thing really. Our team does a lot of collaborating. We have four or five people in the field on any given day, and they are calling on four or five different customers, so there always seems to be an interesting new challenge to tackle. A day does not go by where I don’t speak to one of our field team members about a specific customer problem or interesting issue and work with that team member to find the best solution for customer.

I also do a lot of coordinating with our factory in Europe. I try to help make sure that we are focusing on the right things and doing what we need to in order to be a market leader in terms of quality, service, and delivery.

What is Weiler doing to provide its customers with increased engineering support?
We have a formal program called Weiler Process Solutions (WPS), which focuses on working directly with end users and understanding how we can bring value to their unique applications. At a basic level, we examine what they are doing and work to understand their challenges. We document their entire process to make sure that we are properly leveraging our technology and expertise to help solve their unique manufacturing challenges.

By understanding their full manufacturing processes, we can help solve many different types of problems relating to quality, delivery, and consumable spend. The WPS tools help us clearly define our customers’ manufacturing challenges and document the cost savings and productivity gains our products help achieve.

We have four application experts placed throughout the country, but no one has a specific geography per se. If a particular team member has an expertise that is suitable for a specific customer’s challenge, we will get them on an airplane to support that customer. We make sure the appropriate technical team member is available to work with our customers and solve their manufacturing challenges.

What has Weiler been developing that will aid in gear manufacturing?
The Global Weiler team has recently developed a new bond technology for gear grinding that we are calling the V59 bond. I like to think of the bond as the foundation of the grinding wheel as it represents roughly half of the grinding wheel, and it is what holds everything together. Our new bond is extremely strong. This strength allows us to produce grinding wheels that are safer and stronger than other vitrified bonds in the market. Weiler V59 bond gear grinding wheels will be rated for very high speeds, up to 80 meters per second and occasionally higher for specific applications. The increased strength of our V59 bond also allows us to make very high porosity wheels. This porosity allows for greater chip clearance and penetration of coolant into the grind zone, which results in higher metal removal rates as well as shorter cycle times. Additionally, customers will experience a cooler cutting grinding wheel that holds form better; this will reduce our customers’ dressing consumable cost and again reduce overall cycle time.

There are a myriad of mechanical and thermodynamic advantages in being able to produce grinding wheels with very open structures. We can pair our V59 bond technology with advanced aluminum oxide technologies and have an aluminum oxide wheel that is far more capable of metal-removal rate and form holding — something not previously available to the marketplace.

We also have developed a unique ceramic grain technology. When we pair these grains with our new V59 bond, we’re able to produce the highest performing wheels in the world and, in-turn, offer gear manufacturers significant improvements in their grinding applications.

What does Weiler hope to gain from its recent AGMA membership?
We joined AGMA because it is an opportunity for us to learn. We are committed to being the market leader in the gear grinding and deburring markets. So, for Weiler to be part of AGMA, that means we can learn from and partner with the most innovative gear companies in the world.

The organization is known for being on the cutting edge. They are the people who come up with the standards that set the tone for the industry, and being a member will allow us to network and collaborate with some of the best companies in the world.

We are a company with unique technology, and we are extremely customer focused. AGMA will give us a chance to collaborate and stay out in front of the technology that is being developed, while giving AGMA a partner in grinding and deburring.

Also, by joining the AGMA, we have the opportunity to be a part of AGMA’s technical committees. We intend for some of our team to join one of the technical committees and contribute their expertise. I think it is an excellent opportunity and an excellent fit for the Weiler Abrasives.

What should attendees expect when they stop by your booth at the Motion + Power Technology Expo in October?
We will have our new V59 bond technology on display, and we will be displaying our full gear-grinding offerings in terms of geometry, shape, and size. We will also be introducing attendees to our deburring technology, including our wire-brush technology and our Nylox brush technology.

Our booth will be staffed by our technical experts, so attendees can have an immediate discussion about some of their technical challenges, and hopefully we can solve them right there on the floor.

weilerabrasives.com
Shop and compare the full range of power transmission solutions utilizing mechanical power transmission, pneumatics, hydraulics, electric motors, and drives.

250+ exhibiting companies

50 first-time exhibitors showcasing unique solutions

FLUID POWER PAVILION — your destination to learn if hydraulics and pneumatics could improve your project.

EMERGING TECHNOLOGY PAVILION — provides a look at new, cutting-edge technology that is coming into the manufacturing space.

To search a complete list of exhibitors by name or product category, visit MotionPowerExpo.com
The Mitsubishi ZE26C Gear Grinding Machine: Precision Gears for Precision Systems

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

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

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